

School of Life Science & Technology

ACADEMIC HAND BOOK



**Ordinance & Academic
Regulations**
BACHELOR OF SCIENCE IN CBZ (BIOLOGY)
(Academic Session 2024-25)

1. **Preamble:**

The new curriculum of B.Sc. in Science (CBZ) offer deep knowledge with required technical skills which are essential to study the plants in a holistic manner. The trained students in all areas of plant biology would have the unique combination of core, elective and vocational papers along with significant inter-disciplinary components.

Skilled student would learn cutting-edge technologies used in the study of evolution, life cycle of plants and their and interactions with other organisms found/present in the ecosystem. This will enrich the knowledge of a candidate so that he/she may aware with the social and environmental importance of plants and their connection to the national economy.

B.Sc. CBZ program covers academic activities within the classroom sessions along with practical concepts at laboratory sessions. Infield, outstation activities and projects are also required to be organized for real-life experience and learning.

Candidates who have curiosity in plants kingdom, ecosystem, love exploring exotic places and wish to work as researchers or professions like Botanist, Conservationist, Ecologist, etc. can choose B.Sc. CBZ course.

2. **Definitions and Nomenclatures:**

1. “Programme” means Degree Programme like B.Sc. CBZ (Biology)
2. “Course” means a theory or practical subject that is normally studied in a semester.
3. “Vice-Chancellor of IIMT-University” means the Head of the University.
4. “Registrar” is the Head of all Academic and General Administration of the University.
5. “Dean” is the authority of the school, responsible for all academic activities of all the programmes running under the school and implementation of all the rules of these Regulations pertaining to the Academic Programmes.
6. “Controller of Examinations” is that authority of the University responsible for all activities of the University Examinations like conduction of the Examinations, publication of results, award of grade sheets and degrees etc.
7. “Dean – Student Welfare” is responsible for all student related activities including student discipline, extra and co-curricular activities, attendance and meetings with class representatives, Student Council, and parent-teacher meet.
8. “HoD” means the Head of the Department concerned.
9. “University” means IIMT-University, Meerut.
10. “TCH” means Total Contact Hours-refers to the teaching-learning periods.
11. “DEC” means Department Exam Committee.
12. “BoS” means Board of Studies.
13. “ACM” means Academic Council Meeting the highest authoritative body for approval for all Academic Policies.
14. “Class Co-ordinator” is a faculty of the class who takes care of the attendance, academic performance, and the general conduct of the students of that class.
15. “IA” is Internal Assessment which is assessed for every student for every course during the semester.
16. “ESE” is End Semester Examination conducted by the University at the End of the Semester for all the courses of that semester.
17. “UGC” means University Grants Commission.
18. “MHRD” means Ministry of Human Resource Development, Govt. of India.
19. “AICTE” means All India Council of Technical Education. 20. “HEI” means Higher Education Institutions.

3. Vision and Mission of the School:

Vision: To become the finest institution and to create social, economic and intellectual well-being of the students through discovery, learning and innovations.

Mission: To fulfill the educational needs of students through imparting value based knowledge and innovative skills in an unbiased manner to meet greater challenges involving food, farming, fiber, feed, families, health, energy water and environment.

4. Program Educational Objectives:

Transformed curriculum will develop educated outcome-oriented candidature, fostered with discovery-learning, equipped with practice & skills to deal practical hurdles with current pedagogical trends in e-learning based education, flipped class and hybrid learning to develop into responsible citizen who can give his/her maximum towards the nation and may help in the transformation of the country so that the upcoming generations may be benefitted with their knowledge obtained in the field of plant science. After the completion of the program, a candidate will find him/herself in the following field of education-

After the completion of Certificate,

- A. A candidate may establish himself in the field of basic Microbiology Laboratory. He may explore the diversity of microbes like viruses, bacteria, algae, Fungi etc. and may establish himself as Plant pathologist by identifying the symptoms.
- B. He may explore the diversity of Archegoniates like Bryophytes, Pteridophytes, Gymnosperms.

After the completion of Diploma, along with the PEOs of Certificate, he may-

- A. Find himself suitable for the identification of plants on the basis of morphological characters by using the plant identification keys. He may explore the vegetation of different areas as taxonomist. He may also set the Museum and herbarium collection.
- B. He will be able to consume the different parts of the plants according to their economic and medicinal values. He may establish himself in the field of Pharmacognosy industries also.

After the completion of Bachelor Degree, along with the PEOs of Certificate and Diploma-

- A. A Candidate may establish Plant Tissue culture lab as plant physiology is a very important part of PTC.
- B. With the overall knowledge of the program, he may develop saplings of rarely available plants or economically important plants as most of the ayurvedic medicinal companies are based on plants parts.

5. Program outcome:

PO1: CBCS syllabus with a combination of general and specialized education shall introduce the concept so breadth and depth in learning.

PO2: Shall produce competent plant biologists, zoologist and chemists who can employ and apply their knowledge gained after studying this program in basic and applied aspects that will profoundly influence the prevailing pattern of industry, agriculture, environment and health care to provide sustainable development.

PO3: Will increase the ability of critical thinking, development of scientific attitude, handling of

problems and generating solution, improve practical skills, enhance communication skill, social inter action and increase awareness injudicious use of plant resources by recognizing the ethical value system.

- PO4:** The training provided to the students will make them competent enough for doing jobs in Govt. and private sector so academia, research and industry along with graduate preparation For national as well as international competitive examinations, especially UGC-CSIRNET, UPSC Civil Services Examination, IFS, NSC,FCI, BSI, FRI etc.
- PO5:** Certificate and diploma courses are framed to generate self-entrepreneurship and self-employ ability, if multi exit option is opted.
- PO6:** By drawing attention towards the knowledge of world-wide plants and their domestication, lifelong learning may be achieved.

6. Program Specific outcome:

B.Sc. I Year/Certificate course in Microbial Technology & Classical Botany

This Programme enriches the candidature through teaching, interactions and practical knowledge on diverse fields of plant biology. By maintaining a balance between the traditional botany and modern science a student may shift himself towards the frontier and advanced areas of plant sciences with applied approach. The aim of the syllabi is to enable the learners to prepare them for self-entrepreneurship and employment in various fields including academics as well as competitive exams. Students would gain wide knowledge in following aspects:

1. Diversity of plants and micro best heir habitat, morphology, architecture and re production.
2. Plant disease auingmicrobes, symptoms & control.
3. Economic value of plants and their use in Human Welfare.

B.Sc. II Year (Diploma in Plant Identification, Utilization & Ethno medicine)

This course provides a broad understanding of identifying, growing and using plants. This course is primarily aimed to introduce people to the richness of plant diversity found in surrounding areas. Lecture sessions are designed to cover fundamental topics concerning classification of plants and their utilization required for understanding the flora and vegetation. Practical sessions are organized following theory for easy understanding of the various parts of the plants, structural organization of floral parts and diversity therein. Participants are taken to different locations covering a variety of habitats and forest types to acquaint them with the native flora in the long run, will contribute towards building momentum for people's participation in environmental conservation without compromise in gon academic rigour and our rich wealth of knowledge inherited over generations.

1. The course will cover conventional topics in Field Botany like Evolutionary History & Diversity of Plants, Complete Morphology, Nomenclature of plants, Systems of Classification, Keys to Important Families of Flowering Plants, Field Data Collection & Herbarium Techniques.

2. The course is designed to become a commercial crop grower, florist and protected cultivator, green belt plant advisor to industries, pharmacologist & taxonomist.

B.Sc. III Year /Bachelor of Science in CBZ

The learning outcomes of three years graduation course are aligned with program learning outcomes but these are specific to-specific courses offered in a program. The core courses shall be the back bone of this framework whereas discipline electives, generic electives and skill enhancement courses would add academic excellence in the subject to gether with multi-dimensional and multi-disciplinary approach.

1. Understanding of plant classification systematic, evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics and molecular biology of various life-forms.
2. This course is suitable to produce expertise in conservation biology like ex-situ conservation, response to habitat change, genotype characterization and reproductive biology.
3. Understanding of various analytical techniques of plant sciences, use of plants as industrial resources or as human livelihood support system and is well versed with the use of transgenic technologies for basic and applied research in plants.
4. Understanding of various life forms of plants, morphology, anatomy, reproduction, genetics, microbiology, molecular biology, recombinant DNA technology, transgenic technology and use of bioinformatics' tools and databases and the application of statistics to biological data.
5. Entrepreneurship Skill Development, Understand the issues of environmental contexts and sustain able development, Incultation of human values,
6. Strengthen mathematical and computational skills. Enable students to use ICT & AI effectively.
7. Develop good skills in laboratory such as observation and evaluation by the use of modern tools and technology.

PSO1: Understanding the nature and basic concepts of all the plant groups, their metabolism, components at the molecular level, biochemistry, taxonomy and ecology.

The course will make the aware of natural resources and environment and the importance of conserving it. Hands on training in various fields will develop practical skills, handling of equipment's and laboratory use along with collection and interpretation of biological materials and data. Knowledge gained through theoretical and lab-based experiments will generate technical personnel in various priority areas such as genetics, cell and molecular biology, plant systematic and biotechnology.

PSO2: Botanists are able to contribute to all these fields and therefore, are mainly employed with educational institutions, government or public sectors or companies in industries, such as agriculture or forestry, oil, chemical, biotechnology, geological survey, environmental

protection, drugs, genitures each, planter sources laboratories, plant health inspection services, lumber and paper, food, fermentation, nursery, fruit and so on. Jobs available as a botanist: •Microbiologist, plant pathologist, Taxonomist •Plant Physiologist •Plant Biochemist •Researcher •Mycologist •Ecologist •Weed Scientist •Palaeobotanist •Conservationist •Fruit Grower •Morphologist •Cytologist •Ethno botanist •Plant geneticists etc.

PSO3: Inculcate strong fundamentals on modern and classical aspects of Botany, underst and knowledge of Botany is an essential pre-requisite for the pursuit of many applied sciences. It will facilitate students for taking up and shaping a successful career in Botany and allied sciences.

PSO4: Introduction of research project wills inculcators' each aptitude and passion for higher education and scientific research.

8. **Admission:** The admission policy and procedure shall be decide dromtime to time by the board of Studies (BOS) of the University based on the guidelines issued by the UGC/NEP and Ministry of Education (MoE), Government of India. Seats are also made for Non-Resident Indians and foreign nationals, who satisfy the admission eligibility norms of the University. The number of seats shall be in accordance with the directives by the university.

9. **Eligibility in all year as NEP (entry & exit) as per NEHQF and NSQF (if applicable):**
A Candidate must have 10+2 PCB or any Biology/ Life Science stream with at least 40% Marks from a recognized Board shall be eligible for admission to the course. The admission to the course will be on the basis of the merit and according to the guidelines from the university and Government of Uttar Pradesh.

After the term-end examination at the end of each semester, the student will be provisionally admitted to the next semester.

Each semester will be followed by a break not exceeding 15 days.

As per NEP 2020, a student can complete the program in three steps. After the completion of II Semester (two Semesters), he/ she may get the certificate, IV Semester (four semesters), Diploma and VI semester (Six Semesters), Degree respectively. (Refer table 8.1)

Table: 8.1

Year	Semester	Certificate/ Diploma/ Degree Name
First Year	I	Certificate Course in Microbial Technology & Applied Botany
	II	
Second Year	III	Diploma in Plant Identification, Utilization & Ethno medicine
	IV	
Third Year	V	Bachelor of Science CBZ (Biology)
	VI	

10. **Curriculum:**

For the purpose of awarding degrees, the curriculum for B.Sc. CBZ (Biology) program is structured to have a minimum of credits + NCC (Non-credit Audit Courses) as specified in the evaluation scheme approved by the university's Board of Studies and spread out across six semesters of study.

Under CBCS, the degree program will consist of the following categories of courses:

1. Core Courses : CC
2. Ability Enhancement Courses: AECC
3. Generic Elective Courses : GEC
4. Skill Enhancement Courses : SEC

- NPTEL courses are added as per program under Skill Enhancement Courses.
- NCC is added in each semester as per availability of seats
- Sport is integrated in the curriculum as a non-credit compulsory course.
- Generic Elective Courses are also added in the curriculum.

11. **Medium of Instruction:**

The medium of instruction is ENGLISH for all courses, examinations, seminar presentations and project reports.

12. **Choice base Credit system (CBCS)/LOCF/OBE:**

The Course curriculum would be as per CBCS & NEP 2020.

The course of study shall contain the subjects of Core Courses, Ability Enhancement courses, Generic Elective Courses and Skill Enhancement Courses. The marks shall be awarded to the candidates pursuing the programme for the written papers, mini/major project report/industrial visits/ Excursion Trips/ presentation /viva-voce examinations, if any as specified in the scheme of Examinations.

13. **Registration for course in a semester:**

In the beginning of the semester the candidate will choose the subjects of his choice and will register for the current semester within the three days of commencement of the session.

14. **Attendance:**

The faculty handling a course must finalize the attendance, 3 calendar days before the last instructional day of the course and submit to the HoD through the class teacher.

A regular student shall not be permitted to appear in semester examination, unless he/she has regularly attended not less than 75% classes held in aggregate of all subjects. The university however may, condone the short age in attendance upto 10% in each subject for any of the following reasons.

- **Condonation of medical cases**

For medical cases, submission of complete medical history and records with prior information from the parent / guardian to Dean (Students Welfare) is mandatory. The assessment of such cases will be done by the attendance sub – committee on the merit of the case and put-up recommendations to the Vice-Chancellor. Such condonation is permitted only twice for a student in the entire duration of the program.

The Vice-Chancellor, based on the recommendation of the attendance sub - committee may then give condonation of attendance, only if the Vice-Chancellor deems it fit and deserving. But in any case, the condonation can not exceed 10%.

- **Additional Condonation:**

Additional condonation may be considered in rare and genuine cases which includes, approved leave for attending select NCC / Sports Camps, cases requiring prolonged medical treatment and critical illness involving hospitalization. For such select NCC/Sports Camps prior

permission for leave shall be obtained by the respective faculty coordinator / Director of sports from the designated authority, before reporting the students.

15. Assessment procedure:

Each Core paper shall be of 100 marks, out of which internal and external assessments will carry 25 marks and 75 marks respectively. While the Skill enhancement and Ability Enhancement Courses will be of 50 marks, out of which internal and external assessments will carry 15 marks and 35 marks for Ability Enhancement courses and Skill Enhancement Courses will carry only internal assessment based on the certificates and credits. University Social Responsibility Courses are merely qualifying courses. However, the awarded marks will not be included in the grand total.

• **Internal Assessment (IA)&External Assessment (EA):**

The Internal Assessment marks awarded to the students should be forwarded to the Controller of Examinations at least one week before the commencement of the semester examination. The internal assessment marks shall be base on factors such as marks secured in Sessional examinations, submission of written assignments, classroom participation and attendance. The weightage given to each of these factors for a paper shall be decided and announced at the beginning of the semester.

ASSESSMENT:

INTERNAL AND EXTERNAL ASSESSMENT FOR THEORY			
Internal Assessment	Marks	External Assessment	Marks
Sessional	16	End Semester Final Examination	75
Assignment	5	-	-
Attendance	4	-	-
Total	25		75

14.2 Practical Assessment

Internal Assessment (IA) and External Assessment (EA) are of 20 and 30 marks respectively. External Assessment will be done by the External Examiner appointed by the University outside of the university while Internal Assessment of 20 marks will be based on the laboratory work, Lab attendance, Viva Voce and lab behavior etc.

15. Research Project/Semester Project Assessment Criteria:

Students will have Industrial Training/ Research Project or Survey during the fifth and sixth semesters only. Internal Assessment and External Assessment would be of 25 and 75 marks respectively for the same. A Student can do Research Project under the guidance of any external faculty (outside of the university) with the prior permission of the Dean of the said School and also by maintain his/ her attendance.

Assessment of the project will be done by the presentation and Viva Voce in the front of an External Examiner appointed by the IIMT University. The student shall submit a Project Report (3 Copies) in the prescribed format issued by the University.

* **Note**—Novel Ideas shall be protected by IP Filing (Patent/Design/Copyright).

16. Internship – Research / Industrial Internship:

A student may do the Internship during the summer and winter break.

17. For non – credit courses / audit courses:

The University has provided USR (University Social Responsibility Course) and Sports as a Non- Credit / Audit Courses.

18. Credit weightage:

Credits are the weightages, assigned to the courses based on the following general pattern:

For theory One Hour = 1 credit

For Lab Two Hours = 1 credit

To get a certificate course in Microbial Technology and Applied Botany, a candidate has to qualify minimum 48 Credits as per NEP and the duration of certificate course is one year.

To get a Diploma in Plant Identification, Utilization and Ethno medicine, a candidate has to qualify minimum 96 Credits as per NEP and the duration of certificate course is two years.

To get Degree in Bachelor in Science CBZ (Biology) a candidate has to qualify minimum 120 Credits as per NEP and the duration of Degree course is Three years.

19. Maximum duration of the Program/promotion policy:

A student may complete the program at a slower pace than the regular pace, but in any case, in not more than N+2 years. A student completing the degree programs in the extended period will not be eligible for university ranking.

20. Maximum gaps between semester/year:

A student may be permitted by the Vice- Chancellor to withdraw from the entire programme for a maximum of two semesters for reasons of ill health, start – up venture or other valid reasons as recommended by a committee consisting of Head of Department, Dean of School, and Dean (Student Welfare).

21. Credit system & grading CGPA/SGPA:

IIMT-University implemented the UGC guidelines to all Universities in 2015 for implementation of the choice-based credit system with a view to offer students choice of courses within a program with a flexibility to complete the program by earning credits at a pace decided by the students themselves. The system allowed students to choose inter-disciplinary, intra-disciplinary courses according to their learning needs, interest and aptitude. It was considered as a cafeteria approach and was expected to provide mobility to students.

As per the Current credit system practiced in institutions needs comprehensive reforms as they offer very little flexibility, choice and are less learner centric. Degrees offered today are more self-contained focusing on a specialization area and depend a lot on knowledge available with the faculty from the department only. Though the most requisite credit system does exist, where in students are given a wide choice and flexibility, these exist as small islands in the vast ocean of thousands of educational institutes in India. In such institutions, the curriculum is frequently designed which is learner centric and offering a wide specialization area for students to pick and choose courses from. The institutions shall make attempts where in the design of the credit system and the teaching and evaluation modes shall be the responsibility of individual course teachers. The students should have the freedom to opt for courses from other specializations and not just from their core specialization. For this, there has to be stronger

collaborations between departments of the University and outside.
CGPA/ SGPA/ Grading will be done by the COE of the University.

22. Class / division:

The list of successful candidates after the six semesters examinations of **Bachelor of Science** course shall be arranged as under in two divisions on the basis of the aggregate marks obtained in all semester examinations taken together, and the division obtained by the candidate will be stated in his degree.

- (a) First Division those who obtain 60% or more of the aggregate marks.
- (b) Second Division those who obtain 50% or more but less than 60% of the aggregate marks.
- (c) Those who pass all semester reexaminations in the first attempt obtaining 75% or more marks in the aggregate shall be declared to have passed with **DISTINCTION**.
- (d) Each successful candidate shall receive a copy of detailed marks card on having passed the Semester Examination.

23. Transfer of credit /Academic Credit Bank:

23.1 Within the broad framework of these regulations, the Academic Council, based on the recommendation of the Credit Transfer Committee so constituted may permit students to transfer part of the credit earned nor the approved Universities of repute & status in the India or abroad.

23.2 The Academic Council may also approve admission of students who have completed a portion of course work in another approved Institute of repute under multiple entry & Exit system, based on the recommendation of the credit transfer committee on a case-to-case basis.

23.3 Students who have completed coursework, at least first year, at some university other than the university to which transfer is sought (may request for transfer of admission to this university. A student may be granted admission only through an admission process that will follow the same policy as for fresh admissions. However, a uniform credit system must be followed by all universities to effect transfer of credits.

23.4 Credit Transfer request can be submitted only after the student has been admitted in the concerned program and the following conditions are met:

- i. The course work has been completed at a UGC approved and accredited University through fulltime forms all earning mode.
- ii. The university accreditation grade/ranking is not lower than that of the university to which the transfer is ought.
- iii. The courses prescribe to the common minimum syllabus under UGC CBBCS system.
- iv. The letter grade obtained in the courses is “B” or better.

- v. The number of credits to be transfer redoes not exceed the prescribed limit.
- vi. The program in question must have a similar credit system, in particular, modular or semester and the same numeric and letter grading system along with common meaning of the term “credit” in numerical terms.

The aspect of shelf life of courses needs to be considered while accepting credits as obsolescence of knowledge of certain field in terms of its current relevance needs to be investigated. The time lapsed between successful completion of certain courses of the program and the admission to which program transfer sought needs to be considered. The maxim number of credit points that may be considered under a credit transfer needs to be specified. Contextual variables such as teaching-learning approach adopted, learning facilities offered, use of evaluation modes may also be considered while preparing the credit transfer policy.

24. Change of discipline:

Within 15 days of the commencement of the session and that too eligibility matches and seats are available.

25. Use of technological intervention:

With the pro-life ration of different types of access devices, especially mobile access devices, technology has the potential to augment traditional class room practices and revolutionize learning and evaluation methods. Technology, in fact can be an important driver to enable lifelong learning. Learning and engagement of students is facilitated by use of technology through several modes such as synchronous learning, semi-synchronous learning, blended learning, collaborative learning, flipped classroom etc. MOOC's, especially provided through SWAYAM, are a window of opportunity for lifelong learning and are offered through technology-based plat forms. Learning management systems (LMS) may be used by institutions to integrate then tire teaching, learning and evaluation process.

For a typical examination department of an institution will be an autonomous body right from registration of student to convocation through an integrated system. In fact, steps must be taken to implement a complete examination management system that considers the complete life cycle of examination process. The use of technology will reduce dependency on human intervention and be error free. The following functions will be automated:

- i. Registration of students and generating unique PRN,
- ii. Filling up of examination form,
- iii. Generation of seat numbers and admit cards/hall tickets,
- iv. Preparation of list of paper setter,
- v. Use of question bank system to draw question sets, question paper generation,
- vi. Online is attribution of question papers on the day of examination with system of encryption,

- vii. Barcode system or answer books (this will eliminate issues related to errors, avoid mal practices etc.),
- viii. Digitization of answer scripts and on screen evaluation of answer sheets,
- ix. Tracking of student's performance,
- x. Marks submission through on lines of aware,
- xi. Viewing of result through online system.
- xii. Online verification and revaluation system,
- xiii. Digitization of certificates and mark sheets (to avoid tampering and easy retrieval),
- xiv. Certificate authentication system,
- xv. Submission of various other applications through online system.

The above will lead to conduct of functions of the examination system in an efficient and transparent manner and timely availability of information to students.

26. Student Discipline:

Every student is required to observe utmost discipline and decorum both inside and outside the campus and not to indulge in any activity which may affect adversely the prestige reputation of the University.

27. Student Welfare:

Any act of indiscipline of a student reported to the Dean and Head of the Department will be referred to a Discipline Committee constituted for the purpose. The Committee will enquire into the charges and decide on a suitable punishment if the charges are substantiated. The committee will also authorize the Dean (Students Welfare) to recommend to the Vice-Chancellor for the implementation of the decision. The student concerned may appeal to the Vice-Chancellor, whose decision will be the final.

28. Ragging:

Ragging in any form is a criminal and non-available offence in our country. The current State and Central legislations provide stringent punishments including imprisonment. Once the involvement of a student(s) is established in ragging, offending fellow students/staff, harassment of any nature to the fellow students/staff etc. the student(s) will be liable to be dismissed from the University, as per the laid down procedures of the UGC / Govt. /Institute. Every senior student at the University, along with their parent, shall give an undertaking every year in this regard and the same should be submitted at the time of Registration.

29. Power of modify:

Not with standing all that has been stated above, the Academic Council is vested with powers to modify any or all the above regulations from time to time, if required, subject to the approval by the board of Studies and Final approval by Honorable Vice-Chancellor.

- 30. Exit point:**
A Student may exit after getting certificate (after one year), Diploma (Two years), on the completion of 48 and 96 credits respectively.
- 31. NC/Credit Course:**
USR (University Social Responsibility) and Sports.

Evaluation Scheme

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME
B.Sc. BIOLOGY Year-I / Semester-I

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 1	BSBC-NP-111	Microbiology and Plant Pathology	4	0	0	4	25	75	100
2	Core 2	BSZC-NP-112	Cytology, Genetics and Infectious Diseases	4	0	0	4	25	75	100
3	Core 3	BSCC-NP-113	Fundamentals of Chemistry	4	0	0	4	25	75	100
4.	AECC 1	NHU-N-111	English Communication	3	0	0	3	15	35	50
		NHU-NPR-112	Environment & Ecology							
5.	Gen E	GENCC-101	NCC	2			2			
6.	USEC	NECC-112	University Social Responsibility	0	0	0	0	25	0	NC
PRACTICALS										
7.	Core 1	BSBC-NP-111P	Techniques in Microbiology & Plant Pathology Lab	0	0	2	2	20	30	50
8.	Core 2	BSZC-NP-112P	Cell Biology & Cytogenetics Lab	0	0	2	2	20	30	50
9.	Core 3	BSCC-NP-113P	Quantitative Analysis Lab	0	0	2	2	20	30	50
			TOTAL					150	350	500
10	USEC	SPT-111	Sports	0	0	0	0	50	0	NC

21 (23 including NCC)

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME
B.Sc. BIOLOGY Year-I / Semester-II

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 4	BSBC-NP-121	Archegoniates and Plant Architecture	4	0	0	4	25	75	100
2	Core 5	BSZC-NP-122	Biochemistry and Physiology	4	0	0	4	25	75	100
3	Core 6	BSCC-NP-123	Bioorganic and Medicinal Chemistry	4	0	0	4	25	75	100
4.	AECC 2	NHU-NPR-112	Environment & Ecology	4	0	0	4	25	75	100
5.	GE 1	CBZGE-NP-124a	Soil Health Assessment	4	0	0	4	25	75	100
		CBZGE-NP-124b	Disaster Management System in India							
6.	Gen E	GENCC-201	NCC	2			2			
7.	USEC	NECC-122	University Social Responsibility	0	0	0	0	25	0	NC
8.	SEC	NECC-124	MOOCS	2	0	0	2	50	0	50
PRACTICALS										
9.	Core 4	BSBC-NP-121P	Land Plants Architecture Lab	0	0	2	2	20	30	50
10.	Core 5	BSZC-NP-122P	Physiological, Biochemical & Haematology Lab	0	0	2	2	20	30	50
11.	Core 6	BSCC-NP123P	Biochemical Analysis Lab	0	0	2	2	20	30	50
12.	AECC 2	NHU-NPR-112P	Environment & Ecology Lab	0	0	1	1	15	35	50
			TOTAL					250	500	750
12.	USEC	SPT-121	Sports	0	0	0	0	50	0	NC

29 (31 including NCC)

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME
B.Sc. BIOLOGY Year-II / Semester-III

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 10	BSBC-NP-231	Flowering Plants Identification & Aesthetic Characteristics	4	0	0	4	25	75	100
2	Core 11	BSZC-NP-232	Molecular Biology, Bioinstrumentation & Biotechniques	4	0	0	4	25	75	100
3	Core 12	BSCC-NP-233	Chemical Dynamics & Coordination Chemistry	4	0	0	4	25	75	100
4.	AECC 4	UPS-301	Professional Skills	3	0	0	3	15	35	50
5	GE 2	CBZGE-NP-234A	Herbal Technology	4	0	0	4	25	75	100
		CBZGE-NP-234b	Biostatistics							
6.	Gen E	GENCC-401	NCC	2			2			
7.	USEC	NECC-232	University Social Responsibility	0	0	0	0	25	0	NC
PRACTICALS										
8.	Core 10	BSBC-NP-231P	Plant Identification Technology Lab	0	0	2	2	20	30	50
9.	Core 11	BSZC-NP-232P	Bioinstrumentation & Molecular Biology Lab	0	0	2	2	20	30	50
10.	Core 12	BSCC-NP-233P	Physical Analysis Lab	0	0	2	2	20	30	50
			TOTAL					175	425	600
11.	USEC	SPT-231	Sports	0	0	0	0	50	0	NC

25 (27 including NCC)

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME
B.Sc. BIOLOGY Year-II / Semester-IV

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 10	BSBC-NP-241	Economic Botany, Ethnomedicine and Phytochemistry	4	0	0	4	25	75	100
2	Core 11	BSZC-NP-242	Diversity of Non-Chordates, Parasitology and Economic Zoology	4	0	0	4	25	75	100
3	Core 12	BSCC-NP-243	Quantum Mechanics and Analytical Techniques	4	0	0	4	25	75	100
4.	AECC 4	UVE-401	Human Values	3	0	0	3	15	35	50
5.	Gen E	GENCC-401	NCC	2			2			
6.	USEC	NECC-242	University Social Responsibility	0	0	0	0	25	0	NC
7.	SEC 2	NECC-244	MOOCS	2	0	0	2	50	0	50
PRACTICALS										
8.	Core 10	BSBC-NP-241P	Commercial Botany and Phytochemical Analysis	0	0	2	2	20	30	50
9.	Core 11	BSZC-NP-242P	Diversity of Non-Chordates, Parasitology and Economic Zoology Lab	0	0	2	2	20	30	50
10.	Core 12	BSCC-NP-243P	Instrumental Analysis Lab	0	0	2	2	20	30	50
			TOTAL					200	350	550
11.	USEC	SPT-241	Sports	0	0	0	0	50	0	NC

23 (25 including NCC)

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME
B.Sc. BIOLOGY Year-III / Semester-V

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 16	BSBC-NP-361	Plant Physiology, Metabolism and Biochemistry	4	0	0	4	25	75	100
2	Core 17	BSZC-NP-362	Diversity of Chordates and Comparative Anatomy	4	0	0	4	25	75	100
3	Core 18	BSCC-NP-363	Organic Synthesis A	4	0	0	4	25	75	100
4	Industrial Training/ Research Project	CBZ-RP-361	Industrial Training/ Survey/ Research Project				4	50	0	50
5	Gen E	GENCC-601	NCC	2			2			
6	USEC	NECC-352	University Social Responsibility	0	0	0	0	25	0	NC
PRACTICALS										
7	Core 16	BSBC-NP-351P	Plant Physiology, Metabolism and Biochemistry Lab	0	0	2	2	20	30	50
8	Core 17	BSZC-NP-352P	Diversity of Chordates and Comparative Anatomy Lab	0	0	2	2	20	30	50
9	Core 18	BSCC-NP-353P	Qualitative Analysis Lab	0	0	2	2	20	30	50
			TOTAL					185	315	500
10	USEC	SPT-351	Sports	0	0	0	0	50	0	NC

22 (24 including NCC)

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME
B.Sc. BIOLOGY Year-III / Semester-VI

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 16	BSBC-NP-361	Cytogenetics, Plant Breeding and Nanotechnology	4	0	0	4	25	75	100
2	Core 17	BSZC-NP-362	Ethology, Evolutionary and Developmental Biology	4	0	0	4	25	75	100
3	Core 18	BSCC-NP-363	Organic Synthesis B	4	0	0	4	25	75	100
4	Industrial Training/ Research Project	CBZ-RP-361	Industrial Training/ Survey/ Research Project				4	25	75	100
5.	Gen E	GENCC-601	NCC	2			2			
6	USEC	NECC-362	University Social Responsibility	0	0	0	0	25	0	NC
7	SEC 3 (2 Cr.)	NECC-364	MOOCs/ SWAYAM/	2	0	0	2	50	0	50
PRACTICALS										
1.	Core 16	BSBC-NP-361P	Cytogenetics, Plant Breeding and Nanotechnology Lab	0	0	2	2	20	30	50
2..	Core 17	BSZC-NP-362P	Ethology, Evolutionary and Developmental Biology Lab	0	0	2	2	20	30	50
3.	Core 18	BSCC-NP-363P	Organic Synthetic Lab	0	0	2	2	20	30	50
			TOTAL					210	390	600
4.	USEC	SPT-361	Sports	0	0	0	0	50	0	NC

24 (26 including NCC)

Evaluation Schemes 2024-2025

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME
B.Sc. BIOLOGY Year-I / Semester-I

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 1	BSBC-NP-115	General Microbiology and Plant Pathology	4	0	0	4	25	75	100
2	Core 2	BSZC-NP-112	Cytology, Genetics and Infectious Diseases	4	0	0	4	25	75	100
3	Core 3	BSCC-NP-113	Fundamentals of Chemistry	4	0	0	4	25	75	100
4.	AECC 1	NHU-N-111	English Communication	3	0	0	3	15	35	50
		NHU-NPR-112	Environment & Ecology							
	VAC 1	VAC-111	Ancient Sanskrit	2	0	0	2	15	35	50
5.	Gen E	GENCC-101	NCC	2			2			
6.	USEC	NECC-112	University Social Responsibility	0	0	0	0	25	0	NC
PRACTICALS										
7.	Core 1	BSBC-NP-115P	Techniques in Microbiology & Plant Pathology Lab	0	0	2	2	20	30	50
8.	Core 2	BSZC-NP-112P	Cell Biology & Cytogenetics Lab	0	0	2	2	20	30	50
9.	Core 3	BSCC-NP-113P	Quantitative Analysis Lab	0	0	2	2	20	30	50
			TOTAL					165	385	550
10	USEC	SPT-111	Sports	0	0	0	0	50	0	NC

23 (25 including NCC)

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME
B.Sc. BIOLOGY Year-I / Semester-II

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 4	BSBC-NP-125	Cryptogams and Phanerogams	4	0	0	4	25	75	100
2	Core 5	BSZC-NP-126	Introductory Animal Physiology	4	0	0	4	25	75	100
3	Core 6	BSCC-NP-123	Bioorganic and Medicinal Chemistry	4	0	0	4	25	75	100
4.	AECC 2	NHU-N-121	English Communication	4	0	0	4	25	75	100
		NHU-NPR-112	Environment & Ecology							
5.	GE 1	CBZGE-NP-124a	Soil Health Assessment	4	0	0	4	25	75	100
		CBZGE-NP-124b	Disaster Management System in India							
6.	Gen E	GENCC-201	NCC	2			2			
7.	USEC	NECC-122	University Social Responsibility	0	0	0	0	25	0	NC
8.	SEC 4(2 Cr.)	NECC-124	MOOCs/ SWAYAM	2	0	0	2	50	0	50
PRACTICALS										
9.	Core 4	BSBC-NP-125P	Cryptogams and PhanerogamsLab	0	0	2	2	20	30	50
10.	Core 5	BSZC-NP-126P	Introductory Animal PhysiologyLab	0	0	2	2	20	30	50
11.	Core 6	BSCC-NP-123P	Biochemical Analysis Lab	0	0	2	2	20	30	50
12.	AECC 2	NHU-NPR-112P	Environment & Ecology Lab	0	0	1	1	15	35	50
			TOTAL					250	500	750
12.	USEC	SPT-121	Sports	0	0	0	0	50	0	NC

29 (31 including NCC)

Format-1

NEP-2020 IMPLEMENTATION 3 STEPS PLAN (FORMAT-1,2 & 3)
CBCS: Statement of Credits distribution

Format -1

College/School:	Credit range: Minimum 120 for UG
Programme:	160 for UG (Hons.), 80 for PG
Duration: UG (6 Sem.), UG (Hons./Research) 8 Sem., PG (4 Sem.)	(Suggested by CBCS-NEP Committee)

Course	Credit	Semester	CORE (Th 4+P 2) Major	DSE (Th 4+P 2) Minor	AECC (Th 3)	SEC **	GE (Th 4) Interdisciplinary	General Elective (2)	Value Added Course (VAC) (2)	Industrial Training/ Survey / Research Project (4)	Total Credits
Certificate Course in Microbial Technology and Classical Botany	52	Ist	C1- GeneralMicrobiology and Plant Pathology C 2-Cytology, Genetics and Infectious Diseases C-3-Fundamentals of Chemistry		AECC 1- English Communication / Environment & Ecology			NCC	VAC-1 Ancient Sanskrit		23 (Excluding NCC)
		2nd	C4-Cryptogams and Phanerogams C5-Introductory animal Physiology C-6-Bioorganic and Medicinal Chemistry		AECC-2 English Communication/ Environment Science (Credits -5)	SEC 1 – MOOCs/NPTE L	Soil Health Assessment/ Disaster Management System in India	NCC			29 (Excluding NCC)
Entry and Exit point											

Diploma in Plant Identification, Utilization and Ethnomedicine	50	3 rd	C 7-Taxonomy of Flowering Plants and aesthetic characteristics C-8-Molecular Biology, Bio-instrumentation and Biotechniques C-9-Chemical Dynamics and Coordination Chemistry		AECC-3-Professional Skills		GE 2 Herbal Technology/ Biostatistics	NCC	VAC-2 Indian Ethos & Modern Management		27 (Excluding NCC)
		4 th	C-10-Plant Resource Utilization C-11-Diversity of Non-Chordates, Parasitology and Economic Zoology C-12-Quantum Mechanics and Analytical Techniques		AECC 4-Human Values	SEC 2- MOOCs/ NPTEL		NCC			23 (Excluding NCC)
Entry and Exit point											
B.Sc. Of Science in CBZ	48	5 th	C-13-Plant Physiology and Biochemistry C-14-Diversity of Chordates and Comparative Anatomy C-15-Organic Synthesis A					NCC	VAC-3 Yoga	Industrial Training/ Survey/Research Project (Credit-4, for 3 years programmes)	24

		6 th	C-16-Cytogenetics, Plant Breeding, Tissue Culture and nanotechnology C-17- Evolution and Embryology C-18-Organic Synthesis B			SEC 3- MOOCs/NPTEL		NCC		Industrial Training/ Survey/Re search Project (Credit-4, for 3 years programm es)	24 (Excluding NCC)

Note: For 03 years undergraduate programmes, research projects will be of 4 credits each in last 02 semesters.

*General Elective: Certificate will be provided to the students opted for NCC apart from degree.

** One SEC must be E&I and IPR (Can be through NPTEL or IPR can be from TIFAC, DST)

Master of Science in Botany	95	7 th	C19- Elements of Microbiology C 20- Mycology, Phycology and Lichens	DSE 1- Cell Biology/ Biotechnolog y in Human Welfare	AECC- 5- English Communication			NCC	VAC-1 Encient Sanskrit		23 (Excluding NCC)
		8 th	C-21 Bryophytes, Pteridophytes andGymnosper ms C-22- Plant Systematics and Taxonomy	DSE-1 Anatomy and Embryology of Angiosperms / Environment, Ecology & Biodiversity Conservation		SEC 4- MOOCs (E&I/IPR)	GE -3 Environment, Ecology and Biodiversity/ Entrepreneurship Development	NCC	VAC-2 Indian Ethos and Modern Management		26 (Excluding NCC)

		9 th	C-23- Principles of Plant Pathology & Disease Management C-24- Physiology of Plants & their Biochemistry C-25- Microbial genetics & Molecular Biology				GE-4 Economic Botany & Plant Biotechnology/ Disease Biocontrol & Disease Resistance in Plants	NCC		Seminar/ Industrial Training/ Research (Credits-4)	28 (Excluding NCC)
		10 th				SEC 5- MOOCs		NCC		Research Project (Credits - 16)	18(Excluding NCC)

Format 2

IIMTU-NEP Implementation: Exit Points

Format-2

After the completion of I and II

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
CERTIFICATE COURSES IN MICROBIAL TECHNOLOGY AND CLASSICAL BOTANY	FIRST YEAR	SEMESTER -I	i)C1- General Microbiology and Plant Pathology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i)C1-General Microbiology and Plant Pathology	Unit=8/Period=60	40% Marks in 12 th with a subject of life Science/ Biology (PCB)	Agriculture/ B. Pharm
			ii) C 2-Cytology, Genetics and Infectious Diseases(Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C 2-Cytology, Genetics and Infectious Diseases	Unit=5/Period=60		N/A
			iii)C-3-Fundamentals of Chemistry	4+2	8	60+60	iii)C-3-Fundamentals of Chemistry	Unit=8/Period=60		N/A
			iv) AECC-1- English Communication (Th.3 Cr)	3	3	45	iv) AECC-1- English Communication	Unit=5/Period=45		N/A
			v) Ancient Sanskrit (Th. 2 Cr.)	2	2	30	v) Ancient Sanskrit (Th. 2 Cr.)	Unit=5/Period=30		N/A

		SEMESTER - II	i) C4-Cryptogams and Phanerogams(Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C4-Cryptogams and Phanerogams	Unit=8/Period=60	40% Marks in 12 th with a subject of life Science/ Biology (PCB)+ I Semester in B.Sc. CBZ with the matching of syllabus	N/A
			ii)C5-Introductory Animal Physiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C5-Introductory Animal Physiology	Unit=5/Period=60		N/A
			iii) C-6-Bioorganic and Medicinal Chemistry(Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iii) C-6-Bioorganic and Medicinal Chemistry	Unit=8/Period=60 Unit=5/Period=45		N/A
			iv) AECC-2- Environment & Ecology (Th.4 Cr)	3	3	45	iv) AECC-2- Environment & Ecology	Unit=5/Period=60 Unit=5/Period=30		N/A
			v) GE 1 -Soil Health Assessment / Disaster Management System in India(Th.4 Cr)	4	4	60	v) GEC1 -Soil Health Assessment / Disaster Management System in India			N/A
			vi) SEC-2 MOOCs/Swayam (Th. 2)	2	2		vi) SEC-2 MOOCs/Swayam			N/A

Programme Outcome: After the completion of the certificate program, a candidate will be able to-

PO1 : Work as a Lab Technician

PO2: differentiate between the groups of different plants

PO3: Understand the chemical components of life and their importance.

PO4: Identify the plant diseases on the basis of their symptoms

PO5: Assess the quality of the soil which is an important aspects for growing of the plants.

Programme Specific Outcome: This Programme imparts knowledge on various fields of plant biology through teaching, interactions and practical classes. It shall maintain a balance between the traditional botany and modern science for shifting it towards the frontier areas of plant sciences with applied approach. This syllabus hasbeen drafted to enable the learners to prepare them for self-entrepreneurship and employment in various fields including academics as well as competitive exams. Students would gain wide knowledge in following aspects:

1. PSO1:Diversity of plants and microbes their habitat, morphology, architecture and reproduction.
2. PSO2 :Plant disease causing microbes, symptoms &control.
3. PSO3 :Economic value of plants and their use in HumanWelfare.

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
DIPLOMA IN PLANT IDENTIFICATION & ETHNOMEDICINE (92 Credits)	SECOND YEAR	SEMESTER -III	i)C 7- Taxonomy of Flowering Plants and aesthetic Characteristics (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i)C 7- Taxonomy of Flowering Plants and aesthetic Characteristics	Unit=8/Period=60	40% Marks in 12 th with a subject of life Science/ Biology (PCB)+ Certificate course in Microbial technology and Classical Botany with the matching of syllabus	N/A
			ii) C-8-Molecular Biology, Bio-instrumentation and Biotechniques(Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C-8-Molecular Biology, Bio-instrumentation and Biotechniques	Unit=8/Period=60		N/A
			iii)C-9-Chemical Dynamics and Coordination Chemistry(Th.4 Cr.+ P 2Cr.)	4+2	8	60	iii)C-9-Chemical Dynamics and Coordination Chemistry	Unit=8/Period=60		N/A
			iv)AECC-3-Professional Skills	3	3	45	iv) AECC-3-Professional Skills	Unit=5/Period=45		N/A
			v) GE2- Herbal Technology/ Biostatistics(Th.4 Cr)	4	4	60	v) GE2- Herbal Technology/ Biostatistics	Unit=5/Period=60		N/A

			Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
		SEMESTER - IV	i)C-10-Economic Botany, Ethnomedicine and Phytochemistry(Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i)C-10-Economic Botany, Ethnomedicine and Phytochemistry	Unit=8/Period=60	40% Marks in 12 th with a subject of life Science/ Biology (PCB)+ Certificate course in Microbial technology and Classical Botany + III Semester with the matching of syllabus	N/A
			ii) C-11-Diversity of Non-Chordates, Parasitology and Economic Zoology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C-11-Diversity of Non-Chordates, Parasitology and Economic Zoology	Unit=8/Period=60		N/A
			iii) C-12-Quantum Mechanics and Analytical Techniques (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iii) C-12-Quantum Mechanics and Analytical Techniques	Unit=8/Period=60		N/A
			iv) AECC-4- Human Values (Th.3 Cr)	3	3	45	iv) AECC-4- Human Values	Unit=5/Period=45		N/A
			v) SEC-4 MOOCs/Swayam (Th. 2)	2	2	30	v) SEC-4 MOOCs/Swayam	Unit=5/Period=30		N/A

Programme Outcome: After the completion, student will be able to

- PO1 : Explore the floral vegetation of different areas
PO2: Explore the fauna of Non-Chordates
PO3: Handle different instruments used in laboratory.
PO4: Apply the use of different plants and their parts in pharmaceutical industries.
PO5: have the knowledge of different chemical compounds present on plant parts and their uses.

Programme Specific Outcome: This course provides a broad understanding of identifying, growing and using plants. This course is primarily aimed to introduce people to the richness of plant diversity found in surrounding areas. Lecture sessions are designed to cover fundamental topics concerning classification of plants and their utilization required for understanding the flora and vegetation. Practical sessions are organized following theory for easy understanding of the various parts of the plants, structural organization of floral parts and diversity therein. Participants are taken to different locations covering a variety of habitats and forest types to acquaint them with the native flora. in the long run, will contribute towards building momentum for people's participation in environmental conservation without compromising on academic rigour and our rich wealth of knowledge in herited over generations.

1. PSO1 The course will cover conventional topics in Field Botany like Evolutionary History

& Diversity of Plants, Complete Morphology, Nomenclature of plants, Systems of Classification, Keys to Important Families of Flowering Plants, Field Data Collection & Herbarium Techniques.

2. PSO2 The course is designed to become a commercial crop grower, florist, protected cultivator, green belt plant advisor to industries, pharmacologist & taxonomist.

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
UNDER GRADUATE DEGREE IN CBZ (132 Credits)	THIRD YEAR	SEMESTER - V	i)C-13-Plant Physiology, Metabolism and Biochemistry(Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i)C-13-Plant Physiology, Metabolism and Biochemistry	Unit=8/Period=60	40% Marks in 12 th with a subject of life Science/ Biology (PCB)+ Diploma in Plant Identification & Ethnomedicine with the matching of syllabus	N/A
			ii)C-14-Diversity of Chordates and Comparative Anatomy(Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii)C-14-Diversity of Chordates and Comparative Anatomy	Unit=8/Period=60		N/A
			iii)C-15 Organic Synthesis A(Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iii)C-15 Organic Synthesis A	Unit=8/Period=60		N/A
			*Research project/ Industry Training/ Internship Survey	4	4	60	Research project/ Industry Training/ Internship Survey			

SEMESTER - VI	i)C-16-Cytogenetics, Plant Breeding and Nanotechnology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i)C-15- Cytogenetics, Plant Breeding and Nanotechnology	Unit=8/Period=60	40% Marks in 12 th with a subject of life Science/ Biology (PCB)+ Diploma in Plant Identification & Ethnomedicine +V Semester with the matching of syllabus	Open to all but special for B.Sc. Biotechnology, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.Sc. Food Science. N/A
	ii) C-17-Ethology, Evolutionary and Developmental Biology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C-16-Ethology, Evolutionary and Developmental Biology	Unit=8/Period=60		
	iii) C-18- Organic Synthesis B (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iii)C-18- Organic Synthesis B	Unit=8/Period=30		
	iv) SEC-6 MOOCs/Swayam (Th.2)	2	2	30	iv) SEC-6 MOOCs/Swayam	Unit=5/Period=30		N/A
	*Research project/ Industry Training/ Internship Survey	4	4	60				

*Research Topic may be selected from any one of 02 core papers.

Programme Outcome: After the completion of the program, student will be able to-

PO₁: Deal with the biochemical aspects of different living beings.

PO₂: Understand the evolutionary biology of organisms.

PO₃: Deal with different fields of Chemistry.

PO₄: Explore the fauna of Non-Chordates as well as Chordates

PO₅: Differentiate the animals on the basis of their external morphology also.

Note: Correlation between CO/PO/PSO3 are to be established by bloom taxonomy:

Programme Specific Outcome:The learning outcomes of three years graduation course are aligned with program learning outcomes but these are specific to-specific courses offered in a program. The core courses shall be the backbone of this framework whereas discipline electives, generic electives and skill enhancement courses would add academic excellence in the subject together with multi-dimensional and multidisciplinary approach.

1. Understanding of plant classification systematics, evolution, ecology, developmental biology, physiology, biochemistry, plant interactions with microbes and insects, morphology, anatomy, reproduction, genetics and molecular biology of various life-forms.
2. This course is suitable to produce expertise in conservation biology like ex-situ conservation, response to habitat change, genotype characterization and reproductive biology.

3. Understanding of various analytical techniques of plant sciences, use of plants as

- industrial resources or ashuman livelihood support system and is well versed with the use of transgenic technologies for basic and applied research in plants.
4. Understanding of various life forms of plants, morphology, anatomy, reproduction, genetics, microbiology, molecular biology, recombinant DNA technology, transgenic technology and use of bioinformatics tools and databases and the application of statistics to biological data.
 5. Entrepreneurship Skill Development, Understand the issues of environmental contexts and sustainable development, Incultation of human values,
 6. Strengthen mathematical and computational skills. Enable students to use ICT & AI effectively.
 7. Develop good skills in laboratory such as observation and evaluation by the use of modern tools and technology.

PSO1: Understanding the nature and basic concepts of all the plant groups, their metabolism, components at the molecular level, biochemistry, taxonomy and ecology.

The course will make them aware of natural resources and environment and the importance of conserving it. Hands on training in various fields will develop practical skills, handling equipments and laboratory use along with collection and interpretation of biological materials and data. Knowledge gained through theoretical and lab-based experiments will generate technical personnel in various priority areas such as genetics, cell and molecular biology, plant systematic and biotechnology.

PSO2 : Botanists are able to contribute to all these fields and therefore, are mainly employed with educational institutions, government or public sectors or companies in industries, such as agriculture or forestry, oil, chemical, biotechnology, geological survey, environmental protection, drugs, genetic research, plant resources laboratories, plant health inspection services, lumber and paper, food, fermentation, nursery, fruit and so on. Jobs available as a botanist: •Microbiologist, plant pathologist, Taxonomist • Plant Physiologist • Plant Biochemist • Researcher • Mycologist • Ecologist • Weed Scientist •Palaeobotanist •Conservationist •Fruit Grower •Morphologist •Cytologist •Ethnobotanist •Plant geneticists etc.

PSO3: Inculcate strong fundamentals on modern and classical aspects of Botany, Understand knowledge of Botany is an essential pre-requisite for the pursuit of many applied sciences. It will facilitate students for taking up and shaping a successful career in Botany and allied sciences.

PSO4.Introduction of research project will inculcate research aptitude and passion for higher education and scientific research.

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
POST GRADUATE DEGREE IN BOTANY(90 Credits)	FIRST YEAR	SEMESTER -I	i) C-19- Elements of Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C-19- Elements of Microbiology	Unit=5/Period=60	40% Marks in Graduation with Botany, Zoology and Chemistry Stream.	N/A
			ii)C-20- Mycology, Phycology and Lichens (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii)C-20- Mycology, Phycology and Lichens	Unit=5/Period=60		N/A
			iii)DSE-1Plant Cell Biology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iii)DSE-1Plant Cell Biology	Unit=5/Period=45		N/A
			iv) AECC-1- English Communication (Th.3 Cr)	3	3	45	iv) English Communication	Unit=5/Period=30		N/A
			v) Ancient Sanskrit (Th. 2 Cr.)	2	2	30	v) Ancient Sanskrit			N/A
POST GRADUATE DEGREE IN BOTANY(90 Credits)	FIRST YEAR	SEMESTER -II	i) C-21- Bryophytes, Pteridophytes and Gymnosperms(Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C-21Bryophytes, Pteridophytes and Gymnosperms	Unit=5/Period=60	40% Marks in Graduation with Botany, Zoology and Chemistry Stream.	N/A
			ii)C-22Plant Systematics and Taxonomy (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii)C-22- Plant Systematics and Taxonomy	Unit=5/Period=60		N/A
			iii)DSE-2Anatomy and Embryology of Angiosperms(Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iii) DSE-2Anatomy and Embryology of Angiosperms	Unit=5/Period=60		N/A
			iv) GE-4- Environment, Ecology and Biodiversity(Th.4 Cr)	4	4	45	iv) GE-4- Environment, Ecology and Biodiversity	Unit=5/Period=30		N/A
			v) SEC-4 MOOCs/ SWAYAM(Th. 2 Cr.)	2	2	30	v) SEC-4 MOOCs/ SWAYAM			N/A

Programme Specific Outcome:

PSO-1: Students will get the knowledge about the diversity of microorganisms, their importance.

PSO-2: They will learn about the application of microorganisms in different aspects of life.

PSO-3: Students will know the difference between algae, fungi and lichens.

PSO-4: Student will gain knowledge about the biology of the cell at its molecular level.

PSO-5: After the completion of the course, student would be able to understand different fields of botany like anatomy, morphology, reproduction and molecular biology of different forms of life.

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
POST GRADUATE DEGREE IN BOTANY(90 Credits)	SECOND YEAR	SEMESTER -III	i) C-23- Principles of Plant Pathology & Disease Management (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	C-23- Principles of Plant Pathology & Disease Management	Unit=5/Period=60	40% Marks in Graduation with Botany, Zoology and Chemistry Stream.	N/A
			ii) C-24 Physiology of Plants & their Biochemistry (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	C-24 Physiology of Plants & their Biochemistry	Unit=5/Period=60		N/A
			iii) C-25 Microbial genetics & Molecular Biology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iii) C-25 Microbial genetics & Molecular Biology	Unit=5/Period=60		N/A
			iv) GE-5- Economic Botany & Plant Biotechnology (Th.4 Cr.)	4	4	45	vi) GE-5- Economic Botany & Plant Biotechnology	Unit=5/Period=30		N/A
			v) SEC-4 MOOCs/ SWAYAM (Th. 2 Cr.)	2	2	30	vii) SEC-4 MOOCs/ SWAYAM			N/A
			Industrial Training/Research Project	4	4	60	Industrial Training/Research Project			

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
POST GRADUATE DEGREE IN BOTANY(90 Credits)	SECOND YEAR	SEMESTER -IV	i) Industrial Training/Research Project	16	16	16	i) Industrial Training/Research Project	Unit=5/Period=30	40% Marks in Graduation with Botany, Zoology and Chemistry Stream.	N/A
			ii) SEC-5MOOCs/ SWAYAM (Th. 2 Cr.)	2	2	2	ii) SEC-5 MOOCs/ SWAYAM			

**Programme Outcome: After the completion of the program,
a candidate will be able to-**

PO-1: To impart the advanced knowledge on various fields of biology

PO-2: The curriculum of the program fosters problem-solving and critical thinking skills, so that a candidate may face any kind of challenges

PO-3: To inculcate the insights of the key research areas of botany into student's mind

PO-4: The program maintains a balance between theoretical and practical sessions which enables a candidate to apply their learning and may obtain good and satisfactory end results.

PO-5: Various applied fields of Botany like Microbial Genetics, Plant Pathology, Plant Tissue culture etc can be understand.

Programme Specific Outcome:

PSO-1: Understand recent concepts in Plant pathogenesis.

PSO-2: Student will be trained in skill enhancement courses.

PSO-3: Students completing the course may execute experiments related to basic studies on Plant pathology.

PSO-4: Students gained practical knowledge of handling the plants and using them as model organism

Format-3

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: B.Sc. (CBZ) Certificate/Diploma/Degree/ CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY AND CLASSICAL BOTANY UG(R)/PG/Ph.D. Class: Certificate		Year: I Semester: I
Credits: 4 Theory: 4 Practical: 0	Subject: Botany	
Course Code: BSBC-NP-111	TITLE: MICROBIOLOGY AND PLANT PATHOLOGY	
Course Objectives: 1. Classification and diversity of different microbes including Algae, Fungi, Bacteria, Virus and Lichens and their Economic Importance. 2. To have thorough knowledge about identifying microbes, Biofertilizers, pathogens and lichens. 3. Commercial use of microbes and microbial products. 4. Host-pathogen relationship and disease management. 5. Different types of diseases, their, symptoms and their remedy. 6. Application of microbes in different fields. 7. Structure and function of certain selected bacteria, algae, fungi and lichens. 8. Gain Knowledge about the economic value of this lower group of this plant community.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents	Lectures
I	A. Introduction to Indian ancient, Vedic and heritage Botany and contribution of Indian Botanists (in all branches), in context with the holistic development of modern science and technology, has to be taught, practiced and accessed via class interaction/assignments/self-study mentioned under Continuous Internal Evaluation (CIE). B. Microbial Techniques & instrumentation Microscopy- Elementary knowledge of Light, phase contrast, electron, scanning and transmission electron microscopy, staining techniques, for light microscopy, sample preparation for electron microscopy. Common equipment of microbiology lab and principle of their working- autoclave, oven, laminar air flow, centrifuge. Colorimetry and spectrophotometry, immobilization methods, fermentation and fermenters.	8
II	Microbial world Cell structure of Eukaryotic and prokaryotic cells, Gram positive and Gram-negative bacteria, Structure of a bacteria and plasmids; Bacterial chemotaxis and Quorum sensing, Bacterial Growth curve, Factors affecting growth of	8

	microbes; measurement of growth; Batch culture, fed batch culture and continuous culture; Synchronous growth of microbes; Sporulation and reproduction and recombination in bacteria. Viruses, general characteristics, viral culture, Structure of viruses, TMV and retro viruses, Bacteriophages, Structure of T4 & λ -phage; Lytic and Lysogenic cycles, mycophages, viroid, Prions & mycoplasma & phytoplasma, Actinomycetes (Actinobacteria) and their economic uses.	
III	Phycology Range of thallus organization in Algae, Pigments, Flagella, Reserve food, Types of Reproduction, Classification and comparative life cycle of- <i>Nostoc</i> , <i>Chlorella</i> , <i>Volvox</i> , <i>Oedogonium</i> , <i>Chara</i> ; <i>Sargassum</i> . Economic importance of algae- Role of algae in soil fertility-biofertilizer- Nitrogen fixation- Symbiosis; Commercial product of algae-biofuel, Agar, Diatomite.	7
IV	Mycology Study of general characteristics, nutrition, life cycle, Economic importance of Fungi, Classification upto class. Distinguishing characters of Myxomycota : General characters of True Fungi (Eumycota): Mastigomycotina Synchronytrium: Zygomycotina : <i>Rhizopus</i> , Ascomycotina : <i>Saccharomyces</i> , <i>Penicillium</i> . Basidiomycotina : <i>Ustilago</i> , <i>Puccinia</i> , <i>Agaricus</i> ; Deuteromycotina : <i>Fusarium</i> , <i>Alternaria</i> . <i>Heterothallism</i> , <i>Heterokaryosis</i> & <i>Parasexuality</i> .	7
V	Mushroom Cultivation, Lichenology & Mycorrhiza Mushroom cultivation, General account of Lichens, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.	7
VI	Plant Pathology Disease concept, Symptoms, Etiology & Causal complex, Primary and Secondary inoculum, infection, Pathogenicity and pathogenesis, Koch's Postulates. Mechanism of infection (Brief idea about Pre- penetration and Post-penetration), Disease cycle (monocyclic, polycyclic and polyetic). Defense mechanism. Fungicides- Bordeaux mixture, Lime Sulphur, Tobacco decoction, Neem cake & oil.	7
VII	Diseases and Control Symptoms, Causal organism, Disease cycle and Control measures of –Early & Late Blight of Potato, Black Stem Rust of Wheat, <i>Alternaria</i> spot and white rust of Crucifers, Red Rot of Sugarcane, Wilting of Arhar, Mosaic diseases on tobacco and cucumber, yellow vein mosaic of bhindi; citrus canker, little leaf of brinjal; Damping off of seedlings, Disease management; Quarantine, Chemical, Biological, Integrated pest disease management.	8
VIII	Applied Microbiology Elementary knowledge of Food fermentations and food produced by microbes, Production of antibiotics, enzymes, vitamins, alcoholic beverages, organic acid. Mass production of bacterial biofertilizers, blue green algae, Azolla and mycorrhiza. Introduction to: Plant growth promoting rhizobacteria & biopesticides- <i>Trichoderma</i> sp. and <i>Pseudomonas</i> , Single cell proteins (<i>Spirulina</i>), Organic farming inputs, Microbiology of water, Biopolymers, Bioindicators, Biosensors, Bioremediation, Production of biofuels, Biodegradation of Pollutants and biodeterioration of materials & cultural	8

property. Microbial biofactories (<i>E. coli</i> and Yeast) for production of recombinant proteins.	
Suggested Readings: 1. Moderna Microbiology (hindi) (hb) ISBN: 9788177543599 Edition: 1Year: 2018 Author: Dr. Purbhit SS, Dr. Singh T Publisher: Agrobios (India) 2. Suggested books “Plant Pathology by R.S. Mehrotra, Tata McGraw-Hill Education” are included in reading resource list. 3. Suggested book- “Eminent Indian Botanists: Past and Present (Biographies and contributions)”, P.Suresh Narayan and T. Pullaiah, Regency Publications, (2011)	
If the course is available as Generic Elective then the students of following departments may opt it. 1. Agriculture 2. B. Pharma	
Evaluation/Assessment Methodology	
Max. Marks	
1) Sessional Examination	16
2) Assignments	5
3) Attendance	4
4) ESE	75
Total:	100
Prerequisites for the course:40% Marks in 12 th from a recognized Board with a subject of life Science/ Biology (PCB)	
Course Learning Outcomes: After the completion of the course, the student will be able to 1. Know about the working principle and uses of different instruments and microbial technologies 2. Understanding about classification and diversity of different microbes including Algae, Fungi, Bacteria, Virus and Lichens and their Economic Importance. 3. Know about various algal genus and their life cycle patterns with their economic importance. Develop conceptual skills about identifying microbes, Biofertilizers, pathogens and lichens. 4. Understand the structure and function of some selected fungal genus and their life cycle. 5. Learn the commercial production of microbial products and may establish himself as an entrepreneur 6. Gain the knowledge about the relationship between Host and pathogen and the management of the diseases caused by pathogen 7. Get knowledge about the application of microbes in every aspect of life and have Knowledge about the economic value of this lower group of this plant community.	

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: B.Sc. (CBZ) Certificate/Diploma/Degree/ CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY AND CLASSICAL BOTANY UG(R)/PG/Ph.D. Class: Certificate		Year: I Semester: I
Credits: 2 Theory: 0 Practical: 2	Subject: Botany	
Course Code: BSBC-NP-111P	TITLE: TECHNIQUES IN MICROBIOLOGY AND PLANT PATHOLOGY	
Course Objectives: 1. .Upon completion of this course the student will have the knowledge and skills to: understand the Difference between: Algae, Fungi, Bacteria and Lichens. 2. They may know about the cultivation of Mushroom and may have a set up a for the same. 3. They can understand the host pathogen relationship and spread of the disease		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents (Minimum any three from each unit, based on the facilities)	No. of Lectures Allotted
I	Topic: INSTRUMENTS & TECHNIQUES 1. Laboratory safety and goodlaboratory practices 2. Principles and application of Laboratory instruments-microscope, incubator, autoclave, centrifuge, LAF, filtration unit, shaker, pH meter. 3. Buffer preparation & titration 4. Cleaning and Sterilization of glass wares 5. Preparation of media-Nutrient Agar and Broth 6. Inoculation and culturing of bacteria in Nutrient agar and nutrient broth 7. Preparation of agar slant, stab, agar plate 8. Phenol Coefficient method to test the efficacy of disinfectants	7
II	Topic: BACTERIAL IDENTIFICATION 1. Isolation of bacteria 2. Growth curve of bacteria. 3. Identification of bacteria. 4. Staining techniques: Gram’s Negative, Endospore, Capsule and Cell Wall. 5. Cultural characteristics of bacteria on NA.	8

	- Pure culture techniques (Types of streaking). - Biochemical characterization, IMViC, Carbohydrate fermentation test, Mannitol motility test, Gelatinlique faction test, Urease test, Nitratereduction test, Catalase test, Oxidase test, Starch hydrolysis, Case in hydrolysis. - Antibacterial potential of natural products - Replica plating - Bacterial transformation - Bacterial gene induction - Bacterio phage growth analysis.	
III	MYCOLOGICAL STUDY: - Isolation of different fungi: Saprophytic, Coprophilous, Keratinophilic. - Identification of fungi by lactophenol cotton blue method. Rhizopus, Saccharomyces, Penicillium, Peziza, Ustilago, Puccinia; Fusarium, Curvularia, Alternaria. - Agaricus: Specimens of button stage and full grown mushroom; Sectioning of gills of Agaricus. Lichens: crustose, foliose and fruticose specimens	8
IV	PHYCOLOGY: Type study of algae and Cyanobacteria- <i>Spirulina</i> , <i>Nostoc</i> , <i>Chlorophyceae-Chlorella</i> , <i>Volvox</i> , <i>Oedogonium</i> , <i>Cladophora</i> and <i>Chara</i> ; <i>Xanthophyceae- Vaucheria</i> ; <i>Bacillariophyceae-Pinnularia</i> , <i>Phaeophyceae-Sargassum</i> , <i>Rhodophyceae-Polysiphonia</i> .	7
V	EXPERIMENTAL PLANT PATHOLOGY - Preparation of fungal media (PDA) & Sterilization process. - Isolation of pathogen from diseased leaf. - Identification: Pathological specimens of Brown spot of rice, Bacterial blight of rice, Loose smut of wheat, Stem rot of mustard, Late blight of Potato; Slides of uredial, telial, pycnial & aecial stages of Puccinia, Few viral and bacterial plant diseases.	8
VI	PRACTICALS IN APPLIED MICROBIOLOGY -1 - Isolation of nitrogen fixing bacteria from root nodules of legumes. - Enumeration of <i>rhizosphere</i> non-<i>rhizo</i> sphere population of bacteria. - Isolation of antagonistic <i>Pseudomonas</i> from soil. - Isolation of <i>Azospirillum</i> sp. from the roots of grasses. - Microscopic observations of root colonization by VAM fungi. - Isolation of phyllosphere microflora. - Isolation of P solubilizing microorganisms	8
VII	PRACTICALS IN APPLIED MICROBIOLOGY-2 - Wine production. - Isolation of lactic acid bacteria from curd. - Isolation of lipolytic organisms from butter or cheese. - Immobilized bacterial cells for production of hydrolytic enzymes. - Enzyme production and assay-cellulase, protease and amylase. - Immobilization of yeast. - Isolation of cellulolytic and anaerobic sulphate reducing bacteria.	8

	8. Isolation and characterization of acidophilic, alkalophilic and halophilic bacteria. 9. Over expression of recombinant protein in Bacteria or Yeast.	
VIII	1. Cultivation of Spirulina & Chlorella in lab for bio fuel. 2. Visit to NBAIM, Mau, Varanasi (Kashi)/IMTECH (Institute of Microbial Technology), Chandigarh for viewing culture Repository 3. Visit to biofertilizers and bio pesticide unit to understand about the Unit operation procedures 4. Mushroom cultivation for Protein 5. Alcohol production from sugarcane juice.	6
Suggested Readings: 1. Dubey, R.C. and Maheshwari. D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi. 2. Pandey. B.P. 2014 Modern Practical botany, (Vol-I) S.Chand & Company, Pvt. Ltd., New Delhi. 3. Gokare A. Ravishankar, Ranga Rao Ambati 2019 Handbook of Algal Technologies and Phytochemicals. 4. Volume II: Phytoremediation, Biofuels and Global Biomass Production Print ISBN: 9780367178192.		

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: B.Sc.(CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Certificate		Year: I Semester: I	
Credits: 4 Theory: 4 Practical:		Subject: Zoology	
Course Code: BSZC-NP-112		Title: Cytology, Genetics and Infectious Diseases	
Course Objectives: CO1: To understand the structure and function of all the cell organelles. CO2: To know about the chromatin structure and its location. CO3: To understand the basic principle of growth and reproduction of an organism.. CO4: To understand cell communication with its neighboring cells. CO5: To understand the basic principles of genetics and pattern of inheritance.			
Nature of Paper: Core/DSE/SEC/GE/AECC: Core			
Minimum Passing Marks/Credits: 40% Marks / 4 Credits			
L:4 T:0 P: 4 (In Hours/Week) 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)			
Unit	Contents	No. of Lectures Allotted	
I	Structure and Function of Cell Organelles I - Plasma membrane: chemical structure-lipids and proteins. - Endomembrane system: protein targeting and sorting, transport, endocytosis, exocytosis. Introduction to all national and international Biologists (Zoologists) who have contributed/contributing to Zoological and Life Sciences as a mark of tribute to ancient and modern biology will be included as part of the continuous Internal Evaluation (CIE) Susrata, Charak, Patanjali, Varahamihira, Prof. H.G. Khorana, Prof. Salim Ali, Prof. Lalji Singh, Prof. R Mishra- to be discussed with the topics being dealt.	6	
II	Structure and Function of Cell Organelles I - Cytoskeleton: microtubules, microfilaments, intermediate filaments. - Mitochondria: Structure, oxidative phosphorylation; electron transport system - Peroxisome and ribosome: structure and function.	6	
III	Nucleus and Chromatin Structure - Structure and function of nucleus in eukaryotes. - Chromatin organization, structure of chromosomes. - Chemical structure and base composition of DNA and RNA.	8	

	Types of DNA and RNA.	
IV	Cell cycle, Cell Division and Cell Signaling - Cell division: mitosis and meiosis. - Introduction to Cell cycle and its regulation, apoptosis. - Signal transduction: intracellular signaling and cell surface receptors - Cell- Cell interaction: Cell adhesion molecules, cellular junctions	8
V	Mendelism and Sex Determination - Basic principles of heredity: Mendel's laws, monohybrid and dihybrid crosses. - Complete and Incomplete Dominance. - Sex Determination: Sex Determination with example of <i>Drosophila</i>. - Sex- linked characteristics and Dosage compensation.	8
VI	Extensions of Mendelism, Genes and Environment - Extensions of Mendelism: Multiple Alleles, Gene Interaction. - The Interaction between Sex and Heredity: Sex-Influenced and Sex-Limited Characteristics. - Cytoplasmic Inheritance, Genetic Maternal Effects.	8
VII	Human Chromosomes and Patterns of Inheritance - Human karyotype. - Chromosomal anomalies: Structural and numerical aberrations with examples. - Pedigree analysis. - Patterns of inheritance: autosomal dominant, autosomal recessive, X-linked recessive, X-linked dominant.	8
VIII	Infectious Diseases - Introduction to pathogenic organisms: viruses, bacteria, fungi, protozoa and worms. - Structure, life cycle, pathogenicity, including diseases, causes, symptoms and control of common parasites: <i>Trypanosoma</i>, <i>Giardia</i> and <i>Wuchereria</i>.	8
Reference / Text Books: - Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004). - Alberts et al: Molecular Biology of the Cell: Garland (2002). - Cooper: Cell: A Molecular Approach: ASM Press (2000). - Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004). - Lewin B. Genes VIII. Pearson (2004). - Watson et al. Molecular Biology of the Gene. Pearson (2004). - Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis KubyKuby Immunology. W H Freeman (2007).		
If the course is available as Generic Elective then the students of following departments may opt it. - no 2		
Evaluation/Assessment Methodology		
Max. Marks:100		

1) Sessional Examination	16
2) Assignments	5
3) Presentations /Seminar /Attendance	4
4) ESE	75
Total:	100
Prerequisites for the course:	
Course Learning Outcomes: CLO1: Student will be able to explain structure and function of cell organelles. CLO2: Student will be able to recognize structure of mitochondria and its functions. CLO3: Student will be able to explain Mendel's laws and the deviations from conventional patterns of inheritance. CLO4: Student will be able to explain basic principles of genetics and pattern of inheritance of genes from one generation to another. CLO5: Student will be able to explain common disease causing agents (Bacteria, Virus and Fungi) CLO6: Student will be able to explain role of cell membrane in organisms.	

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: B.Sc.(CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Certificate	Year: 1 Semester: I	
Credits: 2 Theory: 0 Practical: 2	Subject: Zoology	
Course Code: BSZC-NP-112P	TITLE: Cell Biology & Cytogenetics Lab	
Course Objectives: CO1: To understand the simple and compound microscopes.. CO2: To know about the chromatin structure and its location. CO3 :To understand different stages of mitosis in root top of onion CO4:To understand preparation of polytene chromosomes CO5:To understand the preparation of human Karyotype.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents (Minimum any three from each unit, based on the facilities)	No. of Lectures Allotted
I	1. Understanding of Simple and Compound microscopes. 2. To Study different cell types such as buccal epithelial cells, neurons, striated muscle cells using Methylene blue (virtual/slaughtered tissue). 3. To study the different stages of Mitosis in root top of onion. 4. To study the different stages of Meiosis in testis (Virtual). 5. To check permeability of cells using salt solution of different concentrations.	15
II	1. Study of parasites (Protozoans, Helminthes etc.) from permanent slides. 2. To learn the procedure for preparation of temporary (root tip of onion) and permanent stained/unstained slides with available mounting materials.	15
III	1. Study of polytene chromosomes.(Virtual/model) 2. Study of human Karyotype and study the chromosomal aberrations with respect to number, translocation, deletion etc. from picture provided (virtual/optional).	15
IV	Virtual Labs (Suggestive sites) https://vlab.co.in https://zoologysn.blogspot.com www.vlab.iitb.ac.in/vlab www.onlinelabs.in www.powershow.com	15

	https://vlab.amrita.edu https://sites.dartmouth.edu	
Suggested Reading: 1. Cooper Cell: A Molecular Approach: ASM Press (2000) 2. Karp: Cell and Molecular Biology: Wiley 2002. Pierce B. Genetics. Freeman (2004). 3. Thomas J Kindt, Richard A, Golds By, Barbara A, Osbome, JenisKuby-kuby Immunology W.H. Freeman (2007).		

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: B.Sc.(CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Certificate		Year: I Semester: I
Credits: 4 Theory: 4 Practical: 0		Subject: Chemistry
Course Code: BSCC-NP-113		Title: Fundamentals of Chemistry
Course Objectives: 1. Molecular geometries, physical and chemical properties of the molecules. 2. The chapter Recapitulation of basics of organic chemistry gives the most primary and utmost important knowledge and concepts of organic Chemistry. 3. It describes the types of reactions and the Kinetic and thermodynamic aspects one should know for carrying out any reaction and the ways how the reaction mechanism can be determined. 4. This course gives a broader theoretical picture in multiple stages in an overall chemical reaction. It describes reactive intermediates, transition states and states of all the bonds broken and formed. It enables to understand the reactants, catalyst, stereochemistry and major and minor products of any organic reaction. 5. The chapters Stereochemistry gives the clear picture of two-dimensional and three-dimensional structure of the molecules, and their role in reaction mechanism.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: P: 4 Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits) Practical- 2 Hrs.=1 Credit (4Hrs./Week=2Credits)		
Unit	Contents	No. of Lectures Allotted
I	Molecular polarity and Weak Chemical Forces: Fajan's rules and consequences of polarization. Hydrogen bonding, van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interaction. Effects of weak chemical forces, melting and boiling points, solubility, energetics of dissolution process. Lattice energy and Born-Haber cycle, solvation energy, and solubility of ionic solids.	10
II	Simple Bonding theories of Molecules: Atomic orbitals, Aufbau principle, multiple bonding (σ and π bond approach) and bond lengths, the valence bond theory (VBT), Concept of hybridization, hybrid orbitals and molecular geometry, Bent's rule, Valence shell electron pair repulsion theory (VSEPR), Molecular orbital theory (MOT). Molecular orbital diagrams, bond orders of homonuclear and heteronuclear diatomic molecules and ions ($N_2, O_2, C_2, B_2, F_2, CO, NO$, and their ions)	10

III	Periodic properties of Atoms (with reference to s & p-block): Brief discussion, factors affecting and variation trends of following properties in groups and periods. Effective nuclear charge, shielding or screening effect, Slater rules, Atomic and ionic radii, Electronegativity, Pauling's/ Allred Rochow's scales, Ionization enthalpy, Electron gain enthalpy.	05
IV	Recapitulation of basics of Organic Chemistry: Hybridization, bond lengths and bond angles, bond energy, hyperconjugation, Dipole moment; Electronic Displacements: Inductive, electromeric, resonance mesomeric effects and their applications.	05
V	Mechanism of Organic Reactions: Homolytic and heterolytic bond fission, Types of reagents – electrophiles and nucleophiles, Types of organic reactions, Energy considerations. Reactive intermediates Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples).	10
VI	Stereochemistry: Concept of isomerism, Types of isomerism; Optical isomerism – elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomer, inversion, retention and racemization. Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature. Geometric isomerism – determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds. Conformational isomerism – conformational analysis of ethane and n-butane; conformations of cyclohexane, projection and Sawhorse formulae, Fischer and flying wedge formulae.	10
VII	Basic Computer system (in brief): Hardware and Software; Input devices, Storage devices, Output devices, Central Processing Unit (Control Unit and Arithmetic Logic Unit); Number system (Binary, Octal and Hexadecimal Operating System); Computer Codes (BCD and ASCII); Numeric/String constants and variables. Operating Systems (DOS, WINDOWS, and Linux); Software languages: Low level and High Level languages (Machine language, Assembly language; QBASIC, FORTRAN and C++); Software Products (Office, chem. sketch, scilab, matlab, hyperchem, etc.), internet application.	05
VIII	Mathematical Concepts for Chemistry: Logarithmic relations, curve sketching, linear graphs and calculation of slopes, differentiation of functions like Kx , e^x , X^n , $\sin x$, $\log x$; maxima and minima, partial differentiation and reciprocity relations, Integration of some useful/relevant functions; permutations and combinations, Factorials, Probability.	05

Reference / Text Books:

1. Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
2. Huheey, J.E., Keiter, E.A., Keiter, R. L., Medhi, O.K. Inorganic Chemistry, Principles of Structure and Reactivity, Pearson Education 2006.
3. Douglas, B.E. and McDaniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
4. Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.*, Oxford University Press, 1994.

5. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.
6. Singh J., Yadav L.D.S., Advanced Organic Chemistry, Pragati Edition
7. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
8. Carey, F. A., Giuliano, R. M. *Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
9. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
10. Clayden, J., Greeves, N. & Warren, S. *Organic Chemistry*, 2nd edition, Oxford University Press, 2012.
11. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry*, John Wiley & Sons, Inc.
12. Sykes, P. *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003
13. Francis, P. G. *Mathematics for Chemists*, Springer, 1984

Evaluation/Assessment Methodology

Max. Marks

1) Sessional Examination	16
2) Assignments	5
3) Attendance	4
4) ESE	75
Total:	100

Prerequisites for the course: 40% Marks in 12th from a recognized Board with a subject of life Science/ Biology (PCB)

Course Learning Outcomes:

- Students will understand the concept of various molecular geometries and their affects in physical and chemical properties of the molecules.
- Students will be able to understand the various types of organic intermediates & transition states and its mechanistic importance in organic chemistry.
- Students will be able to understand Stereochemistry of the two and three-dimensional organic molecules and their role in reaction mechanisms.
- Students will be able to understand the basics of information technology and Mathematical tools needed in chemistry.

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: B.Sc (CBZ)		Year: I
Certificate/Diploma/Degree/		Semester: I
UG(R)/PG/Ph.D.		
Class: Certificate		
Credits: 2		Subject: Chemistry
Theory: 0		
Practical: 2		
Course Code: BSCC-NP-113P		Title: Quantitative Analysis Lab
Course Objectives:		
Upon completion of this course the student will have the knowledge and skills to: understand the laboratory methods and tests related to estimation of metals ions and estimation of acids and alkali contents in commercial products.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4		
T:		
P: 4		
Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)		
Practical- 2 Hrs.=1 Credit (4Hrs./Week=2Credits)		
Unit	Contents	No. of Lectures Allotted
I	Water Quality analysis 1. Estimation of hardness of water by EDTA. 2. Determination of chemical oxygen demand (COD). 3. Determination of Biological oxygen demand(BOD).	16
II	Estimation of Metals ions 1. Estimation of ferrous and ferric by dichromate method. 2. Estimation of copper using thiosulphate.	14
III	Estimation of acids and alkali contents 1. Determination of acetic acid in commercial vinegar using NaOH. 2. Determination of alkali content – antacid tablet using HCl. 3. Estimation of oxalic acid by titrating it with KMnO ₄ .	14
IV	Estimation of inorganic salts and hydrated water 1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture. 2. Estimation of calcium content in chalk as calcium oxalate by permanganometry. 3. Estimation of water of crystallization in Mohr's salt by titrating with KMnO ₄ .	16
Reference / Text Books:		
1. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.		
2. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters3-5.		

3. Harris, D.C. <i>Exploring Chemical Analysis</i> , 9th Ed. New York, W.H. Freeman, 2016. 4. Khopkar, S.M. <i>Basic Concepts of Analytical Chemistry</i> . New Age International Publisher, 2009. 5. Skoog, D.A. Holler F.J. and Nieman, T.A. <i>Principles of Instrumental Analysis</i> , Cengage Learning India Edition	
Evaluation/Assessment Methodology	
	Max. Marks
1) Lab Performance	10
2) Attendance	5
3) Record	5
4) ESE	30
Total:	50
Prerequisites for the course: 40% Marks in 12 th from a recognized Board with a subject of life Science/ Biology (PCB).	
Course Learning Outcomes: - Potability tests of water samples. - Estimation of metal ions in samples - Estimation of alkali and acid contents in samples - Estimation of inorganic salts and hydrated water in samples	

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: B.Sc. (CBZ) Certificate/Diploma/Degree/ CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY AND CLASSICAL BOTANY UG(R)/PG/Ph.D. Class: Certificate		Year: I Semester: II
Credits: 4 Theory: 4 Practical: 0	Subject: Botany	
Course Code: BSBC-NP-121	TITLE: ARCHEGONIATES AND PLANT ARCHETECTURE	
Course Objectives: 1. This course aims at making a familiarity with special groups of Bacteria, Viruses, Fungi, algae and plants reproduction. 2. Study of morphology, anatomy, reproduction and developmental changes there in through typological study should create a knowledge base in understanding plant diversity, economic values, taxonomy of lower group of plants. 3. To acquaint the students with external and internal basic structure and cellular composition of the Bacteria, Viruses, Fungi, Bryophytes and Pteridophytes and Gymnosperms. 4. To gain knowledge of diversity, life forms, life cycles, morphology and importance of microorganisms (Bacteria and algae). 5. To introduce students with various fungal groups and lichens, their ecology, classification, characteristics, reproduction and economic Importance.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No.	Topics	Lectures
Unit I	Introduction to Archegoniates and Bryophytes Unique features of archegoniates, bryophytes: General characteristics, adaptation to land habit. Range of thallus organization. Classification (upto family). Morphology, Anatomy and reproduction of Riccia, Marchantia, Anthoceros, Sphagnum and Funaria. (Developmental details not to be included). Economic importance of Bryophytes.	7
Unit II	Pteridophytes General characteristics, early fossils <i>Rhynia</i> , Classification (upto family)	8
	with examples. Heterospory and seed habitat, Stelar evolution. Economic importance of pteridophytes. Comparative study of morphology, anatomy and reproduction of <i>Selagenella</i> , <i>Equisetum</i> , <i>Pteris</i> .	
Unit III	Gymnosperms	8

	Classification and distribution of Gymnosperms; Salient features of Cycadales, Ginkgoales, Coniferales and Gnetales, their examples with special reference to Cycas, Ginkgo, Pinus, Ephedra, Structure and reproduction; Economic importance.	
Unit IV	Palaeobotany General account of Cycadofilicales, Bennettitales, Pentoxylales and Cordaitales; Geologocal time scale. Brief account on the process of fossilization and types of fossils.	8
Unit V	Angiosperm Morphology Morphology and modifications of root, stem, leaf and bud, Types of inflorescence; flower, flower parts, fruits and types of placentation; Definition and types of seeds.	
Unit VI	Plant Anatomy Meristematic and permanent tissues. Organs (root, stem and leaf). Apical meristems and theories on apical organization. Secondary Growth- root and stem- cambium (structure and function), annual rings, periderm, Anomalous secondary growth- <i>Bignonia</i> , <i>Boerhaavia</i> , <i>Dracaena</i> , <i>Nyctanthes</i> .	7
Unit VII	Reproductive Botany Plant embryology, Structure of microsporangium, microsporogenesis, structure of megasporangium and its types, megasporogenesis, structure and types of female gametophytes, Types of pollination, Methods of pollination, Germination of pollen grains, Structure of male gametophyte, fertilization, Structure of dicot and monocot embryo, Endosperm, double fertilization, Apomixis and Polyembryony.	8
Unit VIII	Palynology Pollen structure, pollen morphology, Pollen allergy, Applied Palynology: Basic concepts, Palaeopalynology, Aeropalynology, Forensic Palynology, Role in Taxonomic evidences.	7

Suggested Readings:

1. Botany: Algae, Fungi, Lichens, Bacteria, Virus, Bryophytes, Pteridophytes, Gymnosperms. Singh, Pandey and Jain, Rastogi Publication, Meerut.
2. New Introductory Botany. Dr. S.K. Gupta, 2017. Kedarnath Ramnath Publications.
3. A.K. Sharma and Rajeshwari Sharma 2018. Botany. B.Sc. I Year. S.R. Scientific Publishers.
4. Parihar, N.S. (1991). An Introduction to Embryophyta. Vol. I. Bryophyta Central Book Depot, Allahabad.
5. Bhatnagar S P (1996), Gymnosperms: A New Age International Publisher.
6. Dutta, A.C. (2016) Botany for Degree students. Oxford University Press.

Evaluation/Assessment Methodology

		Max. Marks
1) Sessional Examination		16
2) Assignments		5
3) Attendance		4
4) ESE		75
Total:		100

Prerequisites for the course: 40% Marks in 12th from a recognized Board with a subject of life Science/ Biology (PCB)

Course Learning Outcomes:

After the completion of the course, the student will be able to

1. Develop critical understanding of morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.
2. Understanding of plant evolution and their transition to land habitat.
3. Understand morphology, anatomy, reproduction and developmental changes there in through typological studies and create knowledge base understanding the basis of plant diversity, economic values and taxonomy of plants.
4. Understanding the details of external and internal features of the plants.

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: B.Sc. (CBZ) Certificate/Diploma/Degree/ CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY AND CLASSICAL BOTANY UG(R)/PG/Ph.D. Class: Certificate		Year: I Semester: II
Credits: 2 Theory: 0 Practical: 2	Subject: Botany	
Course Code: BSBC-NP-121P	TITLE: LAND AND PLANTSARCHITECTURE LAB	
Course Objectives: After the completion of the course the students will be able to: 1. The students will be made aware of the group of plants that have given rise to land habit and the flowering plants. Through field study they will be able to see these plants grow in nature and become familiar with the biodiversity. 2. Students would learn to create their small digital reports where they can capture the zoomed in and zoomed out pictures as well as videos in case, they are able to find some rare structure or phenomenon related to these plants. 3. Develop an understanding by observation and table study of representative members of phylogenetically important groups to learn the process of evolution in a broad sense. 4. Understand morphology, anatomy, reproduction and developmental changes therein through typological study and create a knowledge base in understanding plant diversity, economic values & taxonomy of lower group of plants 5. Understand the composition, modifications, internal structure &architecture of flowering plants for becoming a Botanist.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents (Minimum any three from each unit, based on the facilities)	No. of Lectures Allotted
I	Bryophytes: Marchantia: Morphology of thallus, W.M. of rhizoids and scales, V.S. thallus through Gemma cup, W.M. of Gemmae (all temporary slides), V.S. Antheridiophore, Archaeogoniophore, L.S. sporophyte (all permanent slides). Sphagnum morphology, W.M. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, L.S. capsule and protonema.	8
II	Pteridophytes: <i>Lycopodium</i> : Habit, stem, T.S. Strobilus, V.S. <i>Selaginella</i> : Habit, rhizophore T.S. Stem, T.S. axis of strobilus, V.S. Strobilus, Megasporophyll and microsporophyll.	7

	<i>Equisetum</i> : Habit, rhizome and T.S. and V.S. of strobilus. <i>Azolla</i> : Habit and structure.	
III	Gymnosperms: 1. Cycas: seedling, coralloid roots, T.S. of coralloid roots, T.S. leaflet and rachis, micro and megasporophyll, V.S. of male cone, microsporophyll and V.S. of ovule. Pinus: Branch of indefinite growth, spur shoot, T.S. of old stem and needle, L.S. of stem, male and female cone, V.S. of male and female cone. 2. Ephedra & Thuja: Habit, stem, T.S. (young and mature), T.S. of leaf, male and female strobilus, V.S. of male and female cone, V.S. of ovule and seed.	8
IV	Palaeobotany 1. Morphology of Rhynia and fossil Gymnosperms and other groups. 2. Visit to Birbal Sahni Institute of Palaeoscience or virtual conference with their scientists to learn fossilization. 3. Mark and learn about Indian geographical sites rich in plant fossils.	6
V	Angiosperm Morphology: 1. To study diversity in leaf shape, size and other foliar features. 2. To study monopodial and sympodial branching. 3. Morphology of fruits. 4. Inflorescence types-study from fresh/ preserved specimens. 5. Flowers- study of different types from fresh/ preserved specimens. 6. Fruits- study of different types from fresh/ preserved specimens. 7. Study of ovules (permanent slides/ specimens/ photographs)- types (anatropous, orthotropous, amphitropous and campylotropous) 8. Modifications in root, stem, leaves and inflorescence.	7
VI	Plant Anatomy: Normal and anomalous secondary thickening: Bignonia, Dracaena, Boerhaavia and Nyctanthes. Study of primary and secondary growth in the root and stem of monocots and dicots by section cutting and permanent slides. Study of internal structures of monocot and dicot leaves. Study of structure of stomata.	8
VII	Reproductive Botany: 1. Structure of anther, microsporogenesis and pollen grains. 2. Structure of ovule and embryo sac development through slides. 3. Study of embryo development in monocots and dicots. 4. Vegetative propagation by the means of cutting, budding and grafting exercises. 5. Study of seed germination. 6. Study of pollen morphology of the following plants- Hibiscus, Vinca, Balsam, Ixora, Croton, Bougainvillea by microscopic observation. 7. Calculation of pollen viability percentage using in vitro pollen germination techniques. 8. Reproductive tissue processing, Block preparation and Microtomy Techniques.	8
VIII	Commercial Uses and Production Technology: 1. Azolla production	8

	2. Production technology of Resins. 3. Production and propagation of ornamental Pteris, Cycadales, Coniferales for land scaping. 4. Lab method for qualitative testing/ extraction of Ephedrine, Taxol and Thuja oil.	
Suggested Reading: 1. Practical Botany, Part I & II Writer: Ashok Bendre and Ashok Kumar. Rastogi Publication. 2. Practical Botany B.Sc. I and II. S.B. Agarwal. Publication: Shilal Agarwal & Co. 3. A.M. and Kumar. A Textbook of Practical Botany. Vol. I and II. Rastogi Publication Meerut. 4. Pandey B.P. and Chadha. 1997. Vol. III. Vikas Publishing House.		
This course can be opted as an elective by the students of the following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture and B. Pharma.		

IIMTU-NEP IMPLEMENTATION
Year: I / Semester: II

Programme: B.Sc.(CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Certificate		Year: I Semester: II	
Credits: 4 Theory: 4 Practical: 0		Subject: Zoology	
Course Code: BSZC-NP-122		Title: Biochemistry and Physiology	
Course Objectives: CO1: To understand Structure and Function of Biomolecules. CO2: To know about Enzyme Action and Regulation. CO3: To understand the blood composition, types, groups and circulatory system. CO4: To understand physiology of excretory system and nervous system of human beings. CO5: To know about Metabolism of Proteins and Nucleotides.			
Nature of Paper: Core/DSE/SEC/GE/AECC: Core			
Minimum Passing Marks/Credits: 50% Marks / 2 Credits			
L: 4 T: 0 P: 4 (In Hours/Week) 4 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)			
Unit	Contents	No. of Lectures Allotted	
I	Structure and Function of Biomolecules - Structure and Biological importance of carbohydrates (Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates) - Lipids (saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids) - Structure, Classification and General Properties of amino acids; Essential and non-essential amino acids; Levels of organization in proteins; Simple and Conjugate proteins.	6	
II	Enzyme Action and Regulation - Nomenclature and classification of enzymes; Cofactors; Specificity of enzyme action. - Isozymes; Mechanism of enzyme action - Enzyme kinetics; Factors affecting rate of enzyme-catalysed reactions; Equation of Michaelis-Menten, Concept of Km and Vmax, Enzyme inhibition - Allosteric enzymes and their kinetics; Regulation of enzyme action.	6	
III	Metabolism of Carbohydrates and Lipids Metabolism of Carbohydrates: glycolysis, citric acid cycle, gluconeogenesis, phosphate pentose pathway	8	

	- Glycogenolysis and Glycogenesis. - Lipids-Biosynthesis of palmitic acid; Ketogenesis, β-oxidation and omega-oxidation of saturated fatty acids with even and odd number of carbon atoms.	
IV	Metabolism of Proteins and Nucleotides - Catabolism of amino acids: Transamination, Deamination, Urea cycle. - Nucleotides and vitamins - Peptide linkages.	8
V	Digestion and Respiration in humans - Structural organization and functions of gastrointestinal tract and associated glands. - Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Mechanism of respiration, pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood Respiratory pigments, Dissociation curves and the factors influencing it; Control of respiration. Histology of trachea and lung.	8
VI	Circulation and Excretion in humans - Components of blood and their functions; hemopoiesis. - Blood clotting: Blood clotting system, Blood groups: Rh factor, ABO and MN. - Structure of mammalian heart-conduction of heart beat - Cardiac cycle; Cardiac output and its regulation, Electrocardiogram, Blood pressure and its regulation. - Structure of kidney and its functional unit; Mechanism of urine formation.	8
VII	Nervous System and Endocrinology in humans - Structure of neuron, resting membrane potential. - Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibres. - Types of synapse - Endocrine glands- pineal, pituitary, thyroid, parathyroid, pancreas, adrenal: hormones secreted by them - Classification of hormones; Mechanism of Hormone action	8
VIII	Muscular System in humans Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus.	8

Reference / Text Books:

- Nelson & Cox: Leininger's Principles of Biochemistry: McMillan (2000).
- Murray et al: Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott: Biochemistry and Molecular Biology: Oxford University Press.
- Guyton, A.C. & Hall, J.E. Textbook of Medical Physiology, XI Edition. Hercourt Asia PTE Ltd./W.B. Saunders Company. (2006).
- Tortora, G.J. & Grabowski, S. Principles of Anatomy & Physiology. XI Edition John Wiley & Sons (2006).
- Hill, Richard W., et al. Animal physiology, Vol. 2 Sunderland, MA: Sinauer Associates, (2004).
- Chatterjee C C Human Physiology Volume 1 & 2. 11th edition. CBS Publishers (2016).

If the course is available as Generic Elective then the students of following departments may opt it.

1.no

2.

Evaluation/Assessment Methodology

Max. Marks:100

1) Sessional Examination	16
2) Assignments	5
3) Presentations /Seminar /Attendance	4
4) ESE	75
Total:	100

Prerequisites for the course:

Course Learning Outcomes:

CLO1: Student will be able to explain the concept of the blood circulation and heart.

CLO2: Student will be able to explain the process of digestion.

CLO3: Student will be able to explain Respiratory system.

CLO4: Student will be able to explain thermoregulation, role and function of hormones.

CLO 5: Student will be able to explain Muscular System in humans.

CLO 6: Student will be able to explain amino acid structures, types of amino acids, classifications, structure of proteins and types of proteins.

IIMTU-NEP IMPLEMENTATION
Year: I / Semester: II

Programme: B.Sc.(CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Certificate	Year:1 Semester: II	
Credits: 2 Theory: 0 Practical: 0	Subject: Zoology	
Course Code: BSZC-NP-122P	TITLE: Physiological, Biochemical and Haematology Lab	
Course Objectives: CO1:To understand preparation of hemin and haemochromogen crystals CO2: To study permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve Cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid CO3:To understand unconditioned reflex action (Deep tendon reflex such as knee jerk reflex) CO4: To understand action of salivary amylase under optimum conditions CO5: To study permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents (Minimum any three from each unit, based on the facilities)	No. of Lectures Allotted
I	• Estimation of haemoglobin using Sahli’shaemoglobinometer • Preparation of hemin and haemochromogen crystals • Counting of RBCs and WBCs using Haemocytometer • To study different mammalian blood cell types using Leishman stain. • Recording of blood pressure using a sphygmomanometer • Recording of blood glucose level by using glucometer	20
II	• Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve Cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid. • Recording of simple muscle twitch with electrical stimulation (or Virtual) • Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)	15
III	• Ninhydrin test for α-amino acids. • Benedict’s test for reducing sugar and iodine test for starch. • Test for sugar and acetone in urine. • Qualitative tests of functional groups in carbohydrates, proteins and lipids.	20

	• . Action of salivary amylase under optimum conditions	
IV	Virtual Labs (Suggestive sites) • https://www.vlab.co.in • https://zoologysan.blogspot.com • www.vlab.iitb.ac.in/vlab • www.onlinelabs.in • www.powershow.com • https://vlab.amrita.edu	15
Suggested Reading: • Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H.Freeman and Co., New York. • Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins. • Arey, L.B. (1974). Human Histology. IV Edition. W.B. Saunders. • Kesar, Saroj and Vasishta N. (2007). Experimental Physiology: Comprehensive Manual, Heritage Publishers, New Delhi.		

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: B.Sc (CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Certificate		Year: I Semester: II	
Credits: 4 Theory: 4 Practical: 0		Subject: Chemistry	
Course Code: BSCC-NP-123		Title: Bioorganic and Medicinal Chemistry	
Course Objectives: 1. Importance of Chemistry of Carbohydrates, proteins, nucleic acids. 2. Importance of medicinal chemistry. 3. Introduction of solid state and its properties. 4. Introduction of polymer chemistry, kinetics and polymerization mechanisms. 5. About synthetic dyes and its various properties.			
Nature of Paper: Core			
Minimum Passing Marks/Credits: 40% Marks / 4 Credits			
L: 4 T: P: 4 Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits) Practical- 2 Hrs.=1 Credit (4Hrs./Week=2Credits)			
Unit	Contents		No. of Lectures Allotted
I	Chemistry of Carbohydrates: Classification of carbohydrates, reducing and non-reducing sugars, General Properties of Glucose and Fructose, their open chain structure. Epimers, mutarotation and anomers. Mechanism of mutarotation Determination of configuration of Glucose (Fischer’s proof). Cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Inter conversions of sugars (ascending and descending of sugar series, conversion of aldoses to ketoses). Lobry de Bruyn-van Ekenstein rearrangement; stepping-up (Kiliani- Fischer method) and stepping-down (Ruff’s & Wohl’s methods) of aldoses; end-group-interchange of aldoses Linkage between monosachharides, structure of disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation		10
II	Chemistry of Proteins: Classification of <i>amino acids</i> , zwitter ion structure and Isoelectric point. Overview of primary, secondary, tertiary and quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxy peptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection & C-activating groups and Merrifield solid phase synthesis. Protein denaturation/		10

	renaturation Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action(Including stereo specificity), Enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and Non-Competitive inhibition including allosteric inhibition).	
III	Chemistry of Nucleic Acids: Constituents of Nucleic acids: Adenine, guanine, thymine and Cytosine (Structure only), Nucleosides and nucleotides (nomenclature), Synthesis of nucleic acids, Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation	05
IV	Introductory Medicinal Chemistry: Drug discovery, design and development; Basic Retrosynthetic approach. Drugaction-receptor theory. Structure–activity relationships of drug molecules, binding role of –OH group, –NH ₂ group, double bond and aromatic ring. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryltrinitrate), HIV-AIDS related drugs (AZT- Zidovudine)	10
V	Solid State: Definition of space lattice, unit cell. Laws of crystallography – (i) Law of constancy of interfacial angles, (ii) Law of rationality of indices and iii) Symmetry elements in crystals and law of symmetry . X-ray diffraction by crystals. Derivation of Bragg equation. Determination of crystal structure of NaCl, KCl and CsCl (Laue's method and powder method).	05
VI	Introduction to Polymer: Monomers, Oligomers, Polymers and their characteristics, Classification of polymers: Natural synthetic, linear, cross linked and network; plastics, elastomers, fibres, Homopolymers and Co-polymers, Bonding in polymers: Primary and secondary bond forces in polymers; cohesive energy, and decomposition of polymers. Determination of Molecular mass of polymers: Number Average molecular mass(M _n) and Weight average molecular mass (M _w) of polymers and determination by (i) Viscosity (ii) Light scattering method (iii) Gel permeation chromatography (iv) Osmometry and Ultra centrifuging. Silicones and Phosphazenes: Silicones and phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes.	10
VII	Kinetics and Mechanism of Polymerization: Polymerization techniques, Mechanism and kinetics of copolymerization, Addition or chain- growth polymerization, Free radical vinyl polymerization, ionic vinylpolymerization, Ziegler-Natta polymerization and vinyl polymers, Condensation or step growth-polymerization, Polyesters, polyamides, phenol formaldehyde resins, urea formaldehyde resins, epoxy resins and polyurethanes, Natural and synthetic rubbers, Elementary idea of organic conducting polymers.	05

VIII	Synthetic Dyes: Colour and constitution (electronic Concept), Classification of dyes, Chemistry and synthesis of Methyl orange, Congo red, Malachite green, crystal violet, phenolphthalein, fluorescein, Alizarin and Indigo.	05
Reference / Text Books: 1. Davis, B. G., Fairbanks, A. J., <i>Carbohydrate Chemistry</i>, Oxford Chemistry Primer, Oxford University Press. 2. Finar, I. L. <i>Organic Chemistry (Volume 2)</i>, Dorling Kindersley (India) Pvt. Ltd.(Pearson Education). 3. Nelson, D. L. & Cox, M. M. <i>Lehninger's Principles of Biochemistry 7th Ed.</i>, W. H. Freeman. 4. Berg, J. M., Tymoczko, J. L. & Stryer, L. <i>Biochemistry 7th Ed.</i>, W. H. Freeman. 5. Morrison, R. T. & Boyd, R. N. <i>Organic Chemistry</i>, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 6. Patrick, G. L. <i>Introduction to Medicinal Chemistry</i>, Oxford University Press, UK, 2013. 7. Singh, H. & Kapoor, V.K. <i>Medicinal and Pharmaceutical Chemistry</i>, Vallabh Prakashan, Pitampura, New Delhi, 2012. 8. Atkins, P. W. & Paula, J. de <i>Atkin's Physical Chemistry Ed.</i>, Oxford University Press 13(2006). 9. Ball, D. W. <i>Physical Chemistry</i> Thomson Press, India (2007). 10. Castellan, G. W. <i>Physical Chemistry 4th Ed.</i> Narosa (2004). 11. R.B. Seymour & C.E. Carraher: <i>Polymer Chemistry: An Introduction</i>, Marcel Dekker, Inc. New York, 1981. 12. G. Odian: <i>Principles of Polymerization</i>, 4thEd.Wiley, 2004. 13. F.W. Billmeyer: <i>Text book of Polymer Science</i>, 2ndEd. Wiley Inter science, 1971. 14. P. Ghosh: <i>Polymer Science & Technology</i>, Tata McGraw-Hill Education, 1991.		
Evaluation/Assessment Methodology		
		Max. Marks
1) Sessional Examination		16
2) Assignments		5
3) Attendance		4
4) ESE		75
Total:		100
Prerequisites for the course: Basic knowledge of Chemistry taught in the preceding semester.		
Course Learning Outcomes: 1. Students will understand the concept of carbohydrates, proteins, nucleic acids. 2. Students will be able to understand the various types of drugs and medicines and its importance. 3. Students will be able to understand solid state chemistry. 4. Students will be able to understand the basics of polymer chemistry & its mechanisms. 5. Students will be able to understand about synthetic dyes and its importance in daily life.		

IIMTU-NEP IMPLEMENTATION
Year: I / Semester: II

Programme: B.Sc (CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Certificate	Year: I Semester: II	
Credits: 2 Theory: 0 Practical: 2	Subject: Chemistry	
Course Code: BSCC-NP-123P	Title: Biochemical Analysis Lab	
Course Objectives: This course will provide basic qualitative and quantitative experimental knowledge of biomolecules such as carbohydrates, proteins, amino acids, nucleic acids drug molecules. Upon successful completion of this course students may get job opportunities in food, beverage and pharmaceutical industries.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: P: 4 Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits) Practical- 2 Hrs.=1 Credit (4Hrs./Week=2Credits)		
Unit	Contents	No. of Lectures Allotted
I	Qualitative and quantitative analysis of Carbohydrates: . 1. Separation of a mixture of two sugars by ascending paper chromatography 2. Differentiate between a reducing/ non reducing sugar Synthesis of Osazones.	15
II	Qualitative and quantitative analysis of Proteins, amino acids and Fats 1. Isolation of protein. 2. Determination of protein by the Biuret reaction. 3. TLC separation of a mixture containing 2/3 amino acids 4. Paper chromatographic separation of a mixture containing 2/3 amino acids 5. Action of salivary amylase on starch 6. To determine the concentration of glycine solution by formylation method. 7. To determine the saponification value of anoil/fat. 8. To determine the iodine value of anoil/fatEstimation of copper using thiosulphate.	20
III	Determination and identification of Nucleic Acids 1. Determination of nucleic acids. 2. Extraction of DNA fromonion/cauliflower.	12
IV	Synthesis of Simple drug molecules 1. To synthesize aspirin by acetylation of salicylic acid and compare it with the ingredient of an aspirin tablet by TLC. 2. Synthesis of barbituric acid	13

3. Synthesis of propranolol	
Reference / Text Books: 1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. <i>Practical Organic Chemistry</i>, 5th Ed., Pearson (2012). 2. Mann, F.G. & Saunders, B.C. <i>Practical Organic Chemistry</i>, Pearson Education. 3. <i>Vogel's Qualitative Inorganic Analysis</i>, Revised by G. Svehla. 4. Vogel, A.I. <i>A Textbook of Quantitative Analysis</i>, ELBS.1986 5. Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. <i>Vogel's Textbook of Practical Organic Chemistry</i>, ELBS. 6. Ahluwalia, V.K. & Aggarwal, R. <i>Comprehensive Practical Organic Chemistry</i>, Universities Pres 7. Cooper, T.G. <i>Tool of Biochemistry</i>. Wiley-Blackwell (1977). 8. Wilson, K. & Walker, J. <i>Practical Biochemistry</i>. Cambridge University Press (2009). 9. Varley, H., Gowenlock, A.H & Bell, M.: <i>Practical Clinical Biochemistry</i>, Heinemann,	
Evaluation/Assessment Methodology	
	Max. Marks
1) Lab Performance	10
2) Attendance	5
4) Record	5
3) ESE	30
Total:	50
Prerequisites for the course: Basic knowledge of chemistry taught in the preceding semester.	
Course Learning Outcomes: This course will provide basic qualitative and quantitative experimental knowledge of biomolecules such as carbohydrates, proteins, amino acids, nucleic acids drug molecules. Upon successful completion of this course students may get job opportunities in food, beverage and pharmaceutical industries.	

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: B.Sc. (CBZ) Certificate/Diploma/Degree/ Bachelor Of Science In CBZ UG(R)/PG/Ph.D. Class: DEGREE		Year: I Semester: II
Credits: 4 Theory: 4 Practical: 0	Subject: Botany	
Course Code: CBZGE-NP-124a		Title: SOIL HEALTH ASSESSMENT
Course Objectives: 1. Soil health Assessment and management will continue to play a prominent role in agricultural production systems of arid and semi-arid agroecosystems. 2. Learn about healthy soil maintenance as it is more resilient against fluctuations in growing conditions. 3. Learn about soil profiles, types and other relevant physical as well as chemical characteristics of soil that are best suited for crop production. 4. To know the impact of heavy metals in the soil. 5. To know the importance of soil health card. 6. To know the significance of Soil Seed Bank.		
Nature of Paper: Generic Elective		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
Unit	Topics	Lectures
I	Concept of soil health and its significance. Key indicators for soil health for sustainable agriculture. Soil sample collection (vertical and horizontal profiling)	12
II	Soil Physical Tests: • Soil Texture • Soil moisture content and its availability in different types of soil. • Water holding capacity of soil, its importance and field capacity of the soil. • Soil Porosity and its importance • Soil bulk density • Soil temperature and its effect on different living beings (Plants, microbes and soil living animals)	12
III	Soil Chemical Tests: Cation exchange capacity of the soil and its importance in crop yield. pH of soil and its role in crop growth and crop yield. Organic carbon and its significance to soil quality and its effect on crop. Availability of nitrogen in the soil. Nitrogen cycle. Nitrogen fertilizers.	12
IV	Heavy metal analysis in the soil. Its positive and negative effects on the soil and crop yields and on animals living in the soil. Soil seed bank and soil microbiota analysis.	12
V	Classification of soil and its types.	12

	Soil Health card preparation Recommendation regarding utility of soil sample for suitable crops.	
References:		
1. Ashok Bendre, Ashok Kumar, Rastogi Publication, Meerut. 2. Piper, C.S. (1944) Soil and plant analysis, Interscience Publications, Inc. NY. 3. ICAR (2015) Soil Health Card, Ministry of Agriculture and Farmer Welfare, Govt. of India.		
Evaluation/Assessment Methodology		
		Max. Marks
1) Sessional Examination		16
2) Assignments		5
3) Attendance		4
4) ESE		75
Total		100
Course Learning Outcomes:		
After the completion of the course, the students will be able to-		
1. Understand the instruments, techniques and good laboratory practices for field work. 2. Identify the soil health issues and their management for safe agriculture/ horticulture. 3. Understand the preparation of soil health card for agricultural utility during pre-harvest and post-harvest management. 4. Start own enterprise on soil health assessment.		

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: B.Sc. (CBZ) Certificate/Diploma/Degree/ BACHELOR OF SCIENCE IN CBZ UG(R)/PG/Ph.D. Class: DEGREE	Year: I Semester: II	
Credits: 4 Theory: 4 Practical: 0	Subject: Botany	
Course Code: CBZGE-NP-124b	DISASTER MANAGEMENT SYSTEM IN INDIA	
Course Objectives: 1. This course aims to teach students ways to reduce the risk of disasters caused by human error, deliberate destruction, and building or equipment failures. 2. They will be better prepared to recover from a major natural catastrophe. 3. They will also learn about recovery of lost or damaged records or information after a disaster. 4. The course also aims to ensure the organization's ability to continue operating after a disaster.		
Nature of Paper: Generic Elective		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
Unit	Topics	Lectures
I	Overview and understanding of disaster, Definitions of Disasters, Hazard, Vulnerability, Resilience and Risks.	7
II	Classification of disaster, Natural hazards and man made disasters, Causes and social impacts, Urban disasters, Pandemics and climatic changes.	7
III	Panchayati raj Institutions/ Urban local bodies (PRIs/ ULBs), States, centre and other stake holders, CRBN disasters, NDMA, NDRF, NIDM, STATE DM	8
IV	Disaster Risk Management System in India Hazard and vulnerability profile of India, Components of Disaster relief: water, food, sanitation, shelter, Health, Fire, Waste management Institutional arrangements.	8
V	Mitigation, Response and preparedness, DM Act and Policy, Other Related Policies, Plans, Programs and legislations.	7
VI	Disaster-induces refugee problem- Problems of women and children during disasters; Principles of psycho-social care, issues and recovery Relationships between disasters, development and vulnerabilities	8
VII	Equity issues in disasters; Issues of rehabilitation and resettlement of survivors; Stakeholders in disaster relief management.	7
VIII	Disaster Risk reduction-Strategies, preparedness plans, Action plans and procedures, Early warning system; Factors contributing to vulnerability. Capacity building	8
Suggested Readings: 1. Disaster Management R. Subramanian Vikas Publishing House- Business & Economy. 2. Gupta Anil K., Sreeja S. Nair 2011. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi.		

3. Indian Journal of Social work 2002. Special issue on Psychosocial Aspects of Disasters, Volume 63, Issue 2, April.
4. Kapur, Anu & Others, 2005; Disasters in India, Studies of Grim reality, Rawat Publishers, Jaipur.
5. Kapur Anu, 2010. Vulnerable India: A Geographical studies of Disasters IIA Sand Sage Publishers, New Delhi.
6. Govt. of India: Disaster Management Act, 2005. Govt. of India, New Delhi.
7. Govt. of India, 2009. National Disaster Management Policy.

Evaluation/Assessment Methodology

	Max. Marks
1) Sessional Examination	16
2) Assignments	5
3) Attendance	4
4) ESE	75
Total	100

Course Learning Outcomes:

1. The course focuses on basic concept of disaster(s) and disaster management, their significance and types.
2. This course will enable to develop the analytical skills to study relationship between vulnerability, disasters prevention and risk reduction.
3. The knowledge creates awakened group for integrated Disaster management in the Country.
4. It will enable young people in each city district or village to understand and explore avenues of reducing disaster risks and work towards preparedness and contribute towards minimizing losses and saving lives.

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: III

Programme: B.Sc. (CBZ) Certificate/Diploma/Degree/ DIPLOMA IN PLANT IDENTIFICATION & ETHNOMEDICINE UG(R)/PG/Ph.D. Class: Diploma		Year: II Semester: III
Credits: 4 Theory: 4 Practical: 0	Subject: Botany	
Course Code: BSBC-NP-231	TITLE: FLOWERING PLANTS IDENTIFICATION & AESTHETIC CHARACTERISTICS	
Course Objectives: This subject aims for students to 1. Understand the taxonomic principles. 2. Know the history of taxonomy. 3. Learn the different phases of taxonomy. 4. Know the philosophy of classification. 5. Understand the different types of classifications		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No.	Topics	Lectures
Unit I	Taxonomic Resources and Nomenclature Components of taxonomy (identification, nomenclature, classification); Taxonomic resources Herbarium – functions &important herbaria, Botanical gardens, Flora, artificial keys. Binomial Nomenclature: Principles and rules of Botanical nomenclature according to ICN(ranks and taxa; principle of priority, type method, author citation, valid publication.)	7
Unit II	Types of Classification and Evidences Artificial, natural and phylogenetic, Bentham and Hooker (upto series), Takhtajaan, Angiosperm Phylogeny Group (APG IV) classification. Introduction to taxonomic evidences from cytology, phytochemistry & Molecular biology data (Protein and Nucleic acid homology).	8
Unit III	Identification of Angiospermic families-I:(Families can be chosen University wise as for local available Flora) A comparative study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham & Hooker’s system) Ranunculaceae, Malvaceae, Rutaceae, Fabaceae, Cucurbitaceae, Apiaceae, Asteraceae.	8+1 =9

Unit IV	Identification of Angiospermic families-II:(Families can be chosen University wise as for local available Flora) A comparative study of the following families with emphasis on the morphological peculiarities and economic importance of its members (based on Bentham and Hooker's system)- Asclepiadaceae, Solanaceae, Amaranthaceae, Euphorbiaceae, Liliaceae, Poaceae, Lamiaceae.	7+1 =8
Unit V	Phylogenetic Systematics Brief Idea on Phenetics, Biometrics (Neighbourjoining), Cladistics: Basics and methodology; Supraspecific taxa (Monophyletic, Polyphyletic and Paraphyletic Groups); Plesiomorphy and Apomorphy).	8
Unit VI	Tools and Softwares in Plant Identification Digital taxonomy (e-flora), Description language for Taxonomy-DELTA Internet directory for Botany.	7-2 =5
Unit VII	Computer usage, Android applications & Character Analysis MS Office: PPT,Microsoft Excel, data entry, graphs, GPS tagging, Plant Identification Apps.	7
Unit VIII	Aesthetic Characteristics of Plants Elementary knowledge of Aesthetic characteristics of plants, English, Italian, French, Persian, Mughal and Japanese; Features of a garden (Garden wall, fencing, Steps, Hedge, Edging, Lawn, Trees, shrubs and shrubberies, Climbers and Creepers. Rockery, flower beds, Shrubbery, Borders, water Garden). Some famous gardens of India. Conservatory, greenhouses, Indoor Garden, Roof Garden, Topiary, Bonsai.	8

Suggested Readings:

1. Moderna Microbiology (hindi) (hb) ISBN: 9788177543599 Edition: 1Year: 2018 Author: Dr. Purbhit SS, Dr. Singh T Publisher: Agrobios (India)
2. "Taxonomy of Angiosperms" by Gurucharan Singh
3. Suggested book- "Eminent Indian Botanists: Past and Present (Biographies and contributions)", P.Suresh Narayan and T. Pullaiah, Regency Publications, (2011)
4. Taxonomy by Saxena & Saxena.
5. Taxonomy by N S Subramanyam.
6. Flowering Plants Identification & Aesthetic characteristics by Pragati Publication. (Botany III). Kumar A., Kumar, S., Chachar SS and A. Kumar.
7. Taxonomy by O.P. Sharma.

Evaluation/Assessment Methodology

Max. Marks	
1) Sessional Examination	16
2) Assignments	5
3) Attendance	4
4) ESE	75
Total:	100

Prerequisites for the course:40% Marks in 12th from a recognized Board with a subject of life Science/ Biology (PCB)

Course Learning Outcomes:

After the completion of the course, the student will be able to

1. To gain understanding of the history and the concepts underlying various approaches to plant taxonomy and classification.
2. To learn the major patterns of diversity among plants and the characters and the type of data used to

classify plants.

3. To compare the different approaches to classification with regards to the analysis of data.
4. To become familiar with the major taxa and their identifying characteristics and to develop in depth knowledge of the current taxonomy major plant family.
5. To discover and use diverse taxonomic resources, reference materials, herbarium collections and publications.
6. For the entrepreneur career in plant, one can establish nursery, start land scaping business, Set up a farm or run a plant consultancy firm.

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: III

Programme: B.Sc. (CBZ) Certificate/Diploma/Degree/ DIPLOMA IN PLANT IDENTIFICATION, UTILIZATION & ETHNOMEDICINE UG(R)/PG/Ph.D. Class: Diploma		Year: II Semester: III
Credits: 2 Theory: 0 Practical: 2	Subject: Botany	
Course Code: BSBC-NP-231P	TITLE: PLANT IDENTIFICATION AND TECHNOLOGY LAB	
Course Objectives: After the completion of the course the students will be able: 1. To learn how plant specimens are collected, documented, and curated for a permanent record. 2. To observe, record, and employ plant morphological variation and the accompanying descriptive terminology. 3. To gain experience with the various tools and means available to identify plants. 4. To develop observational skills and field experience. 5. To identify a taxonomically diverse array of native plants. 6. To recognize common and major plant families. 7. To Understand aesthetic characters of flowering plants by making-landscapes, gardens, bonsai, miniatures 8. Comprehend the concepts of plant taxonomy and classification of Angiosperms.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents (Minimum any three from each unit, based on the facilities)	No. of Lectures Allotted
I	Topic: Herbarium: Plant Collection, Preservation and Documentation: Stepwise practicing Herbarium techniques: (A) FIELD EQUIPMENTS, Global Positioning System (GPS) instrument and collection of any wild 25 plant specimens. (B) Learn to handle Herbarium making tools. (C) Pressing and drying of collected plant specimens. (D) Special treatments for various groups of plants. (E) Mount on standard herbarium sheets. (F) Label them using Standard methods. (G) Organize them and give Index Register Number.	7
II	Topic: Taxonomic Identification using Plant Structure Classify 25 plants on the basis of Taxonomic description (Plant morphology, Anatomy, Reproductive parts, Habit, Adaptation anomalies according to	8

	Bentham and Hooker system of classification in the following families: Malvaceae, Fabaceae (Papilionaceae), Solanaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae, Poaceae.	
III	Topic: Identification during excursions (A) Conducting spot identification (Binomial Family) of common wild plants from families including in the theoretical syllabus (list to be provided) and making FIELD NOTEBOOK and filling sample of page of field book, used in Botanical Survey of India. (B) Describe/Compare flowers in semi-technical language giving V.S. of flowers, T.S. of ovaries, Floral diagrams and Floral Formulae. Identify and assign them to their respective families giving reasons.	8
IV	COLLECTION PRESERVATION AND STORAGE OF ALGAE, FUNGI BRYOPHYTES, PTERIDOPHYTES (TWO EACH)	7
V	Topic:-Botanical Nomenclature and Reporting Method: (A) Give nomenclature to collected plants as per ICN rules and prepare labels as per BSI (B) Author citation, effective Publication and principle of priority: To show a specimen paper on basic structure of a taxonomic research published on a new species in taxonomic Journal.	7
VI	Topic:- Computer Application and Character Coding (A) Learning to use Excel Microsoft PowerPoint and word, working with folder and Windows utility, create and manage files and folder tree, selection of character, Coding and Preparation of Data Matrix in Ms Office or MS Excel. (B) Practice browsing different sites using search engines. Practice and understand different E-mail services- Outlook, Yahoo Mail, rediffmail etc. Practice creating E-mail accounts, sending, receiving and storing of mails. (C) Create and participate in virtual conferencing in an interactive zoom meeting.	8
VII	Topic:- Computer Application In Taxonomy (A) Use Taxonomic Softwares (Dichotomous Key) (B) Practicals on phylogenetic analysis (C) Make line drawing of plants for description (D) Using of plant identification apps on android phones	8
VIII	(A) Create a Bonsai of any plant (B) Develop a miniature Garden (C) Draw layouts of various types of gardens (D) Plant propagation methods practice	8
Suggested Readings: 1. Plant Systematics. Arun K Pandey and Shruti Kansana. 2020. Jaya publishing house. 2. Dutta A.C. 2016. Botany for Degree Students. Oxford University Press. 3. Heywood, V.H. and D.M. Moore (Eds). 1984. Current Concepts in Plant Taxonomy. Academic Press, London.		

IIMTU-NEP IMPLEMENTATION

Programme: B.Sc (CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Diploma		Year: II Semester: III
Credits: 4 Theory: 4 Practical: 2	Subject: ZOOLOGY	
Course Code: BSZC-NP-232	Title: Molecular Biology, Bioinstrumentation & Bio techniques	
Course Objectives: CO1:To understand salient features of Nucleic Acids and DNA model. CO2:To understand key events of molecular biology comprising of mechanism of DNA Replication, Transcription and Translation in Prokaryotes and Eukaryotes. CO3: To provide adequate knowledge about Post Transcriptional Modifications and Processing of Eukaryotic RNA. CO4:To understand transcriptional regulation with examples of lac operon and tryptophan operon in prokaryotic as well as eukaryotic organisms along with key concept of Gene Silencing to the course learners. CO5:To develop comprehensive understanding regarding DNA Repair Mechanisms in the course learners.		
Nature of Paper: Core/DSE/SEC/GE/AECC: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P: 4 (In Hours/Week) 4 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Protein synthesis I: Process of Transcription • Fine structure of gene • RNA polymerases • Transcription factors and machinery • Formation of initiation complex • Initiation, elongation and termination of transcription in prokaryotes and eukaryotes	6
II	Protein synthesis II: Process of Translation • The Genetic code • Ribosome • Factors involved in translation • Aminoacylation of tRNA, tRNA-identity, aminoacyl-t RNA-synthetase • Initiation, elongation and termination of translation in prokaryotes and	6

	eukaryotes	
III	Regulation of Gene Expression I - Regulation of gene expression in prokaryotes: <i>lac</i> and <i>trp</i> operons in <i>E.coli</i> - Regulation of gene expression in eukaryotes: Role of chromatin in gene expression - Regulation at transcriptional level, Post-transcriptional modifications: Capping, Splicing, Polyadenylation - RNA editing.	8
IV	Regulation of Gene Expression II - Regulation of gene expression in eukaryotes - Regulation at translational level, Post- translational modifications etc. - Intracellular protein degradation - Gene silencing, RNA interference (RNAi)	8
V	Principle and Types of Microscopes - Principle of Microscopy and Applications - Types of Microscopes: light microscopy, dark field microscopy, phase-contrast microscopy. - Fluorescence microscopy, confocal microscopy, electron microscopy	8
VI	Centrifugation and Chromatography - Principle of Centrifugation - Types of Centrifuges: high speed and ultracentrifuge - Types of rotors: Vertical, Swing-out, Fixed-angle etc. - Principle and Types of Chromatography: paper, ion-exchange, gel filtration, HPLC, affinity.	8
VII	Spectrophotometry and Biochemical Techniques - Biochemical techniques: Measurement of pH, Preparation of buffers and solutions - Principle of Colorimetry/Spectrophotometry: Beer-Lambert law - Measurement applications and safety measures of radio-tracer techniques.	8
VIII	Molecular Techniques - Detection of nucleic acid by gel electrophoresis - DNA sequencing; DNA fingerprinting, RFLP - Polymerase Chain Reaction (PCR) - Detection of proteins, PAGE, ELISA, Western blotting	8
Reference / Text Books: - Benjamin Lewin. Genes XII.2017. Benjamin-Cummings Pub Co. London. - Harvey Lodish. 2016. Molecular cell biology. 8th Edition.W. H. Freeman. America. - David. P. Clark. 2010. Molecular Biology. Academic Press. USA. - Brown. T.A.2017. Genomes. 4thEdn. Wiley-Liss (New York). - Larry Snyder, Wendy Champness. 2013. Molecular Genetics of Bacteria. 4th Edn. American Society for Microbiology. USA. - Sandy B. Primrose, Richard M. Twyman, Robert W. Old, 2016. Principles of Gene Manipulation and genomics. 8th Edn. Blackwell Science. United States. - Volker A. Erdmann. 2015. RNA and DNA Diagnostics. Springer International Publishing Switzerland.		

- Suming Huang. Michael. D. Litt. C. Ann Blakey. 2016. Epigenetic Gene Expression and Regulation. Academic Press London.

If the course is available as Generic Elective then the students of following departments may opt it.

- 1.no
- 2.

Evaluation/Assessment Methodology

Max. Marks:100

1) Sessional Examination	16
2) Assignments	5
3) Presentations /Seminar /Attendance	4
ESE	75
Total:	100

Prerequisites for the course:

Course Learning Outcomes:

CLO1: Student will be able to explain structure of Nucleic Acids and DNA model.

CLO2: Student will be able to explain of mechanism of DNA Replication, Transcription and Translation in Prokaryotes and Eukaryotes.

CLO3: Student will be able to explain Post Transcriptional Modifications and Processing of Eukaryotic RNA.

CLO4: Student will be able to explain transcriptional regulation with examples of lac operon and tryptophan operon in prokaryotic as well as eukaryotic organisms.

CLO5: Student will be able to explain DNA Repair Mechanisms and significance.

CLO6: Student will be able to explain applications of bioinstruments.

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: III

Programme: B.Sc (CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Diploma		Year: II Semester: III	
Credits: 2 Theory: 0 Practical: 2		Subject: Zoology	
Course Code: BSZC-NP-232P		TITLE: Bioinstrumentation and Molecular Biology Lab	
Course Objectives: CO1:To provide working principle and Simple, Compound and Binocular microscopes. CO2:To impart knowledge about Laminar Flow, Incubator, Centrifuge, Chromatography apparatus, etc. CO3: To identify different amino acids in a mixture using paper chromatography. CO4: To prepare solutions and buffers. CO5: To estimate amount of DNA using spectrophotometer.			
Nature of Paper: Core			
Minimum Passing Marks/Credits: 50% Marks / 2 Credits			
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)			
Unit	Contents (Minimum any three from each unit, based on the facilities)		No. of Lectures Allotted
I	• To study the working principle and Simple, Compound and Binocular microscopes. • To study the working principle of various lab equipment such as pH Meter, Electronic balance, use of glass pipettes and micropipettes, Laminar Flow, Incubator, Centrifuge, Chromatography apparatus, etc. (Any three)		15
II	• To prepare solutions and buffers. • To measure absorbance in Colorimeter or Spectrophotometer (optional/virtual). • Demonstration of differential centrifugation to fractionate different components in a mixture (optional).		15
III	• To identify different amino acids in a mixture using paper chromatography. • Demonstration of DNA extraction from blood or tissue samples. • To estimate amount of DNA using spectrophotometer.		15
IV	Virtual Labs (Suggestive sites) • www.labinapp.com • www.uwlax.edu		15

	• www.labster.com • www.onlinelabs.in • www.powershow.in • https://vlab.amrita.edu • info@premiereducationaltechnologyies.com • https://li.wsu.edu	
Suggested Reading: 1. Sambrook <i>et al.</i> Molecular Cloning Vols I,II,III. CSHL (2001). 2. Primrose. Molecular Biotechnology. Panima (2001). 3. Clark & Switzer. Experimental Biochemistry. Freeman (2000)		

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: III

Programme: B.Sc (CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Diploma		Year: II Semester: III	
Credits: 4 Theory: 4 Practical: 0		Subject: Chemistry	
Course Code:BSCC-NP-233		Title: Chemical Dynamics & Coordination Chemistry	
Course Objectives: 1. Importance of Chemical kinetics in chemistry. 2. Importance of various equilibria in chemistry such as chemical and phase equilibria. 3. Introduction of various states in chemistry such as gaseous and liquid states of matter. 4. Introduction of various aspects of co-ordination chemistry. 5. Inorganic spectroscopy and its various factors and usefulness of it in chemistry.			
Nature of Paper: Core			
Minimum Passing Marks/Credits: 40% Marks / 4 Credits			
L: 4 T: P: 4 Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits) Practical- 2 Hrs.=1 Credit (4Hrs./Week=2Credits)			
Unit	Contents		No. of Lectures Allotted
I	Chemical Kinetics: Rate of a reaction, molecularity and order of reaction, concentration dependence of rates, mathematical characteristic of simple chemical reactions – zero order, first order, second order, pseudo order, half-life and mean life. Determination of the order of reaction – differential method, method of integration, half-life method and isolation method. Theories of chemical kinetics: Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy		10
II	Chemical Equilibrium: Equilibrium constant and free energy, thermodynamic derivation of law of mass action. Le-Chatelier's principle.		05
III	PhaseEquilibrium: Statementandmeaningoftheterms-phase,component and degreeoffreedom, derivation of Gibbs phase rule, phase equilibria of one component system– water systems. Phase equilibria of two component systems – Solid - liquid equilibria.		05
IV	Kinetic theories of gases: Gaseous State: Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waals equation of state. Critical phenomena: PV isotherms of real gases, continuity of states, the		10

	isotherms of Van der Waals equation, relationship between critical constants and Van der Waals constants, the law of corresponding states, reduced equation of state.	
V	Liquid State: Intermolecular forces, structure of liquids (a qualitative description). Structural differences between solids, liquids and gases. Liquid crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholesterol phases. Thermography and seven segment cell. Liquids in solids (gels): Classification, preparation and properties, inhibition, general application	05
VI	Coordination Chemistry: Coordinate bonding: Double and complex salts. Werner's theory of coordination complexes, classification of ligands, ambidentate ligands, chelates, coordination numbers, IUPAC nomenclature of coordination complexes (up to two metal centers), Isomerism in coordination compounds, constitutional and stereo isomerism, geometrical and optical isomerism in square planar and octahedral complexes.	05
VII	Theories of Coordination Chemistry I Metal- ligand bonding in transition metal complexes, limitations of valence bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, factors affecting the crystal-field parameters. II. Thermodynamic and kinetic aspects of metal complexes: A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, stability constants of complexes and their determination, substitution reactions of square planar complexes	10
VIII	Inorganic Spectroscopy and Magnetism I) Electronic spectra of Transition Metal Complexes Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, Orgel-energy level diagram for d1 and d9 states, discussion of the electronic spectrum of $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ complex ion. II) Magnetic properties of transition metal complexes, types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for 3d-metal complexes. Physical properties and molecular structure: Optical activity, polarization – (Clausius - Mossotti equation), orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment-temperature method and refractivity method, dipole moment and structure of molecules, magnetic properties paramagnetism, diamagnetism and ferromagnetism, magnetic susceptibility, its measurements and its importance.	10
Reference / Text Books: 1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13(2006). 2. Ball, D. W. Physical Chemistry Thomson Press, India (2007). 3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).		

4. Cotton, F.A, Wilkinson, G and Gaus, P. L, Basic Inorganic Chemistry, 3rd Edition, Wiley 1995
5. Lee, J.D, Concise Inorganic Chemistry 4th Edition ELBS, 1977
6. Douglas, B, McDaniel, D and Alexander, J, Concepts of Models of Inorganic Chemistry, John Wiley & Sons; 3rd edition, 1994
7. Shriver, D. E Atkins, P.W and Langford, C.H, Inorganic Chemistry, Oxford University Press, 1994.
8. Porterfield, W.W, Inorganic Chemistry, Addison Wesley 1984.
9. Sharpe, A. G, Inorganic Chemistry, ELBS, 3RD edition, 1993
10. Miessler, G.L, Tarr, D.A, Inorganic Chemistry, 2nd edition, Prentice Hall, 2001

Evaluation/Assessment Methodology

	Max. Marks
1) Sessional Examination	16
2) Assignments	5
3) Attendance	4
4) ESE	75
Total:	100

Prerequisites for the course: Basic knowledge of chemistry taught in the preceding semester.

Course Learning Outcomes:

1. Students will understand the concept of chemical kinetics and various parameters related.
2. Students will be able to understand the various type's equilibria in chemistry such as chemical and phase equilibria.
3. Students will be able to understand liquid state chemistry and kinetic theory of gases.
4. Students will be able to understand the basics co-ordination chemistry & its various aspects of it.
5. Students will be able to understand about inorganic spectroscopy and magnetism effects.

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: III

Programme: B.Sc (CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Diploma		Year: II Semester: III
Credits: 2 Theory: 0 Practical: 2		Subject: Chemistry
Course Code: BSCC-NP-233P		Title: Physical Analysis Lab
Course Objectives: Upon successful completion of this course students should be able to calibrate apparatus and prepare solutions of various concentrations, estimation of components through volumetric analysis; to perform dilatometric experiments: one and two component phase equilibrium experiments.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: P: 4 Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits) Practical- 2 Hrs.=1 Credit (4Hrs./Week=2Credits)		
Unit	Contents	No. of Lectures Allotted
I	Strengths of Solution Calibration of fractional weights, pipettes and burettes. Preparation of standards solutions. Dilution–0.1 M to 0.001 M solutions. Mole Concept and Concentration Units: Mole Concept, molecular weight, formula weight, and equivalent weight. Concentration units: Molarity, Formality, Normality, Molality, Mole fraction, Percent by weight, Percent by volume, Parts per thousand, Parts per million, Parts per billion, pH, pOH, milli equivalents, Milli moles	20
II	Surface Tension and Viscosity 1. Determination of surface tension of pure liquid or solution. 2. Determination of viscosity of liquid pure liquid or solution.	06
III	Boiling point and Transition Temperature 1. Boiling point of common organic liquid compound <i>sn</i> butyl alcohol, cyclohexanol, ethyl methyl ketone, cyclohexanone, acetylacetone, isobutyl methyl ketone, isobutyl alcohol, acetonitrile, benzaldehyde and acetophenome. [Boiling points of the chosen organic compounds should preferably be within 180 ⁰ C]. 2. Transition Temperature, Determination of the transition temperature of the given substance by thermometric/dilatometric method (e.g. MnCl2.4H2O/SrBr2.2H2O)	14
IV	Phase Equilibrium 1. To study the effect of a solute (e.g. NaCl, succinic acid) on the critical	20

	solution temperature of two partially miscible liquids (e.g. phenolwater system) and to determine the concentration of that solute in the given phenol-watersystem. 2. To construct the phase diagram of two component (e.g .diphenylamine benzophenone)systemby cooling curve method.	
Reference / Text Books: 1. Skoog D.A., West. D.M and Holler .F.J., “Analytical Chemistry: An Introduction”, 7th edition, Saunders college publishing, Philadelphia,(2010). 2. Larry Hargis. G” Analytical Chemistry: Principles and Techniques” Pearson© (1988) Note: For the promotion of Hindi language, course books published in Hindi may be prescribed by the University		
Evaluation/Assessment Methodology		
		Max. Marks
1) Lab Performance		10
2) Attendance		5
4) Record		5
3) ESE		30
Total:		50
Prerequisites for the course:Basic knowledge of practical chemistry taught in the preceding semester		
Course Learning Outcomes: Upon successful completion of this course students should be able to calibrate apparatus and prepare solutions of various concentrations, estimation of components through volumetric analysis; to perform dilatometric experiments: one and two component phase equilibrium experiments.		

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: IV

Programme: B.Sc. (CBZ) Certificate/Diploma/Degree/ DIPLOMA IN PLANT IDENTIFICATION, UTILIZATION & ETHNO MEDICINE UG(R)/PG/Ph.D. Class: DIPLOMA		Year: II Semester: IV
Credits: 4 Theory: 4 Practical: 0	Subject: Botany	
Course Code: BSBC-NP-241	TITLE: ECONOMIC BOTANY, ETHNOMEDICINE AND PHYTOCHEMISTRY	
Course Objectives: 1. To explain the mechanisms which underlie evolution at the molecular level. 2. To identify the following crops: Sorghum, Maize, Rice, and Wheat 3. To know the origin, distribution, spread and taxonomy of the above listed crops 4. To be able to describe morphological feature 5. To know the economic importance of the listed crops.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No.	Topics	Lectures
I	Origin and Domestication of Cultivated Plants Centers of diversity of plants, origin of Crop plants. Domestication and introduction of Crop plants. Concepts of sustainable development; cultivation, production and uses of Cereals, legumes, Spices & beverages.	7
II	Botany of oils, Fibers, Timber yielding plants & dyes Study of the plants with Botanical names, Family, part used and economic uses yielding edible and essential oils; Sugar, Starch, Fibres, Paper, Fumigatories& Masticatories, Rubber, Dyes, Timber, Biofuel Crops.	7
III	Commercial Production of Flowers, Vegetables and Fruits (To Be Chosen Area Wise) Commercial greenhouse cultivation of rose, Gerbera, Gladiolus, Anthurium/Lilium/lily, tomato, bell pepper, cucumber, strawberry and exotic leafy vegetables using hydroponics.	7

IV	IPR and Traditional Knowledge IPR and WTO (TRIPS, WIPO), Patent Act 1970 and its amendments, Rights, procedure of obtaining patents, working of patents, infringement, copyrights, trademarks, geographical indications, traditional knowledge digital library, protection of traditional knowledge and protection of plant varieties and Biotech inventions.	8
V	Ethnobotany Methodologies of ethnobotanical research: Literature, Herbaria and Musea and other aspects of ethnobotany. Importance of ethno botany in Indian systems of medicine (Siddha, Ayurveda and Unani), role of AYUSH, NMPB, CIMAP and CARL. Tribal knowledge towards disease diagnosis, treatment, medicinal plants, plant conservation and cultivation.	8
VI	Medicinal aspects Study of common plants used by tribes (<i>Aegle marmelos</i> , <i>Ficus religiosa</i> , <i>Embllica officinalis</i> , <i>Eclipta alba</i> , <i>Rauvolfia serpentina</i> , <i>Oxalis and Ocimum sanctum</i>) Ethnobotanical aspects of conservation and management of plant resources, Preservation of primeval forest in the form of Sacred groves of individual species and Botanical uses depicted in our epics. Plants in Primary Health Care: common medicinal plants: <i>Tinospora</i> , <i>Acorus</i> , <i>Ocimum</i> , Turmeric and Aloe. Indian Pharmacopeia, Quality Evaluation of crude drugs & adulteration.	8
VII	Pharmacognosy Preparation of drugs for commercial market- organoleptic evaluation of drugs- Microscopic evaluation of drugs- Physical evaluation of drugs- Active and inert constituents of drugs- Classification of drug plants- Individual drugs- Drug adulteration. Sources of crude drugs- roots, rhizome, bulb, corm, leaves, stems, flowers, fruits and seeds; organoleptic study of <i>Adhatodavasica</i> , <i>Andrographis paniculata</i> , <i>Azadirachta indica</i> , <i>Coriandrum sativum</i> , <i>Datura metel</i> , <i>Eclipta alba</i> , <i>Embllica officinalis</i> , <i>Ocimum sanctum</i> , <i>Phyllanthus amarus</i> , <i>Ricinus Communis</i> , <i>Catharanthus roseus</i> and <i>Zingiber officinale</i> .	8
VIII	Herbal Preparations & Phytochemistry: Collection of wild herbs- Capsules- compresses- Elixirs- Glycerites- Hydrotherapy or Herbal bath- Herbal oils- Liquid extracts or Tincture- Poultices- Salves- Slippery elm Slurry and gruel- Suppositories- Teas. Plant natural products, general detection, extraction and characterization procedures. Glycosides and Flavonoids and therapeutic applications. Anthocyanins and Coumarins and therapeutic applications, Lignans, Terpenes, Volatile oils and Saponins, Carotenoids, Alkaloids and Pharmacological activities	
Suggested Readings: 1. Botany (Taxonomy, Anatomy, Embryology and Economic Botany) by: Singh, Pandey Jain. Rastogi Publication		

2. Kochhar, S.L. (2011). Economic botany in the tropics, Macmillan publishers India Limited New Delhi 4th edition.
3. Sharma, OP. 1996. Hill's Economic Botany (Late Dr. AF Hill, adopted by OP Sharma). Tata McGraw-Hill Company Limited, New Delhi.
4. Krishnamurthy, K.V. (2004). An Advanced text book of Biodiversity-Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.
5. P. Ganguli, Intellectual Property rights: Unleashing the Knowledge Economy, Tata Mc Graw-Hill (2001).
6. Kokate, C. and Gokeale- Pharmacognacy- Nirali Prakashan, New Delhi.
7. Modern Kitchen Garden by Dr. Minu Gupta.

Evaluation/Assessment Methodology

		Max. Marks
1) Sessional Examination		16
2) Assignments		5
3) Attendance		4
4) ESE		75
Total:		100

Prerequisites for the course: 40% Marks in 12th from a recognized Board with a subject of life Science/ Biology (PCB)

Course Learning Outcomes:

After the completion of the course, the student will be able to

1. Develop critical understanding of morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.
2. Understanding of plant evolution and their transition to land habitat.
3. Understand morphology, anatomy, reproduction and developmental changes there in through typological studies and create knowledge base understanding the basis of plant diversity, economic values and taxonomy of plants.
4. Understanding the details of external and internal features of the plants.

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: IV

Programme: B.Sc. (CBZ) Certificate/Diploma/Degree/ DIPLOMA IN PLANT IDENTIFICATION, UTILIZATION & ETHNO MEDICINE UG(R)/PG/Ph.D. Class: DIPLOMA		Year: II Semester: IV	
Credits: 2 Theory: 0 Practical: 2	Subject: Botany		
Course Code: BSBC-NP-241P	TITLE: COMMERCIAL BOTANY AND PHYTOCHEMICAL ANALYSIS LAB		
Course Objectives: 1. Know about the commercial products produced from plants. 2. Gain the knowledge about cultivation practices of some economic crops. 3. Understand about the ethnobotanical details of plants. 4. Learn about the chemistry of plants & herbal preparations 5. Can become a protected cultivator, aromatic oil producer, Pharmacologist or quality analyst in drug company.			
Nature of Paper: Core			
Minimum Passing Marks/Credits: 50% Marks / 2 Credits			
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)			
Unit	Contents (Minimum any three from each unit, based on the facilities)		No. of Lectures Allotted
I	Economic Botany and Microtechnique: Cereals: Wheat (Habit sketch, L.S./ T.S of grain, starch grain, Micro chemical tests); Rice (Habit sketch, study of paddy and grain, starch grain, Micro chemical tests). Legume: Pea or ground nut (habit, fruit, seed structure, Micro chemical tests) Source of sugars and starches: Sugarcane (Habit sketch; cane juice-micro chemical tests); Potato (Habit sketch, tuber morphology, T.S of tuber to show localization of starch grains, W.M. of starch) grains, Micro chemical tests. Tea Leaves: test for tannin. Mustard Plant: specimen, seeds, tests for fat in crushed seeds. Timbers: Section of young stem.		8
	Jute: Specimen, T.S. of stem, tests for lignin on T.S. of stem and study of specimen by following maceration technique. Study of specimens of economic importance mentioned in Unit I & II.		

II	Commercial Cultivation: Field visit to green houses to understand Floriculture & vegetables production. Development of hydroponics nutrient solutions & running models of cultivation of fodder.	8
III	Cultivating Medicinal and aromatic Plants & Essential oil extraction Lemon grass/ Neem/ Zinger/ Rose/ Mint	7
IV	Documentation from traditional Knowledge Digital: Library, Mark the Geographic Indications on map, Understand- Nakshatra Vatika, Navgrahvatika and development in your college. To extract the names of the plants and Botanical uses depicted in our epics. Visit NISCAIR, New Delhi.	7
V	Ethnobotany: Study of common plants used by Tribes. <i>Aegle marmelos</i> , <i>Ficus religiosa</i> , <i>Cynodondactylon</i> . Visit a tribal area and collect informations on their traditional method of treatment using crude drugs. Familiarize with atleast 5 folk medicines and study the cultivation, extraction and its medicinal application. Observe the plants of ethnobotanical importance in your area. Visit to an Ayurveda college or Ayurvedic Research institute/ Hospital.	7
VI	Instrumentation and Herbal Preparations: Develop capsules of herbs/ Develop herbal oils/ Develop Poultice/ cream analyse some active ingredients using chromatography/ Spectrophotometry.	7
VII	Pharmacognosy: Organoleptic studies of plants mentioned in the theory. A. Morphological studies of vegetative and floral parts. B. Microscopic preparations of root, stem and leaves. C. Stomatal Number and Stomatal Index. D. Veinlet Number. E. Palisade Ratio. F. Fibres and vessels (maceration) G. Starch test H. Protein and Lipid test.	8
VIII	Phytochemistry: Determination of the percentage of foreign leaf in a drug composed of a mixture of leaves. Dimensions of Calcium oxalate crystals in powdered crude drug. Preliminary phytochemical tests for alkaloids, terpenoids, glycosides, volatile oils, Tannins and resins. Any 5 herbal preparations.	7
Suggested Reading: 1. Plant Ecology and Economic Botany by Dhankar Sharma-Trivedi RBD Publication. 2. Pharmacognosy- Shivkant, Pankaj Kumar Brahmiya: Thakur Publication. 3. Practical Botany Part 2: Ashok Bendre and Ashok Kumar, Rastogi Publication Meerut.		

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: IV

Programme: B.Sc (CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Diploma	Year: II Semester: IV	
Credits: 4 Theory: 4 Practical: 0	Subject: Zoology	
Course Code: BSZC-NP-242	Title: Diversity of Non-Chordates, Parasitology and Economic Zoology	
Course Objectives: CO1: To understand the structure and organization of invertebrate animals. CO2: To explain modifications in various functions of animals during transition from invertebrates. CO3: To understand evolutionary significance of larval forms of invertebrates. CO4: To identify invertebrate’s homology, analogy and modifications of mouthparts in relation to feeding habits. CO5: To understand the segmentation in animal kingdom.		
Nature of Paper: Core/DSE/SEC/GE/AECC: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 P: 4 (In Hours/Week) 4 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Protozoa to Coelenterate- Salient feature and outline classification included • Protozoa - Paramecium (Morphology and Reproduction) • Porifera - <i>Sycon</i> (Canal System) • Coelenterata -<i>Obelia</i> (Morphology and Reproduction)	6
II	Ctenophora to Nematelminthes - Salient features and outline classification included • Ctenophora - Salient features • Platyhelminthes - <i>Taenia</i> (Tape worm) (Morphology and Reproduction) • Nematelminthes- <i>Ascaris lumbricoides</i> (Morphology and Reproduction)	6
III	Annelida - Salient features and outline classification included • Annelida - <i>Hirudinaria</i> (Leech) (Morphology and Reproduction)	12
IV	Arthropoda - Salient features and outline classification included • Arthropoda - <i>Palaemon</i> (Prawn) Morphology Appendages, Nervous System and Reproduction).	8
V	Mollusca to Hemichordata - Salient Features and outline classification included	8

	- Mollusca - <i>Pila</i> (Morphology, Shell, Respiration Nervous System and Reproduction) - Echinodermata - <i>Pentaceros</i> (Morphology and Water Vascular System)	
VI	Vectors and pests Life cycle and their control of following pests: <i>Gundhi</i> bug. Sugarcane leafhopper, Rodents. Termites and Mosquitoes and their control	8
VII	Economic Zoology-1 Animal breeding and culture: Pisciculture	8
VIII	Economic Zoology-2 Sericulture, Apiculture, Lac-culture, Vermiculture	8
Reference / Text Books: - Structure and Functions of invertebrates” by Barrington E J W - The Invertebrates by Hyman, L. H. Mc Graw Hill co New York - Invertebrate Zoology, 3rd edition.; Barnes, R. D.		
If the course is available as Generic Elective then the students of following departments may opt it. 1.no 2.		
Evaluation/Assessment Methodology		
		Max. Marks:100
1) Sessional Examination		16
2) Assignments		5
3) Presentations /Seminar /Attendance		4
4) ESE		75
Total:		100
Prerequisites for the course:		
Course Learning Outcomes: CLO1: Student will be able to explain taxonomic rules of animal classification CLO2: Student will be able to explain salient feature and outline classification of Invertebrates CLO3: Student will be able to explain morphology and reproduction of Invertebrates. CLO4: Student will be able to explain life cycle and control of pests. CLO5: Student will be able to explain animal breeding and pisci culture. CLO6: Student will be able to explain various steps of Sericulture, Apiculture, Lac-culture and Vermi culture.		

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: IV

Programme: B.Sc (CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Diploma		Year: II Semester: IV
Credits: 2 Theory: 0 Practical: 2	Subject: Zoology	
Course Code: BSZC-NP-242P	TITLE: Diversity of Non-Chordates, Parasitology and Economic Zoology Lab	
Course Objectives: CO1: To prepare permanent stained slide of septal nephridia of earthworm CO2: To study animal specimen of various animal phyla. CO3: To understand aquatic ecosystem, its biotic components and food chain. CO4: To study larval stages of helminthes. CO5:To study life history of silkworm, honeybee and lac insect.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents (Minimum any three from each unit, based on the facilities)	No. of Lectures Allotted
I	1. To prepare permanent stained slide of septal nephridia of earthworm 2. To study nerve ring of earthworm.(Virtual/model) 3. To study statocyst, appendages and hastate plate from <i>Palaemon</i> (demo/online allowed). (Virtual/model)	15
II	1. Study of animal specimen of various animal phyla 2. Study on use and ethical handling of model organisms (Mice, rats, rabbit and pig). stained/unstained slide of placoid scales. .(Virtual/model)	15
III	1. Permanent Preparation of: <i>Euglena</i> , <i>Paramecium</i> 2. Study of prepared slides / specimens of <i>Entamoeba</i> , <i>Giardia</i> , <i>Leishmania</i> , <i>Trypanosoma</i> , <i>Plasmodium</i> , <i>Fasciola</i> , <i>Taenia</i> , <i>Polystoma</i> , <i>Schistosoma</i> , <i>Echinococcus</i> , <i>Enterobius</i> , <i>Ascaris</i> and <i>Ancylostoma</i> . 3. Permanent Preparation of <i>Cimex</i> (bed bug), <i>Pediculus</i> (louse), <i>Haematopinus</i> (cattle louse), fresh water annelids, arthropods, and soil arthropods as per availability. 4. Larval stages of helminths. 5. Permanent mount of wings, mount parts and development stage of mosquito and house fly. 6. Identification of pests. 7. Life history of silkworm, honeybee and lac insect.	15

	8. Study of different types of important edible fishes of India. (Virtual/model) 9. Study of an aquatic ecosystem, its biotic. Components and food chain. 10. Project Report/ model chart making. 11. Dissection: through multimedia / models 12. Cockroach: Central nervous system. .(Virtual/model)	
IV	Virtual Labs (Suggestive sites) https://www.vlab.co.in https://zoolagysan.blogspot.com www.vlab.iib.ac.in/vlab https://www.vlab.co.in https://zoolagysan.blogspot.com www.vlab.iib.ac.in/vlab www.onlinelabes.in www.powershow.com https://vlab.amrita.edu https://sites.dartmouth.edu	15
Suggested Reading: Harvey et al: The Vertebrate Life (2006) Parker and Haswell: Text Book of Zoology, Vol II		

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: IV

Programme: B.Sc (CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Diploma	Year: II Semester: IV	
Credits: 4 Theory: 4 Practical: 0	Subject: Chemistry	
Course Code: BSCC-NP-243	Title: Quantum Mechanics and Analytical Techniques	
Course Objectives 1. Students will be able to explore new area so free search in both chemistry and allied fields of science and technology. 2. Students will be able to function as a member of an interdisciplinary problem solving team. 3. Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems. 4. Students will gain an understanding of how to determine the structure of organic molecules using IR and NMR spectroscopic techniques. 5. To develop basic skills required for purification, solvent extraction, TLC and column chromatography.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: P: 4 Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits) Practical- 2 Hrs.=1 Credit (4Hrs./Week=2Credits)		
Unit	Contents	No.of Lectures Allotted
I	Atomic Structure: Idea of de-Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrödinger wave equation, significance of Ψ and Ψ^2 , quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, d, orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule.	5
II	Elementary Quantum Mechanics: Black-body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (no derivation) and its defects, Compton effect. de-Broglie hypothesis. Heisenberg uncertainty principle. Hamiltonian Operator. Schrödinger wave equation (time dependent and time independent) and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one dimensional box. Schrödinger wave equation for H-atom, separation into three equations (without derivation), quantum numbers and their importance, hydrogen like wave functions, radial wave functions, angular wave functions. Molecular orbital theory, basic ideas – Criteria for forming MO from AO, construction of MO by LCAO – H ₂ + ion, calculation of energy levels	10

	from wave functions, physical picture of bonding and anti-bonding wave functions, concept of σ , σ^* , π , π^* orbitals and their characteristics.	
III	Molecular Spectroscopy: Introduction: Electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer approximation, degrees of freedom Rotational Spectrum: Diatomic molecules. Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect. Vibrational Spectrum: Infrared spectrum: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups. Raman spectrum: Concept of polarizability, pure rotational and pure vibrational, Raman spectra of diatomic molecules, selection rules. Electronic Spectrum: Concept of potential energy curves for bonding and anti-bonding molecular orbitals, qualitative description of selection rules and Franck-Condon principle.	10
IV	UV-Visible Spectroscopy: Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules. Types of electronic transitions, $\lambda_{\max}$, chromophores and auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; application of Woodward Rules for calculation of $\lambda_{\max}$ for the conjugated dienes: alicyclic, homoannular and heteroannular; extended conjugated systems distinction between cis and trans isomers.	05
V	Infrared Spectroscopy: IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; Hooke's law selection rule, IR absorption positions of various functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Finger print region and its significance; application in functional group analysis and interpretation of I.R. spectra of simple organic compounds.	05
VI	$^1\text{H-NMR}$ Spectroscopy (PMR) NMR Spectroscopy: introduction; nuclear spin; NMR active molecules; basic principles of Proton Magnetic Resonance; choice of solvent and internal standard; equivalent and non-equivalent protons; chemical shift and factors influencing it; ring current effect; significance of the terms: up-/downfield, shielded and deshielded protons; spin coupling and coupling constant (1st order spectra); relative intensities of first-order multiplets: Pascal's triangle; chemical and magnetic equivalence in NMR; anisotropic effects in alkene, alkyne, aldehydes and aromatics; NMR peak area, integration; relative peak positions with coupling patterns of common organic compounds; interpretation of NMR spectra of simple compounds. Applications of IR, UV and NMR spectroscopy for identification of simple organic molecules.	10
VII	Introduction to Mass Spectrometry: Principle of mass spectrometry, the mass spectrum, mass spectrometry diagram, molecular ion, metastable ion, fragmentation process, McLafferty rearrangement.	05

VIII	Separation Techniques: Solvent: Extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non-aqueous media. Chromatography: Classification, principle and efficiency of the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods.	10
Reference / Text Books: 1. Alberty, R A, Physical Chemistry, 4th edition Wiley Eastern Ltd, 2001. 2. Atkins, PW, the elements of physical chemistry, Oxford, 1991 3. Barrow, G .M, International student Edition .McGraw Hill, McGraw-Hill, 1973. 4. Cotton, F.A, Wilkinson, G and Gaus, P. L ,Basic Inorganic Chemistry, 3rd Edition ,Wiley 1995 5. Lee, J.D, Concise Inorganic Chemistry 4th Edition ELBS, 1977 6. Clayden, J., Greeves, N., Warren, S., <i>Organic Chemistry</i>, Second edition, Oxford University Press 2012. 7. Silverstein, R. M., Bassler, G. C., Morrill, T. C. <i>Spectrometric Identification of Organic Compounds</i>, John Wiley and Sons, INC, Fifth edition. 8. Pavia, D. L. <i>et al. Introduction to Spectroscopy</i>, 5th Ed. Cengage Learning India Ed. 9. Willard, H.H. <i>et al.: Instrumental Methods of Analysis</i>, 7th Ed. Wards worth Publishing Company, Belmont, California, USA, 1988. 10. Christian, G.D. <i>Analytical Chemistry</i>, 6th Ed. John Wiley & Sons, New York, 2004. 11. Harris, D.C.: <i>Exploring Chemical Analysis</i>, 9th Ed. New York, W.H. Freeman, 2016. 12. Khopkar, S.M. <i>Basic Concepts of Analytical Chemistry</i>. New Age International Publisher, 2009.		
Evaluation/Assessment Methodology		
		Max. Marks
1) Sessional Examination		16
2) Assignments		5
3) Attendance		4
4) ESE		75
Total:		100
Prerequisites for the course: Basic knowledge of chemistry taught in the preceding semester.		
Course Learning Outcomes: • Students will understand the concept of atomic structure and basic concept of quantum mechanics. • Students will be able to understand the various types of molecular spectroscopies and its importance in chemistry. • Students will be able to understand various aspects mass spectroscopy. • Students will be able to understand the basics of separation techniques and chromatography.		

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: IV

Programme: B.Sc (CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Degree	Year: II Semester: IV	
Credits: 2 Theory: 0 Practical: 2	Subject: Chemistry	
Course Code: BSCC-NP-243P	Title: Instrumental Analysis Lab	
Course Objectives: Upon completion of this course, chemistry majors are able to employ critical thinking and scientific inquiry in the performance, design, interpretation and documentation of laboratory experiments, at a level suitable to succeed at an entry-level position in chemical industry or a chemistry graduate program.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: P: 4 Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits) Practical- 2 Hrs.=1 Credit (4Hrs./Week=2Credits)		
Unit	Contents	No. of Lectures Allotted
I	Molecular Weight Determination 1. Determination of molecular weight of a non-volatile solute by Rast method/ Beckmann freezing point method. 2. Determination of the apparent degree of dissociation of an electrolyte (e.g., NaCl) in aqueous solution at different concentrations by ebullioscopy	10
II	Spectrophotometry 1. To verify Beer – Lambert Law for KMnO4/K2Cr2O7 and determining the concentration of the given solution of the substance from absorption measurement 2. Determination of pKa values of indicator using spectrophotometry. 3. Determination of chemical oxygen demand (COD). 4. Determination of Biological oxygen demand (BOD).	20
III	Spectroscopy 1. Assignment of labeled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H, C-O, C-N, C-X, C=C, C=O, N=O, C≡C, C≡N stretching frequencies; characteristic bending vibrations are included. Spectra to be provided). 2. Assignment of labeled peaks in the ¹ H NMR spectra of the known organic compounds explaining the relative δ-values and splitting	10

	pattern. 3. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).	
IV	Chromatographic Separations 1. Paper chromatographic separation of following metal ions: i. Ni (II) and Co (II) ii. Cu(II) and Cd(II) 2. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer Chromatography(TLC) 3. Separation and identification of the amino acids present in the given mixture by paper chromatography. Reporting the R _f values 4. TLC separation of a mixture of dyes (fluoresce in and methylene blue)	20
Reference / Text Books: 1. Mendham, J., <i>A. I. Vogel's Quantitative Chemical Analysis 6th Ed.</i> , Pearson, 2009. 2. Willard, H.H. <i>et al.: Instrumental Methods of Analysis</i> , 7 th Ed. Wards worth Publishing Company, Belmont, California, USA, 1988. 3. Christian, G.D. <i>Analytical Chemistry</i> , 6 th Ed. John Wiley & Sons, New York, 2004. 4. Harris, D.C. <i>Exploring Chemical Analysis</i> , 9 th Ed. New York, W.H. Freeman, 2016. 5. Khopkar, S.M. <i>Basic Concepts of Analytical Chemistry</i> . New Age International Publisher, 2009. 6. Skoog, D.A. Holler F.J. and Nieman, T.A. <i>Principles of Instrumental Analysis</i> , Cengage Learning India Edition. 7. Mikes, O. & Chalmes, R.A. <i>Laboratory Handbook of Chromatographic & Allied Methods</i> , Elles Harwood Ltd. London. 8. Ditts, R.V. <i>Analytical Chemistry: Methods of separation</i> . Van Nostrand, New York, 1974.		
Evaluation/Assessment Methodology		
		Max Marks
1) Lab Performance		10
2) Attendance		5
4) Record		5
3) ESE		30
Total:		50
Prerequisites for the course: Basic knowledge of practical chemistry taught in the preceding semester.		
Course Learning Outcomes: - Students will be able to explore new areas of research in both chemistry and allied fields of science and technology. - Students will be able to function as a member of an interdisciplinary problem solving team. - Students will be skilled in problem solving, critical thinking and analytical reasoning as applied to scientific problems - Students will gain an understanding of how to determine the structure of organic molecules using IR and NMR spectroscopic techniques - To develop basic skills required for purification, solvent extraction, TLC and column chromatography		
Course Learning Outcomes: - Students will be able to understand the concept of introductory and advance knowledge of hydrocarbons. - Students will be able to understand aromaticity and arenes. - Students will be able to understand alcohols, phenols and epoxides. - Students will be able to understand the basics chemistry of organic halides.		

IIMTU-NEP IMPLEMENTATION

Year: III / Semester: V

Programme: B.Sc. (CBZ) Certificate/Diploma/Degree/BACHELOR OF SCIENCE IN CBZ UG(R)/PG/Ph.D. Class: DEGREE		Year: III Semester: V
Credits: 4 Theory: 4 Practical: 0	Subject: Botany	
Course Code: BSBC-NP-351	TITLE: PLANT PHYSIOLOGY, METABOLISM AND BIOCHEMISTRY	
Course Objectives: After the completion of the course the students will be able to: 1. Understand the role of Physiological and metabolic processes for plant growth and development. 2. Learn the symptoms of Mineral Deficiency in crops and their management. 3. Assimilate Knowledge about Biochemical constitution of plant diversity. 4. Know the role of plants in development of natural products, nutraceuticals, dietary supplements, antioxidants		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
Unit	Topics	Lectures
I	Plant Water relation, Mineral Nutrition, Transpiration and Translocation in Phloem: Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation. Criteria of essentiality of elements; Role of essential elements; Symptoms of mineral deficiency in major crops. Transport of ions across cell membrane, active and passive transport, composition of phloem sap, girdling experiment, Pressure flow model.	7
II	Carbon Oxidation: Krebs Cycle, Glycolysis fate of pyruvate- aerobic and anaerobic respiration and fermentation, Regulation of Glycolysis, Oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of Krebs cycle, Mitochondrial electron transport, Oxidative phosphorylation, ATP synthetase, Chemiosmotic mechanism, P/O ratio, Cyanide resistance respiration, Factors affecting respiration.	7
III	Nitrogen Metabolism: Nitrate assimilation, Biological nitrogen fixation (examples of legumes and non-legumes), physiology and biochemistry of nitrogen fixation, Ammonia assimilation(GS- GOGAT), reductive amination and transamination, Amino acid synthesis.	8
V	Lipid Metabolism and Photosynthesis: Lipid Metabolism: Synthesis and breakdown of triglycerides, oxidation, Glyoxylate cycle, Gluconeogenesis and its role in mobilization of lipids during seed germination, oxidation. Photosynthesis: Pigments, Action spectra and enhancement effect, Electron Transport system and Photophosphorylation, C3 and C4 Photosynthesis, CAM reaction and significance. Photorespiration.	7
V	Plant Development, Movements, Dormancy & Responses:	8

	Developmental roles of phytohormones (Auxins, Gibberellins, Cytokinins, ABA, Ethylene), Autonomic and Paratonic movements, Photoperiodism (SDP, LDP, Day Neutral Plants); Phytochrome (Discovery and Structure), Red and far red light responses on photomorphogenesis, Seed Physiology and Dormancy, Vernalization & Senescence.	
VI	Biomolecules: Carbohydrates: Nomenclature and Classification; Role of monosaccharides (Glucose, Fructose, Sugar alcohols- Mannitol and Sorbitol); Disaccharides (Sucrose, Maltose and Lactose), Oligosaccharides and Polysaccharides (structural cellulose, hemicelluloses, pectin, chitin, mucilage; Storage- starch, inulin). Lipids: Storage lipids: Fatty acids – Structure and function, Structural Lipids: Phosphoglycerides; Lipids functions: Cell Signals, cofactors, prostaglandins, Introduction of lipid micelles, Monolayers and bilayers.	8
VII	Proteins: Structure of Amino acids; Peptide bonds; Levels of protein structure- Primary, Secondary, Ramchandran Plot, tertiary and quaternary; Isoelectric point, protein denaturation and biological roles of proteins. Nucleic Acids: Structure of nitrogenous bases; structure and function of nucleic acids, nucleic acid denaturation & Re-naturation and MiRNA.	7
VIII	Enzymes: Structure of enzyme: Holoenzyme, Apoenzyme, cofactors, coenzymes and prosthetic groups; Mechanism of action (Activation energy, Lock and key hypothesis, Induced fit theory). Enzyme inhibition and factors affecting enzymes activity, Allosteric enzymes and Abzymes. Elementary phytonutrients, Nutraceuticals, dietary Supplements and Antioxidants.	8

Suggested Readings:

1. Plant Physiology and Biochemistry by Dr. H S Srivastava, Rastogi Publication.
2. Plant Physiology and Biochemistry by Singh, Pandey, Jain Rastogi Publication, Meerut.
3. Plant Physiology and Biochemistry ISBN#81-301-0035-5 Sunil D Purohit, K. Ahmed and K Kukda. Edition 2013 Pages 368+VIII Text Book Hindi.
4. Taiz & Zeiger- Plant Physiology.
5. Plant Physiology by Hopkins.

Evaluation/Assessment Methodology

	Max. Marks
1) Sessional Examination	16
2) Assignments	5
3) Attendance	4
4) ESE	75
Total:	100

Prerequisites for the course: 40% Marks in 12th from a recognized Board with a subject of life Science/ Biology (PCB)

Course Learning Outcomes:

After the completion of the course, the student will be able to

1. Understand the role of Physiological and metabolic processes for plant growth and development.
2. Learn the symptoms of mineral deficiency in crops and their management.
3. Assimilate knowledge about Biochemical constitution of plant diversity.
4. Know the role of plants in development of natural products, nutraceuticals, dietary supplements and antioxidants.

IIMTU-NEP IMPLEMENTATION

Year: III / Semester: V

Programme: B.Sc. (CBZ) Certificate/Diploma/Degree/ BACHELOR OF SCIENCE UG(R)/PG/Ph.D. Class: DEGREE		Year: III Semester: V	
Credits: 2 Theory: 0 Practical: 2		Subject: Botany	
Course Code: BSBC-NP-351P		TITLE: PLANT PHYSIOLOGY, METABOLISM AND BIOCHEMISTRY LAB	
Course Objectives: The course aims to provide students with a basic understanding of: 1. The molecular architecture of eukaryotic cells and organelles, including membrane structure and dynamics 2. The principles of bioenergetics and enzyme catalysis; 3. The chemical nature of biological macromolecules, their three-dimensional construction, and the principles of molecular recognition; 4. Dietary requirements of man and selected domestic animals; 5. The metabolism of dietary and endogenous carbohydrate, lipid, and protein; 6. The principles and major mechanisms of metabolic control and of molecular signalling by hormones; 7. The control of cell proliferation.			
Nature of Paper: Core			
Minimum Passing Marks/Credits: 50% Marks / 2 Credits			
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)			
Unit	Contents (Minimum any three from each unit, based on the facilities)		No. of Lectures Allotted
I	1. Osmosis: By Potato osmoscope experiment 2. Effect of temperature on absorption of water by storage tissue and determination of Q 10. 3. Experiment for demonstration of transpiration by Four leaf experiment. 4. Structure of stomata (Dicot and Monocot) Determination of rate of transpiration using Cobalt Chloride Method. 5. Experiment to measure the rate of transpiration by using Farmer’s Potometer. 6. Experiment to measure the rate of transpiration by using Ganong’s Potometer. 7. Effect of temperature on membrane permeability by colorimetric method.		8

	Study of mineral deficiency symptoms using plant material/ photograph.	
II	Nitrogen Metabolism, Photosynthesis & Respiration. 1. A Basic idea of chromatography: Principle, Paper chromatography and column chromatography, demonstration of column chromatography. 2. Separation of plastid pigments by solvent and paper chromatography. 3. Estimation of Chlorophyll content from different chronologically aged leaves (Young, Matured and senescence) by Arnon Method. 4. Effect of HCO_3^- concentration on oxygen evolution during photosynthesis in an aquatic plant and to find out the optimum and toxic concentration (either by volume measurement or bubble counting) 5. Measurement of oxygen uptake by respiring tissues (per g/ hour) 6. Determination of the RQ of germinating seeds. 7. Effect of light intensity on oxygen evolution in photosynthesis by using Wilmott Bubbler.	8
III	Plant Development, Movement, Dormancy & Responses 1. Geotropism and Phototropism- Klinostate 2. Hydrotropism- Measurement of growth Arc and Liver Auxenometer. 3. To study the phenomenon of seed germination (effect of light) 4. To study the induction of amylase activity in germinating grains. 5. Test of seed viability by TTC method. 6. To study the effect of different concentrations of IAA on Avena coleoptile elongation (IAA Bioassay).	8
IV	Techniques for Biochemical Analysis. 1. Weighing and preparation of solutions- percentage, molar and normal solutions, dilution from stock solution etc. 2. Separation of Amino acids by Paper chromatography. 3. Detection of Organic acids: Citric, Tartaric, Oxalic and Malic from laboratory samples. 4. Qualitative analysis of carbohydrates 5. Estimation of reducing sugar by anthrone method. 6. Qualitative analysis of Lipids. 7. Qualitative analysis of Amino acids and Proteins. 8. Qualitative analysis of Nucleic Acid. 9. Analysis of dietary supplements, nutraceuticals& antioxidants. 10. Testing of adulterants in food items. 11. Purification of Acid Phosphatase from sprouted moong/ Purification of peroxidase from radish. 12. Enzyme kinetics of acid phosphatase/ Enzyme kinetics of peroxidase/ alphaamylase.	8
V	Genetic Material 1. Instruments and equipments used in molecular biology. 2. Preparation of LB medium and cultivation of <i>E. coli</i> on it. 3. Isolation of genomic DNA 4. Isolation of DNA from plants. 5. Examination of the purity of DNA by Agarose Gel Electrophoresis. 6. Quantification of DNA by UV- spectrophotometer. 7. Estimation of DNA by diphenylamine method.	7
VI	Preparation of Models/ Charts	7

	1. Study of experiments establishing nucleic acid as genetic material (Avery et al, Griffith's, Hershey and Chase's and Fraenkel and Conrat's experiment) through photographs. 2. Numericals based on DNA re-association kinetics (Melting profiles and Cotcurves). 3. Study of DNA replication through photographs: Modes of replication-rolling circle, theta and semicontinuous; Semiconservative model of replication (Messelson and Stahl's experiment). 4. Study of structures of t-RNA (2D and 3D); Prokaryotic RNA Polymerase and eukaryotic RNA Polymerase II through photographs. 5. Study of following through photographs: Assembly of Splice of some machinery; Splicing mechanism in group I & Group II introns; Ribozyme and alternative splicing. 6. Understanding the regulation of lactose (lac) Operon (positive and negative regulation)	
VII	Genetic Engineering 1. Isolation of protoplasts 2. Construction of restriction map of circular and linear DNA from the data provided. 3. Isolation of plasmid DNA. 4. Restriction digestion and Gel Electrophoresis of Plasmid DNA (demonstration/Photograph) 5. Calculate the percentage similarity between different cultivars of a species using RAPD profile, Construct a dendrogram and interpret the result. 6. Agarose Gel analysis of plasmid DNA. 7. Restriction Digestion of plasmid DNA- Demonstration of PCR.	7
VIII	Applications of Genetic Engineering 1. ELISA Test 2. Viability tests of cells 3. Study of methods of gene transfer through photographs: Agrobacterium mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment. 4. Study of steps of genetic engineering for production of Bt- cotton, Golden rice, FlavrSavr tomato through photographs.	7
Suggested Reading: 1. Practical Botany Part 3 by Ashok Bendre and Ashok Kumar, Rastogi Publication, Meerut 2. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Willey & Sons. Inc. 3. A Laboratory Manual of Plant Physiology, Biochemistry and Ecology. ISBN: 9788177544589. Edition: 01 Year:2012 Author: Akhtar Inam. Publisher: Agrobiose India.		

IIMTU-NEP IMPLEMENTATION

Year: III / Semester: V

Programme: B.Sc (CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Degree	Year: III Semester: V	
Credits: 4 Theory: 4 Practical: 0	Subject: Zoology	
Course Code: BSZC-NP-352	Title: Diversity of chordates and comparative anatomy	
Course Objectives: CO1: To understand basis of classification of vertebrates. CO2: To learn general characters of different classes. CO3: To study different physiological body processes of vertebrates. CO4: To learn characteristics of fish and amphibians. CO4: To learn general characters of birds and mammals.		
Nature of Paper: Core/DSE/SEC/GE/AECC: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 P: 4 (In Hours/Week) 4 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Origin of Chordates & Hemichordate - Salient feature and outline classification included • Origin of Chordates, Classification of Phylum Chordate up to the class. • Hemichordate: General characteristics, classification, and detailed study of <i>Balanoglossus</i> (Habit and Habitat, Morphology, Anatomy, Physiology and Development)	6
II	Cephalochordata and Urochordate - Salient features and outline classification included • Urochordata: General characteristics, classification and detailed study of <i>Herdmania</i> (Habit and Habitat, Morphology, Anatomy, Physiology and Post Embryonic Development. • Cephalochordata: General characteristics, classification and detailed study of Branchiostoma (<i>Amphioxus</i>) (Habit and Habitat, Morphology, Anatomy, Physiology)	6
III	Classification and General Characteristics of Vertebrates • General Characters and classification of different classes of vertebrates (Pisces, Amphibia, Reptilia, Aves, Mammalia) up to the order with examples.	8

	- Poisonous and Non Poisonous Snakes and Biting mechanism - Neoteny and Paedogenesis - Migration in birds	
IV	Comparative Anatomy and Physiology of Vertebrates - Integumentary System: Structure, functions and derivatives of integument - Skeleton System: Overview of axial and appendicular skeleton, jaw suspensorium, Visceral arches.	8
V	Digestive System Alimentary canal and associated glands, dentition	8
VI	Respiratory System Skin, gills, lungs and air sacs: Accessory respiratory organs	8
VII	Circulatory system General plan of circulation, evolution of heart and aortic arches	8
VIII	Nervous System - Comparative account of brain, Structure and evolution of brain in vertebrates Autonomic nervous system, Spinal cord, Cranial nerves in mammals Sense organs - Classification of receptors, Brief account of visual and auditory receptors in man	8

Reference / Text Books:

- Ridley, M. (2004) Evolution III Edition Blackwell Publishing
- Barton, N. H., Briggs D.E.G., Eisen, J.A. Goldstein, D. B. and Patel, N.H. (2007) Evolution, Cold Spring, Harbour Laboratory Press.
- Hall, B. K. and Hallgrimsson, B. (2008) Evolution IV Edition Jones and Bartlett Publishers
- Campbell N. A. and Reece J.B. (2011) Biology IX Edition, Person, Benjamin, Cummings.

If the course is available as Generic Elective then the students of following departments may opt it.

- no
-

Evaluation/Assessment Methodology

Max. Marks:100

1) Sessional Examination	16
2) Assignments	5
3) Presentations /Seminar /Attendance	4
4) ESE	75
Total:	100

Prerequisites for the course:

IIMTU-NEP IMPLEMENTATION

Year: III / Semester: V

Programme: B.Sc (CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Degree		Year: III Semester: V	
Credits: 2 Theory: 0 Practical: 2		Subject: Zoology	
Course Code: BSZC-NP-352P		TITLE: Diversity of chordates and comparative anatomy	
Course Objectives: CO1: To understand basis of classification of vertebrates. CO2: To learn general characters of different classes. CO3: To study different physiological body processes of vertebrates. CO4: To study osteology of vertebrates. CO4: To study structure of internal ear of <i>Channa punctatus</i> .			
Nature of Paper: Core			
Minimum Passing Marks/Credits: 50% Marks / 2 Credits			
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)			
Unit	Contents (Minimum any three from each unit, based on the facilities)		No. of Lectures Allotted
I	Vertebrates Specimen study: Class- Ascidiaceae: <i>Herdmania, Botryllus, Pyrosoma,Doliolum, Salpa, Oikopleura</i> Class-Pisces: <i>Rhinobatus, Chimaera, Acipensor, Amia,Notopterus, Notopterus, Echeneis, Diodon, Triacanthus, Trichurius</i>		10
II	Class Amphibia: <i>Ichythophis, Ambyostoma, Rhacophorus, Rana</i> Class- Reptilia: <i>Chelone, Chameleon, Draco, Naja, Bungarus, Viper, Alligator</i>		10
III	Class – Aves: Koel, Indian tailor bird, Fowl, Peacock, Emu, Ostrich, Penguin Class- Mammalia: Loris, Indian Otter, Bat, Pangolin, Ornithorhyncus, Kangaroo, Whale, Rhesus monkey, Lion		12
IV	Osteology: bones of fish, frog, rabbit, (Skull, Vertebrae, Pectoral & pelvic girdle, Limb bones), <i>Channa punctata</i> (Demonstration Only) –Internal ear.		12
V	Virtual Labs (Suggestive sites) https://www.vlab.co.in https://zoolagysan.blogspot.com www.vlab.iib.ac.in/vlab https://www.vlab.co.in https://zoolagysan.blogspot.com		10

	https://vlab.amrita.edu https://sites.dartmouth.edu	
Suggested Reading: Harvey et al: The Vertebrate Life (2006) Parker and Haswell: Text Book of Zoology, Vol II		

IIMTU-NEP IMPLEMENTATION

Year: III / Semester: V

Programme: B.Sc (CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Degree		Year: III Semester: V	
Credits: 4 Theory: 4 Practical: 0		Subject: Chemistry	
Course Code: BSCC-NP-353		Title: Organic Synthesis A	
Course Objectives: 1. Synthesis and chemical properties of aliphatic and aromatic hydrocarbons 2. Synthesis and chemical properties of alcohols, halides carbonyl compounds, carboxylic acids and esters. 3. How to design and synthesize aliphatic and aromatic hydrocarbons. 4. How to convert aliphatic and aromatic hydrocarbons to other industrially important compounds. 5. T Functional group inter conversion.			
Nature of Paper: Core			
Minimum Passing Marks/Credits: 40% Marks / 4 Credits			
L: 4 T: P: 4 Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits) Practical- 2 Hrs.=1 Credit (4Hrs./Week=2Credits)			
Unit	Contents		No. of Lectures Allotted
I	Chemistry of Alkanes and Cycloalkanes A) Alkanes: Classification of carbon atom in alkanes, General methods of preparation, physical and chemical properties of alkanes: Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity B) Cycloalkanes: Nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Chair, Boat and Twist boat form so cyclohexane with energy diagrams ring strain in small rings, theory of strain less rings. The case of cyclopropane ring, banana bonds.		10
II	Chemistry of Alkenes Methods of formation of alkenes, Addition to C=C: mechanism (with evidence wherever applicable), reactivity, regioselectivity (Markownik off and anti-Markownik off additions) and stereoselectivity; reactions: hydrogenation, halogenation, hydrohalogenation, hydration, oxymercuration demercuration, hydroboration-oxidation, epoxidation, <i>syn</i> and <i>anti</i> -hydroxylation, ozonolysis, addition of singlet and triplet carbenes; Simmons-Smith cyclopropanation reaction; electrophilic Addition to diene (conjugated dienes and allene); radical addition: HBr addition; mechanism of allylic and benzylic bromination		10

	in competition with bromination across C=C; use of NBS; interconversion of <i>E</i> - and <i>Z</i> - alkenes; contra-thermodynamic isomerization of internal alkenes	
III	Chemistry of Alkynes Methods of formation of alkynes, Addition to C≡C, mechanism, reactivity, regioselectivity and stereoselectivity; reactions: hydrogenation, halogenations, hydrohalogenation, hydration, oxymercuration-demercuration, hydroboration-oxidation, dissolving metal reduction of alkynes (Birch); reactions of terminal alkynes by exploring its acidity; inter conversion of terminal and non-terminal alkynes.	05
IV	Aromaticity and Chemistry of Arenes Nomenclature of benzene derivatives, MO picture of benzene, Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions. Electrophilic aromatic substitution: halogenations, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their Mechanism. Directing effects of the groups. Birch reduction, Methods of formation and chemical reactions of Alkyl benzenes, alkyl benzenes and biphenyl, naphthalene and anthracene.	05
V	Chemistry of Alcohols Classification and nomenclature, Monohydric alcohols – nomenclature, methods of formation by reduction of Aldehydes, Ketones, Carboxylic acids and Esters, Hydrogen bonding, Acidic nature, Reactions of alcohols. Dihydric alcohols nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [Pb(OAc) ₄ and HIO ₄] and pinacol-pinacolone rearrangement. Trihydric alcohols - nomenclature, methods of formation, chemical reactions of glycerol.	10
VI	Chemistry of Phenols : Nomenclature, structure and bonding, preparation of phenols, physical properties and acidic character, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols – electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gattermann synthesis, Hauben-Hoesch reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction	10
VII	Chemistry of Ethers and Epoxides : Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions – cleavage and autoxidation, Ziesel's method. Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.	05
VIII	Chemistry of Organic Halides Nomenclature and classes of alkyl halides, methods of formation, chemical reactions, Mechanisms of nucleophilic substitution reactions of alkyl halides, SN ₂ and SN ₁ reactions with energy profile diagrams; Polyhalogen compounds: Chloroform, carbon tetrachloride; Methods of formation of aryl halides, nuclear and side chain reactions; The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions; Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides, Synthesis and uses of DDT and BHC.	05
Reference / Text Books: 1. Morrison, R. N. & Boyd, R. N. <i>Organic Chemistry</i> , Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).		

2. Sykes, P. *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003.
3. Carey, F. A., Giuliano, R. M. *Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
4. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
5. Clayden, J., Greeves, N. & Warren, S. *Organic Chemistry*, 2nd edition, Oxford University Press, 2012.
6. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry*, John Wiley & Sons, Inc.
7. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
8. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.

Evaluation/Assessment Methodology	
	Max. Marks
1) Sessional Examination	16
2) Assignments	5
3) Attendance	4
4) ESE	75
Total:	100
Prerequisites for the course: Knowledge of chemistry taught in the preceding semester.	

IIMTU-NEP IMPLEMENTATION
Year: III / Semester: VI

Programme: B.Sc. (CBZ) Certificate/Diploma/Degree/ BACHELOR OF SCIENCE IN CBZ UG(R)/PG/Ph.D. Class: DEGREE	Year: III Semester: VI	
Credits: 4 Theory: 4 Practical: 0	Subject:Botany	
Course Code: BSBC-NP-361	TITLE: CYTOGENETICS, PLANT BREEDING AND NANOTECHNOLOGY	
Course Objectives: 1. This Course will cover basic concepts of Mendelian genetics, Deviations and variations, arrangement of genetics material inside a cell, causes and types of genetic abberations, genetic mapping techniques, population genetics etc. 2. Students will develop an understanding of genetic behaviour, expression and also learn about causes of variation and diversity. 3. They develop an understanding in modern genetics and its applications in biotechnology by use of aids such as molecular markers. 4. Nanotechnology study aims towards considerably improving and revolutionizing many technology and industry sectors: information technology, homeland security, medicine, transportation, energy, food safety, and environmental science, among many others.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
Unit	Topics	Lectures
I	Cell Biology: Structure and function of cell wall, Plasma membrane and ribosomes, Endoplasmic reticulum, Golgi apparatus, mitochondria, chloroplast, lysosomes, peroxisomes and cell inclusions- Organization of nucleus: Nuclear envelop, Nucleoplasm and nucleolus. Chromosomal Nomenclature:Chromatids, Centromere, telomere, Satellite, Secondary Constriction. Organization of chromosomes. Nucleic Acid and histones:Types and classification. Lampbrush Chromosomes and Polytene Chromosomes. Karyotype and Idiogram. Cell Cycle: Mitosis, Open and Closed Mitosis, Amitosis, Meiosis, Variation in chromosome numbers (Numerical abbrations), Aneuploidy and Euploidy- haploidy, Polyploidy- Significance (structural aberrations)- Deletion, Duplication, inversion and translocation.	8
II	Genetics: Chromosome theory of Inheritance, Crossing Over and linkage: Incomplete dominance and codominance; Interaction of genes; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Polygenic inheritance; Extra nuclear inheritance, Linkage, Crossing Over, Concept of Sex determination and sex chromosomes; Patterns of sex determination in plants.	7
III	Plant Breeding: Plant introduction. Agencies of plant introduction in India. Procedure of	8

	introduction- Acclimatization- achievements, Selection- Mass selection, pure line selection and clonal selection. Genetic basis of selection methods, Hybridization: Procedure of hybridization- intergeneric, interspecific and inter varietal hybridization with examples. Composite and synthetic varieties, male sterility, heterosis and its exploitation in the plant breeding, Mutation, Molecular breeding (Use of DNA markers in plant breeding), achievements in India, Breeding for pest, pathogenic diseases and stress resistance.	
IV	Biostatistics: Definition, Statistical Methods, Basic principles, Variables- measurements, functions, limitations and uses of statistics. Biometry: Data, sample, population, Random Sampling, Frequency distribution- definition only, Central tendency-Arithmetic Mean, Mode and Median; Measurement of dispersion- Coefficient of variation, Standard Deviation, Standard error of mean; Test of significance: Chi square test for Goodness of fit. Computer application in Biostatistics- MS Excel and SPSS.	7
V	Plant Tissue Culture: Elementary knowledge of principles, Components and techniques of in vitro plant cultures, Callus Cultures, cell culture, cell suspension cultures, Embryogenesis and organogenesis, Protoplast isolation and culturing of protoplast- principle and application, regeneration of protoplast, protoplast fusion and somatic hybridization- Selection of hybrid cells, Somaclonal variation, Plant secondary metabolite production	8
VI	Nanotechnology: Nanoscale assembly of cellular components (Cell membrane and liposomes). Nanoscale assembly of microorganisms (Virus). Nano particle synthesis: Biological synthesis of nanoparticles, Advantage and applications of biologically synthesized nanomaterials. Introduction to biological nanomaterials. Biomineralization, Magnetosomes, Nanopesticides, Nanofertilizers, nano sensors.	7
VII	Artificial Intelligence in Plant Science: Elementary Idea of Big data Analytics, Block Chain Technology, 3-D Printing, Machine learning, Algorithms of machine learning, Expert system and Fuzzy logic, Artificial Neural networks and genetic algorithms, predictive analytics, Agents and Robotics, IoT sensors, Object image capture & analysis; Application of Artificial Neural Networks in Plant Science.	8
VIII	Introduction to Use of Digital Technologies- AI, IoT & ICT in Botany: Educational Softwares- INFLIBNET, NICNET, BRNET, internet as a knowledge repository-google scholar, Science direct, resource management, weather forecasting. IoT Data base Management, IoT platforms, IoT Graphical user interface. IoT application development on Android mobile phones, ICT Applications for different crops and horticulture.	7
Suggested Readings: 1. Cytogenetics, Development and Ecology. By D. P.K. Gupta. Rastogi Publication, Meerut. 2. Cell biology, Genetics, Biotechnology. Sharma and Trivedi by RBD Publisher. 3. Cell Biology and Genetics (Hindi) 2/ePB....Gupta PK(Hindi) Rastogi Publication.		

4. Biotechnology (Hindi) (Hindi paper back, B.D. Singh) Hindi Publisher: Kalyani Publishers ISBN: 9789327246070.
5. Cytogenetics, Plant Breeding, Evolution and Biostatistics. ISBN: 978-81-301-0066-1 Sunil D Purohit & Gotam K Kukda Apex Publishing House.
6. PradapPrajanan (Hindi) Hardcover- 1st January 2016 by Chandra Prakash Shuki (Author) Pointer Publishers, Jaipur.

This course can be opted as an elective by the students of following subjects:

Open to all but special for B.Sc. Biotechnology, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.Sc. Food Science.

Evaluation/Assessment Methodology

	Max. Marks
1) Sessional Examination	16
2) Assignments	5
3) Attendance	4
4) ESE	75
Total:	100

Prerequisites for the course: 40% Marks in 12th from a recognized Board with a subject of life Science/ Biology (PCB)

Course Learning Outcomes:

After the completion of the course, the student will be able to

1. Acquire knowledge on cell ultrastructure.
2. Understand the structure and chemical composition of chromatin and concept of cell division.
3. Interpret the Mendel's Principles, acquire knowledge on cytoplasmic inheritance and sex-linked inheritance.
4. Understand the concept of one gene one enzyme hypothesis along with the molecular mechanism of mutation.

IIMTU-NEP IMPLEMENTATION
Year: III / Semester: VI

Programme: B.Sc. (CBZ) Certificate/Diploma/Degree/ BACHELOR OF SCIENCE UG(R)/PG/Ph.D. Class: DEGREE		Year: III Semester: VI	
Credits: 2 Theory: 0 Practical: 2	Subject: Botany		
Course Code: BSBC-NP-361P	TITLE: CYTOGENETICS, PLANT BREEDING AND NANOTECHNOLOGY LAB		
Course Objectives: 1. Students may develop an understanding of various breeding strategies: sexual as well as asexual. 2. They may be able to identify and select best characteristics through judicious use of cytogenetical tools. 3. They shall be able to use recent nano technological advancements to improve the vegetational quality and quantity.			
Nature of Paper: Core			
Minimum Passing Marks/Credits: 50% Marks / 2 Credits			
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)			
Unit	Contents (Minimum any three from each unit, based on the facilities)		No. of Lectures Allotted
I	Study of following cell organisms with the help of permanent Slides: Cell wall, Plasma Membrane, Ribosome, Endoplasmic Reticulum, Golgi apparatus, Mitochondria, Chloroplast, Lysosomes, peroxisomes, Lampbrush Chromosomes and Polytene Chromosomes. Study of Mitosis and Meiosis with material.		7
II	Study of genetic problems related to: Laws of Mendal, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Polygenic inheritance and Sex determination.		7
III	Plant Breeding 1. Mass selection, 2. pure line selection 3. Clonal selection. 4. Hybridization: Procedure of hybridization 5. Heterosis and its exploitation in the plant breeding,		7
IV	Problems related to Biostatistics 1. Data sample, 2. Population, 3. Random Sampling,		8

	4. Frequency distribution 5. Arithmetic Mean, Mode and Median 6. Measurement of dispersion- Coefficient of variation, Standard Deviation, Standard error of mean 7. Test of significance: Chi square test for Goodness of fit.	
V	Plant Tissue Culture 1. In vitro plant cultures, 2. Callus Cultures, 3. cell culture, 4. cell suspension cultures, 5. Embryogenesis and organogenesis, 6. Protoplast isolation and culturing of protoplast	8
VI	Nanotechnology (Demonstration only) 1. Nanoscale assembly of cellular components (Cell membrane and liposomes). 2. Nanoscale assembly of microorganisms (Virus). 3. Nano particle synthesis 4. Biological synthesis of nanoparticles, 5. Magentosomes, Nanopesticides.	7
VII	Artificial Intelligence in Plant Science (Demonstration only) 1. Block Chain Technology, 2. 3-D Printing, 3. Machine learning, 4. Algorithms of machine learning,	8
VIII	Introduction to Use of Digital Technologies- 1. AI, IoT & ICT in Botany: Educational Softwares- INFLIBNET, NICNET, BRNET, internet as a knowledge, repository-google scholar, Science direct, 2. Weather forecasting. 3. IoT Data base Management,	8

Suggested Readings:

1. Cytogenetics, Development and Ecology. By D. P.K. Gupta. Rastogi Publication, Meerut.
2. Cell biology, Genetics, Biotechnology. Sharma and Trivedi by RBD Publisher.
3. Cell Biology and Genetics (Hindi) 2/ePB....Gupta PK(Hindi) Rastogi Publication.
4. Biotechnology (Hindi) (Hindi paper back, B.D. Singh) Hindi Publisher: Kalyani Publishers ISBN: 9789327246070.
5. Cytogenetics, Plant Breeding, Evolution and Biostatistics. ISBN: 978-81-301-0066-1 Sunil D Purohit Gotam K Kukda Apex Publishing House.
6. PradapPradhan (Hindi) Hardcover- 1st January 2016 by Chandra Prakash Shukla (Author) Pointer Publishers, Jaipur.

Course Outcomes:

1. Understand the basic concepts of the ultrastructure of cell, cell organelles, chromosomes and nucleic acids.
2. Apply the principles of inheritance to plant breeding.
3. Acquaint with the fundamentals of chromosomal and cytoplasmic inheritance, sex determination, mutations and chromosomal aberrations.
4. Learn molecular genetics.

IIMTU-NEP IMPLEMENTATION
Year: III / Semester: VI

Programme: B.Sc (CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Degree	Year: IIIrd Semester: VIth	
Credits: 4 Theory: 4 Practical: 0	Subject: Zoology	
Course Code: BSZC-NP-362	Title: Ethology, Evolutionary and developmental Biology	
Course Objectives: CO1: To understand animal behaviour and types of learning. CO2: To understand theories of evolution. CO3: To understand causes of genetic variation and heritability. CO4:To understand early and late vertebrate development. CO5: To learn general concepts of organogenesis and placentation.		
Nature of Paper: Core/DSE/SEC/GE/AECC: core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 P: 4 (In Hours/Week) 10 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Behavioural Ecology and Chronobiology • Origin and history of Ethology • Instinct Learnt Behaviour • Associative learning, classical and operant conditioning habituation, Imprinting, • Biological clocks , circadian rhythms; Tidal rhythms and Lunar rhythms, Circannual rhythms • Chronomedicine	6
II	Theories of Evolution • Origin of Life • Historical review of evolutionary concept Lamarckism, Darwinism (Natura Sexual and Artificial selection) • Modern synthetic theory of evolution • Adaptive radiations: Patterns of evolution (Divergence, Convergence Parallel, Coevolution)	6
III	Population Genetics • Microevolution and Macroevolution: allele frequencies, genotype frequencies, genotype frequencies, Hardy Weinberg equilibrium and conditions for its maintenance.	8

	- Forces of evolution: mutation, selection, genetic draft - Types of fossils, Incompleteness of fossil record Dating of fossils, Phylogeny of horse	
IV	Species Concept and Extinction - Biological species concept (Advantages and Limitations) Modes of speciation (Allopatric, Sympatric) - Mass extinction (Cause, Names of Five major extinction)	8
V	Gamete Fertilization and Early Development - Gametogenesis, Fertilization - Cleavage pattern - Gastrulation, fate maps - Morphogenesis	8
VI	Development Genes - General concepts of organogenesis - Introduction to genetic basis of embryonic development. - Developmental control genes (Homeobox genes)	8
VII	Early Vertebrate Development - Early development of mammals including placentation - Metamorphosis, regeneration - Environmental regulation of development	8
VIII	Late Development Processes - Development of eye, kidney, limb in amphibian - Mammals female reproductive cycles estrous cycle and menstruation - Aging the biology of senescence	8

Reference / Text Books:

- Ridley, M. (2004) Evolution III Edition Blackwell Publishing
- Barton, N. H., Briggs D.E.G., Eisen, J.A. Goldstein, D. B. and Patel, N.H. (2007) Evolution, Cold Spring , Harbour Laboratory Press.
- Hall, B. K. and Hallgrimsson, B. (2008) Evolution IV Edition Jones and Bartlett Publishers
- Campbell N. A. and Reece J.B. (2011) Biology IX Edition, Person, Benjamin, Cummings.

If the course is available as Generic Elective then the students of following departments may opt it.

- 1.no
- 2.

Evaluation/Assessment Methodology

Max. Marks :100

1) Sessional Examination	16
2) Assignments	5
3) Presentations /Seminar /Attendance	4
4) ESE	75
Total:	100

Prerequisites for the course:

Course Learning Outcomes:

CLO1: Student will be able to explain basic concepts of embryology.

CLO2: Student will be able to explain theories of evolution.

CLO3: Student will be able to explain common disease-causing agents.

CLO4: Student will be able to explain early development of mammals including placentation.

CLO5: Student will be able to explain development of eye, kidney, limb in amphibian.

CLO6: Student will be able to explain species concept and modes of speciation..

IIMTU-NEP IMPLEMENTATION
Year: III / Semester: VI

Programme: B.Sc (CBZ) Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Degree	Year: III Semester: VI	
Credits: 2 Theory: 0 Practical: 2	Subject: Zoology	
Course Code: BSZC-NP-362P	TITLE: Ethology, Evolutionary and Developmental Biology Lab	
Course Objectives: CO1: To study population dynamics through numerical problems CO2: To understand circadian functions in human (daily eating, sleep and temperature patterns). CO3: To study homology and analogy from suitable specimens/pictures CO4: To study fossil evidences from plaster cast model and pictures. CO5: To study life tables from the hypothetical\real data provided.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents (Minimum any three from each unit, based on the facilities)	No. of Lectures Allotted
I	1. Study of life tables from the hypothetical\real data provided 2. Study of population dynamics through numerical problems. 3. Study of circadian functions in human (daily eating, sleep and temperature patterns).	15
II	1. Brief description of chick development. 2. Study of fossil evidences from plaster cast model and pictures. 3. Study of homology and analogy from suitable specimens/pictures 4. Phylogeny of horse with diagram/ cut outs of limbs and teeth of horse ancestors 5. Visit to Natural History museum and submission of report.	15
III	Virtual Labs (Suggestive sites) https://www.vlab.co.in https://zoologysan.blogspot.com www.vlab.iits.acin/vlab	15
Suggested Reading: 1. Animal Behaviour (Ethology) by Agarwal V. K,(2009) S Chand Publishing 2. Campbell N. A. and Reece J.B. (2011) Biology IX Edition, Person, Benjamin, Cummings. 3. Douglas, J. Futuyma (1997) Evolutionary Biology, Sinauer Associates.		

IIMTU-NEP IMPLEMENTATION
Year: III / Semester: VI

Programme: B.Sc (CBZ) Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Class: Degree	Year: III Semester: VI	
Credits: 4 Theory: 4 Practical: 0	Subject: Chemistry	
Course Code: BSCC-NP-363	Title: Organic Synthesis B	
Course Objectives: 1. It relates and gives an analytical aptitude for synthesizing various industrially important compounds. 2. Learn the different types of alkaloids, & terpenes etc and their chemistry and medicinal importance. 3. Explain the importance of natural compounds as lead molecules for new drug discovery.		
Nature of Paper: DSE		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: P: 4 Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits) Practical- 2 Hrs.=1 Credit (4Hrs./Week=2Credits)		
Unit	Contents	No. of Lectures Allotted
I	Reagents in Organic Synthesis: A detailed study of the following reagents in organic transformations Oxidation with DDQ, CAN and SeO ₂ , mCPBA, Jones Oxidation, PCC, PDC, PFC, Collin's reagent and ruthenium tetroxide. Reduction with NaBH ₄ , LiAlH ₄ , Meerwein-Ponndorf-Verley (MPV) reduction, Wilkinson's catalyst, Birch reduction, DIBAL-H	06
II	Organometallic Compounds: Organomagnesium compounds: the Grignard reagents, formation, structure and chemical reactions. Organozinc compounds: formation and chemical reactions. Organolithium compounds: formation and chemical reactions.	04
III	Chemistry of Aldehydes and ketones: Nomenclature and structure of the carbonyl groups, synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones using 1,3-dithianes, synthesis of ketones from nitrites and from carboxylic acids, Physical properties. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations, Condensation with ammonia and its derivatives. Wittig reaction, Mannich reaction. Oxidation of aldehydes, Cannizzaro reaction, MPV, Clemmensen, Wolff-Kishner, LiAlH ₄ and NaBH ₄ reductions. Halogenation of enolizable ketones An introduction to α , β unsaturated aldehydes and Ketones.	10

IV	Carboxylic acids and their Functional Derivatives Nomenclature and classification of aliphatic and aromatic carboxylic acids. Preparation and reactions. Acidity (effect of substituents on acidity) and salt formation, Reactions: Mechanism of reduction, substitution in alkyl or aryl group. Preparation and properties of dicarboxylic acids such as oxalic, malonic, succinic, glutaric, adipic and phthalic acids and unsaturated carboxylic acids such as acrylic, crotonic and cinnamic acids, Reactions: Action of heat on hydroxyl and amino acids, and saturated dicarboxylic acids, stereospecific addition to maleic and fumaric acids. Preparation and reactions of acid chlorides, acid anhydrides, amides and esters, acid and alkaline hydrolysis of esters, trans-esterification.	08
V	Organic Synthesis via Enolates Acidity of α -hydrogens, alkylation of diethyl malonate and ethyl acetoacetate, Synthesis of ethyl acetoacetate: the Claisen condensation, Keto-enol tautomerism of ethyl acetoacetate. Alkylation of 1, 3-dithianes, Alkylation and acylation of enamines.	05
VI	Organic Compounds of Nitrogen- Preparation of nitroalkanes and nitroarenes, Chemical reactions of nitroalkanes. Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media, Picric acid. Halo nitroarenes: reactivity, Structure and nomenclature of amines, physical properties, Stereochemistry of amines, Separation of a mixture of primary, secondary and tertiary amines. Structural features effecting basicity of amines. Amine salts as phase-transfer catalysts, Preparation of alkyl and aryl amines (reduction of nitro compounds, nitrites), reductive amination of aldehydic and ketonic compounds, Gabriel-phthalimide reaction, Hofmann bromamide reaction. Reactions of amines, electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, azo coupling	10
VII	Heterocyclic Chemistry Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine, Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution, Mechanism of nucleophilic substitution reaction in pyridine derivatives, Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six membered heterocycles, Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fischer indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis, Mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline	10
VIII	Natural Products Alkaloids & Terpenes: Natural occurrence, General structural features, their physiological action, Hoffmann's exhaustive methylation, Emde's modification; Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine. Natural Occurrence and classification of terpenes, isoprene rule.	07

Reference / Text Books:

1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Sykes, P. *A guidebook to Mechanism in Organic Chemistry*, Pearson Education, 2003.
3. Carey, F. A., Giuliano, R. M. *Organic Chemistry*, Eighth edition, McGraw Hill Education, 2012.
4. Loudon, G. M. *Organic Chemistry*, Fourth edition, Oxford University Press, 2008.
5. Clayden, J., Greeves, N. & Warren, S. *Organic Chemistry*, 2nd edition, Oxford University Press, 2012.
6. Graham Solomons, T.W., Fryhle, C. B. *Organic Chemistry*, John Wiley & Sons, Inc.
7. Smith, J. G. *Organic Chemistry*, Tata McGraw-Hill Publishing Company Limited.
8. March, J. *Advanced Organic Chemistry*, Fourth edition, Wiley.
9. Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Welly & Sons (1976).
10. Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
11. Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural*
12. *Products)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
13. Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Pragati Prakashan (2010).

Evaluation/Assessment Methodology

	Max. Marks
1. Class tasks/ Sessional Examination	10 + 10
2. Assignments	5
3. ESE	75
Total:	100

Prerequisites for the course: Knowledge of chemistry taught in the preceding semester.

Course Learning Outcomes:

1. Students will understand the concept of various reagents used in organic synthesis.
2. Students will be able to understand the organo metallic compounds and carbonyl compounds.
3. Students will be able to understand carboxylic acid and its various derivatives.
4. Students will be able to understand the enolates, nitrogenous organic compounds and various heterocyclic compounds.
5. Students will be able to understand natural products such as alkaloids and terpenoids.

(2024-2025)
IIMTU-NEP IMPLEMENTATION
Year: I / Semester: I

Programme: B.Sc. (CBZ) Certificate/Diploma/Degree/ CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY AND CLASSICAL BOTANY UG(R)/PG/Ph.D. Class: Certificate		Year: I Semester: I
Credits: 4 Theory: 4 Practical: 0	Subject: Botany	
Course Code: BSBC-NP-115	TITLE: GENERAL MICROBIOLOGY AND PLANT PATHOLOGY	
Course Objectives: 1. Classification and diversity of different microbes including Algae, Fungi, Bacteria, Virus and Lichens and their Economic Importance. 2. To have thorough knowledge about identifying microbes, Biofertilizers, pathogens and lichens. 3. Commercial use of microbes and microbial products. 4. Host-pathogen relationship and disease management. 5. Different types of diseases, their, symptoms and their remedy. 6. Application of microbes in different fields. 7. Structure and function of certain selected bacteria, algae, fungi and lichens. 8. Gain Knowledge about the economic value of this lower group of this plant community.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents	Lectures
I	Microbial Techniques & instrumentation Microscopy- Elementary knowledge of Light, phase contrast, electron, scanning and transmission electron microscopy, staining techniques, for light microscopy. Common equipment of microbiology lab and principle of their working- autoclave, oven, laminar air flow, centrifuge. Colorimetry and spectrophotometry, fermentation and fermenters.	8
II	Microbial world Cell structure of Eukaryotic and prokaryotic cells, Gram positive and Gram-negative bacteria, Structure of a bacteria and plasmids; Bacterial Growth curve, measurement of growth; Batch culture, fed batch culture and continuous culture. Viruses, general characteristics, Structure of viruses, TMV and retro viruses, Bacteriophages, Structure of T4 & λ-phage; Lytic and Lysogenic cycles, mycoplasma.	8
III	Phycology	7

	Range of thallus organization in Algae, Pigments, Flagella, Reserve food, Types of Reproduction, Classification and comparative life cycle of- <i>Nostoc</i> , <i>Chlorella</i> , <i>Volvox</i> , <i>Oedogonium</i> , <i>Chara</i> . Economic importance of algae- Role of algae in soil fertility-biofertilizers.	
IV	Mycology Study of general characteristics, nutrition, life cycle, Economic importance of Fungi, Classification upto class. Distinguishing characters of Myxomycota : General characters of True Fungi (Eumycota): Mastigomycotina Synchronium: Zygomycotina : <i>Rhizopus</i> , Ascomycotina : <i>Saccharomyces</i> , Basidiomycotina : <i>Ustilago</i> , <i>Puccinia</i> ; Deuteromycotina , <i>Alternaria</i> .	7
V	Lichenology & Mycorrhiza General account of Lichens, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.	7
VI	Plant Pathology Disease concept, Symptoms, Etiology & Causal complex, infection, Pathogenicity and pathogenesis, Koch's Postulates. Disease cycle (monocyclic, polycyclic and polyetic). Defense mechanism. Fungicides- Bordeaux mixture, Lime Sulphur, Neem cake & oil.	7
VII	Diseases and Control Symptoms, Causal organism, Disease cycle and Control measures of –Early & Late Blight of Potato, Black Stem Rust of Wheat, <i>Alternaria</i> spot and white rust of Crucifers, Red Rot of Sugarcane, Mosaic diseases on tobacco, citrus canker, little leaf of brinjal; Disease management; Quarantine, Chemical, Biological, Integrated pest disease management.	8
VIII	Applied Microbiology Elementary knowledge of Food fermentations and food produced by microbes, Production of antibiotics, enzymes, vitamins, alcoholic beverages, organic acid.	8
Suggested Readings: 1. Moderna Microbiology (hindi) (hb) ISBN: 9788177543599 Edition: 1Year: 2018 Author: Dr. Purbhit SS, Dr. Singh T Publisher: Agrobios (India) 2. Suggested books “Plant Pathology by R.S. Mehrotra, Tata McGraw-Hill Education” are included in reading resource list. 3. Suggested book- “Eminent Indian Botanists: Past and Present (Biographies and contributions)”, P.Suresh Narayan and T. Pullaiah, Regency Publications, (2011)		
If the course is available as Generic Elective then the students of following departments may opt it.		
1. Agriculture 2. B. Pharma		
Evaluation/Assessment Methodology		
		Max. Marks
1) Sessional Examination		16
2) Assignments		5
3) Attendance		4
4) ESE		75
Total:		100
Prerequisites for the course: 40% Marks in 12 th from a recognized Board with a subject of life Science/ Biology (PCB)		

Course Learning Outcomes:

After the completion of the course, the student will be able to

1. Know about the working principle and uses of different instruments and microbial technologies
2. Understanding about classification and diversity of different microbes including Algae, Fungi, Bacteria, Virus and Lichens and their Economic Importance.
3. Know about various algal genus and their life cycle patterns with their economic importance. Develop conceptual skills about identifying microbes, Biofertilizers, pathogens and lichens.
4. Understand the structure and function of some selected fungal genus and their life cycle.
5. Learn the commercial production of microbial products and may establish himself as an entrepreneur
6. Gain the knowledge about the relationship between Host and pathogen and the management of the diseases caused by pathogen
7. Get knowledge about the application of microbes in every aspect of life and have Knowledge about the economic value of this lower group of this plant community.

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: First

Programme: B.Sc. (CBZ) Certificate/Diploma/Degree/ CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY AND CLASSICAL BOTANY UG(R)/PG/Ph.D. Class: Certificate		Year: I Semester: I
Credits: 2 Theory: 0 Practical: 2	Subject: Botany	
Course Code: BSBC-NP-115P	TITLE: MICROBIOLOGY AND PLANT PATHOLOGY LAB	
Course Objectives: 1. Upon completion of this course the student will have the knowledge and skills to: understand the Difference between: Algae, Fungi, Bacteria and Lichens. 2. They may know about the cultivation of Mushroom and may have a set up a for the same. 3. They can understand the host pathogen relationship and spread of the disease		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents (Minimum any three from each unit, based on the facilities)	No. of Lectures Allotted
I	Topic: INSTRUMENTS & TECHNIQUES 1. Laboratory safety and good laboratory practices 2. Principles and application of Laboratory instruments-microscope, incubator, autoclave, centrifuge, LAF, filtration unit, shaker, pH meter. 3. Buffer preparation & titration 4. Cleaning and Sterilization of glass wares 5. Preparation of media-Nutrient Agar and Broth 6. Inoculation and culturing of bacteria in Nutrient agar and nutrient broth 7. Preparation of agar slant, stab, agar plate 8. Phenol Coefficient method to test the efficacy of disinfectants	7
II	Topic: BACTERIAL IDENTIFICATION 1. Isolation of bacteria 2. Growth curve of bacteria. 3. Identification of bacteria. 4. Staining techniques: Gram’s Negative, Endospore, Capsule and Cell Wall. 5. Cultural characteristics of bacteria on NA. 6. Pure culture techniques (Types of streaking). 7. Biochemical characterization, IMViC, Carbohydrate fermentation test,	8

	Mannitol motility test, Gelatin liquefaction test, Urease test, Nitrate reduction test, Catalase test, Oxidase test, Starch hydrolysis, Casein hydrolysis. 8. Antibacterial potential of natural products 9. Replica plating 10. Bacterial transformation 11. Bacterial gene induction 12. Bacteriophage growth analysis.	
III	MYCOLOGICAL STUDY: 1. Isolation of different fungi: Saprophytic, Coprophilous, Keratinophilic. 2. Identification of fungi by lactophenol cotton blue method. Rhizopus, Saccharomyces, Penicillium, Peziza, Ustilago, Puccinia; Fusarium, Curvularia, Alternaria. 3. Agaricus: Specimens of button stage and full grown mushroom; Sectioning of gills of Agaricus. 4. Lichens: crustose, foliose and fruticose specimens	8
IV	PHYCOLOGY: Type study of algae and Cyanobacteria-<i>Spirulina</i>, <i>Nostoc</i>, <i>Chlorophyceae-Chlorella</i>, <i>Volvox</i>, <i>Oedogonium</i>, <i>Cladophora</i> and <i>Chara</i>; <i>Xanthophyceae-Vaucheria</i>; <i>Bacillariophyceae-Pinnularia</i>, <i>Phaeophyceae-Sargassum</i>, <i>Rhodophyceae-Polysiphonia</i>.	7
V	EXPERIMENTAL PLANT PATHOLOGY 1. Preparation of fungal media (PDA) & Sterilization process. 2. Isolation of pathogen from diseased leaf. 3. Identification: Pathological specimens of Brown spot of rice, Bacterial blight of rice, Loose smut of wheat, Stem rot of mustard, Late blight of Potato; Slides of uredial, telial, pycnial & aecial stages of Puccinia, Few viral and bacterial plant diseases.	8
VI	PRACTICALS IN APPLIED MICROBIOLOGY -1 1. Isolation of nitrogen fixing bacteria from root nodules of legumes. 2. Enumeration of <i>rhizo spherotomon</i>- <i>rhizo</i> sphere population of bacteria. 3. Isolation of antagonistic <i>Pseudomonas</i> from soil. 5. Isolation of <i>Azospirillum</i> sp. from the roots of grasses. 6. Microscopic observations of root colonization by VAM fungi. 7. Isolation of phyllosphere microflora. 8. Isolation of P solubilizing microorganisms	8
VII	PRACTICALS IN APPLIED MICROBIOLOGY-2 1. Wine production. 2. Isolation of lactic acid bacteria from curd. 3. Isolation of lipolytic organisms from butter or cheese. 4. Immobilized bacterial cells for production of hydrolytic enzymes. 5. Enzyme production and assay-cellulase, protease and amylase. 6. Immobilization of yeast. 7. Isolation of cellulolytic and anaerobic sulphate reducing bacteria. 8. Isolation and characterization of acidophilic, alkalophilic and halophilic bacteria. 9. Over expression of recombinant protein in Bacteria or Yeast.	8
VIII	1. Cultivation of <i>Spirulina</i> & <i>Chlorella</i> in lab for bio fuel.	6

	2. Visit to NAIM, Mau, Varanasi (Kashi)/IMTECH (Institute of Microbial Technology), Chandigarh for viewing culture Repository 3. Visit to biofertilizers and bio pesticide unit to understand about the Unit operation procedures 4. Mushroom cultivation for Protein 5. Alcohol production from sugarcane juice.	
Suggested Readings: 1. Dubey, R.C. and Maheshwari. D.K. 2012. Practical Microbiology, S. Chand & Company, Pvt. Ltd., New Delhi. 2. Pandey. B.P. 2014 Modern Practical botany, (Vol-I) S.Chand & Company, Pvt. Ltd., New Delhi. 3. Gokare A. Ravishankar, Ranga Rao Ambati 2019 Handbook of Algal Technologies and Phytochemicals. 4. Volume II: Phycoremediation, Biofuels and Global Biomass Production Print ISBN: 9780367178192.		

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: B.Sc. (CBZ) Certificate/Diploma/Degree/ CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY AND CLASSICAL BOTANY UG(R)/PG/Ph.D. Class: Certificate		Year: I Semester: II
Credits: 4 Theory: 4 Practical: 0	Subject: Botany	
Course Code: BSBC-NP-121	TITLE: CRYPTOGAMS AND PHANEROGAMS	
Course Objectives: 1. Study of morphology, anatomy, reproduction and developmental changes there in through typological study should create a knowledge base in understanding plant diversity, economic values, taxonomy of lower group of plants. 2. IT is framed to educate the students about bryophytes and pteridophytes and to provide them with in-depth knowledge about these organisms' life cycles and lower plants. 3. It is also include comprehending how pteridophytes generate seeds and the growth of stelar organs. 4. The course is designed to acquire understanding of gymnosperm plant life cycles. It also explain the traits in seed plants about their life cycle, and the variety of their plant biology. 5. Students will also learn about the components and purposes of plant tissues and cells and will find out about the importance of double fertilization. 6. Learner will be aware to understand the plant's internal structure and growth pattern, the significance and range of fertilization, endosperm, and embryogenesis.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No.	Topics	Lectures
Unit I	Bryophytes General characteristics and Range of thallus organization in Brophytes; Important Classification of Bryophytes; Economic importance of Bryophytes; Morphology, Anatomy and reproduction of Riccia, Marchantia, Anthoceros and Funaria. (Developmental details not to be included).	8
Unit II	Pteridophytes General characteristics and Classification (upto family) of Pteridophytes; Economic importance of pteridophytes; Heterospory and seed habit; early fossils <i>Rhynia</i> ; Morphology, anatomy and reproductive stages of <i>Selagenella</i> , <i>Equisetum</i> , <i>Pteris</i> . Stelar organization.	10

Unit III	Gymnosperms General characteristics and classification (up to family) of Gymnosperms; Economic importance of Gymnosperm. Paleobotany, Brief account on the process of fossilization and types of fossils. Morphology, anatomy and reproduction of Cycas, Pinus, Ephedra Ginkgo and Gnetum.	12
Unit IV	Angiosperm Morphology Morphology and modifications of root and stem; Types of inflorescence; Basic structure of flower, types of placentation; types of fruits; types of seeds.	8
Unit V	Angiosperm Plant Anatomy Classification of tissues; Meristematic and permanent tissues; Apical meristems and Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Anatomy of Root, stem and leaves (dicot and monocot) Secondary Growth- root and stem- cambium (structure and function), annual rings, periderm, Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Periderm	11
Unit VI	Reproductive Biology of Angiosperms Structure of microsporangium, microsporogenesis, structure of megasporangium and its types, megasporogenesis, Type of Embryo sac, Palynology, Pollen structure, pollen morphology, Pollination types and significance; Germination of pollen grains, Structure of male gametophyte, fertilization, Structure of embryo, Endosperm, double fertilization. Polyembryony	11
Suggested Readings:		
1. Botany: Algae, Fungi, Lichens, Bacteria, Virus, Bryophytes, Pteridophytes, Gymnosperms. Singh, Pandey and Jain, Rastogi Publication, Meerut. 2. New Introductory Botany. Dr. S.K. Gupta, 2017. Kedarnath Ramnath Publications. 3. A.K. Sharma and Rajeshwari Sharma 2018. Botany. B.Sc. I Year. S.R. Scientific Publishers. 4. Parihar, N.S. (1991). An Introduction to Embryophyta. Vol. I. Bryophyta Central Book Depot, Allahabad. 5. Bhatnagar S P (1996), Gymnosperms: A New Age International Publisher. 6. Dutta, A.C. (2016) Botany for Degree students. Oxford University Press. 7. Sachs J, Thiselton Dyer WT. Phanerogams. In: Bennett AW, ed. A Text-Book of Botany: Morphological and Physiological. Cambridge Library Collection - Botany and Horticulture. Cambridge University Press; 2011:421-466		
Evaluation/Assessment Methodology		
		Max. Marks
1) Sessional Examination		16
2) Assignments		5
3) Attendance		4
4) ESE		75
		100
Total:		
Prerequisites for the course: 40% Marks in 12 th from a recognized Board with a subject of life Science/ Biology (PCB)		
Course Learning Outcomes:		

After the completion of the course, the student will be able to:

1. Develop critical understanding of morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.
2. Understanding of plant evolution and their transition to land habitat.
3. Understand morphology, anatomy, reproduction and developmental changes there in through typological studies and create knowledge base understanding the basis of plant diversity, economic values and taxonomy of plants.
4. Understanding the details of external and internal features of the plants.

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: B.Sc. (CBZ) Certificate/Diploma/Degree/ CERTIFICATE COURSE IN MICROBIAL TECHNOLOGY AND CLASSICAL BOTANY UG(R)/PG/Ph.D. Class: Certificate	Year: I Semester: II
Credits: 2 Theory: 0 Practical: 2	Subject: Botany
Course Code: BSBC-NP-121P	TITLE: CRYPTOGRAMS AND PHANEROGAMS LAB
Course Objectives: After the completion of the course the students will be able to: 1. The students will be made aware of the group of plants that have given rise to land habit and the flowering plants. Through field study they will be able to see these plants grow in nature and become familiar with the biodiversity. 2. Students would learn to create their small digital reports where they can capture the zoomed in and zoomed out pictures as well as videos in case, they are able to find some rare structure or phenomenon related to these plants. 3. Develop an understanding by observation and table study of representative members of phylogenetically important groups to learn the process of evolution in a broad sense. 4. Understand morphology, anatomy, reproduction and developmental changes therein through typological study and create a knowledge base in understanding plant diversity, economic values & taxonomy of lower group of plants 5. Understand the composition, modifications, internal structure & architecture of flowering plants for becoming a Botanist.	
Nature of Paper: Core	
Minimum Passing Marks/Credits: 50% Marks / 2 Credits	
Contents (Perform based on the facilities)	No. of Lectures Allotted
1. Study Of Bryophytes: • Riccia: Thallus morphology, Thallus anatomy via V.S., All permanent slides-antheridiophore V.S., archegoniophore V.S. • Marchantia: Thallus morphology, thallus V.S. via gemma cup, All permanent slides- antheridiophore and archegoniophore V.S., sporophyte L.S. and W.M of gemmae • Anthoceros: Thallus morphology, thallus anatomy via VS, All permanent slides- antheridiophore and archegoniophore V.S., sporophyte L.S.	13
2. Study Of Pteridophytes: 3. Selaginella: morphology of leaf with ligule; T.S. of stem; W.M. strobilus; W.M. microsporophyll and megasporophyll (transient slides); L.S. strobilus (permanent slide).	13

4. Equisetum: morphology of leaf with ligule; T.S. of stem; W.M. strobilus; W.M. microsporophyll and megasporophyll (transient slides); L.S. strobilus (permanent slide).	
3. Study Of Gymnosperms: • Cycas : Morphology of plants, coralloid roots, T.S of root, V.S. of leaflet, microsporophyll and megasporophyll • Pinus- Morphology , T.S. Needle, T.S. of stem, male cone and female cones, L.S. of male cone, L.S. of female cone , whole mount of microsporophyll, whole mount of Microspores (temporary slides)	13
4. Anatomy of Angiosperms: • Root: T.S. of Monocot Root, T.S. of Dicot Root • Stem: T.S. of Monocot Stem, T.S. of Dicot Stem • Study of leaf anatomy by V.S.	11
4. Plant Morphology and Reproductive organs of Angiosperms: • Morphology of Angiospermic Plants • Basic structure of flower • Structure of Pollen grains • Structure of Ovule • Type of ovules	10
Suggested Readings: 1. New Introductory Botany. Dr. S.K. Gupta, 2017. Kedarnath Ramnath Publications. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India. 2. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India. 3. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd. Publishers, New Delhi, India. 4. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad. 5. B. P. Pandey (2017), Botany for degree studies (as per CBCS). S.Chand 6. B. S. Acharya and B. K. Mishra (2018). Plant Biodiversity, Kalyani Publishers, New Delhi.	

IIMTU-NEPIMPLEMENTATION

Year: I / Semester: II

Programme: Bachelor of Science Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: B.Sc.(CBZ)	Year: I Semester: II	
Credits: 4 Theory: 4 Practical: 0	Subject: Zoology	
Course Code: BSZC-NP- 126	Title: Introductory Animal Physiology	
Course Objectives: CO1: Gain a comprehensive understanding of the structural organization and functions of the gastrointestinal tract and associated glands, including the mechanical and chemical digestion of food. CO2: Learn about the mechanisms of respiration, including pulmonary ventilation, respiratory volumes and capacities, and the transport of oxygen and carbon dioxide in the blood. CO3: Understand the components of blood, their functions, and processes such as hemopoiesis and blood clotting. Explore blood group systems and their physiological significance. CO4: Learn about the structure and function of the mammalian heart, including the conduction of the heartbeat, the cardiac cycle, and cardiac output regulation. CO5: Classify animals based on their excretory products and understand the structure and function of the nephron and kidney in urine formation. CO6: Study the structure of neurons, the mechanisms of action potentials, and the propagation of nerve signals across different types of nerve fibers.		
Nature of Paper: Core/DSE/SEC/GE/AECC: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P:2 (In Hours/Week)8 Theory-1Hr.=1Credit Practical- 2Hrs.=1 Credit(4Hrs./Week=4Credits)		
Unit	Contents	No.of Lectures Allotted
I	Structural organization and functions of gastrointestinal tract and associated glands, Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins.	6
II	Mechanism of respiration, pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood Respiratory pigments, Dissociation curves and the factors in fluencingit; Control of respiration. Histology of trachea and lung.	6

III	Components of blood and their functions; hemopoiesis, Blood clotting: Blood clotting system, Blood groups: Rh factor, ABO, Structure of mammalian heart, Conduction of Heart beat, Cardiac cycle; Cardiac output and its regulation, Electrocardiogram, Blood pressure and its regulation.	8
IV	Classification of animals on the basis of excretory products: Ammonotelic, Uricotelic and Ureotelic, Structure and function of nephron and kidney, Urine formation mechanism.	8
V	Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibres, Types of synapse, Structure of Mammalian brain.	8
VI	Endocrine glands-pineal, pituitary, thyroid, parathyroid, pancreas, adrenal: hormones secreted by them, Classification of hormones; Mechanism of Hormone action.	8
VII	Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus.	8
VIII	Osmoregulation, Osmotic challenges of different environments, Mechanism of Osmoregulation in fresh water, Estuarine and Marine animals.	8

Reference/Text Books:

1. Guyton, A.C. & Hall, J.E. Text book of Medical Physiology, XI Edition. Harcourt Asia PTE Ltd./W.B. Saunders Company. (2006)
2. Tortora, G.J. & Grabowski, S. Principles of Anatomy & Physiology. XI Edition John Wiley & Sons (2006).
3. Hill, Richard W., et al. Animal physiology, Vol.2 Sunderland, MA: Sinauer Associates, (2004).
4. Chatterjee CC Human Physiology Volume 1 & 2. 11th edition. CBS Publishers (2016).

If the course is available as Generic Elective then the students of following departments may opt it.

1. No
- 2.

Evaluation / Assessment Methodology

		Max.Marks:100
1. Sessional Examination		16
2. Assignments		5
3. Presentations/Seminar/Attendance		4
4. ESE		75
Total:		100

Prerequisites for the course:

Course Learning Outcomes:

CLO1: Identify and describe the structural components and functions of the gastro intestinal tract and associated glands, and explain the processes of mechanical and chemical digestion.

CLO2: Explain the mechanisms of respiration, including the role of respiratory volumes and capacities, and how oxygen and carbon dioxide are transported in the blood.

CLO3: Understand the structure of the heart, the conduction system, and how the cardiac cycle and cardiac output are regulated.

CLO4: Describe the classification of animals based on excretory products and explain the mechanism of urine formation in the nephron and kidney.

CLO5: Illustrate the structure and function of neurons, including the resting membrane potential,

action potential propagation, and types of synapses

CLO6: Explain the functions of endocrine glands and hormones, their classification, and the mechanisms by which they exert their effects on target tissues.

IIMTU-NEPIMPLEMENTATION
Year: I/ Semester: II

Programme: Bachelor of Science Certificate/Diploma/Degree//PG/Ph.D. Class: B.Sc. CBZ	Year: I Semester: II	
Credits: 2 Theory: 0 Practical: 2	Subject: Zoology	
Course Code: BSZC-NP-126P	TITLE: Introductory Animal Physiology Lab	
Course Objectives: CO1: To provide a comprehensive understanding of the scope, historical background, and biological aspects of immunology. CO2: To examine the essential features of antigen s and antibodies, including their structure, classification, and functional roles in the immune response. CO3: To elucidate the different types of immunity, immune responses, and the mechanisms underlying phagocytosis, interferon activity, and the complement CO4: To introduce students to autoimmune diseases, their mechanisms, and the clinical tests used to diagnose these conditions. CO5: To explore the immunological basis of transplantation, including graft types, transplantation reactions, and mechanisms of immune suppression.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L:4 T: P: 4(In Hours/Week) Theory- 1Hr.=1Credit Practical-2Hrs.=1Credit(4Hrs./Week=4Credits)		
S.No	List of Experiments	No. of Lectures Allotted
1.	Unit I (TotalNo.ofLectures:20) - Measure the total red blood cell (RBC) count in your own blood. Measure the total white blood cell (WBC) count in your own blood. - Assess the percentage of hemoglobin in your own blood. - Examinea blood sample to identify its blood group.	15
2.	Unit II (Total No. of Lectures:15) - Identify the Rh factor in human blood. - Determine whether the blood group is Rh-positiveor Rh- negative. - Demonstrate the process of blood coagulation. - Measure the time required for bleeding to stop.	15
3.	Unit III (Total No. of Lectures: 15) - Measure the time required for blood to clot. - Assess blood pressure levels. - Study the histological structures of the liver, heart, pancreas, and kidneys.	15

4.	Unit IV-(Total no. of Lectures=15) Virtual Labs (Suggestive sites) • https://www.vlab.co.in • https://zoologysan.blogspot.com • www.vlab.iitb.ac.in/vlab • www.onlinelabs.in • www.powershow.com • https://vlab.amrita.edu	15
Suggested Readings: • Victor P.Eroschenko.(2008).diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins. • Arey, L.B.(1974). Human Histology. IV Edition. W.B. Saunders. • Kesar,Saroj and VasishtaN.(2007). Experimental Physiology: Comprehensive Manual, Heritage Publishers, New Delhi.		

School of Life Science & Technology

ACADEMIC HAND BOOK

DEPARTMENT OF BIOTECHNOLOGY

ORDINANCE
(As per New Education Policy 2020 & UGC Regulation)
BACHELOR OF SCIENCE IN BIOTECHNOLOGY
(B.Sc. Biotechnology)
(Academic Session 2024-25)

Indexing

1. Preamble
 - 1.1. Introduction to B.Sc. Biotechnology syllabus
2. Definitions and Nomenclatures
3. Vision and mission of the School and Department
4. Program Educational objectives
5. Program outcome/ Program Specific outcome
6. Admission
7. Eligibility in all year as NEP (entry & exit) as per NEHQF and NSQF (if applicable)
8. Curriculum
9. Medium of Instruction
10. Choice base Credit system (CBCS)/LOCF/OBE
11. Registration for course in a semester
12. Attendance
 - 12.1 Condonation of medical cases
 - 12.2 Additional Condonation
13. Assessment procedure
 - 13.1 Internal Assessment (IA) (External Assessment (EA)
 - 13.2 Practical Assessment
14. Research Project/Semester Project Assessment Criteria
15. Internship – Research / Industrial Internship
16. For non – credit courses / audit courses
17. Credit weightage
18. Maximum duration of Programme/promotion policy
19. Maximum gaps between semester/year
20. Credit system & grading CGPA/SGPA
21. Class / division
22. Transfer of credit /Academic Credit Bank
23. Change of discipline
24. Use of technological intervention
25. Student Discipline
26. Student Welfare
27. Ragging
28. Examination code of conduct
29. Power of modify
30. Exit point
31. NC/Credit course

ORDINANCE
BACHELOR OF SCIENCE IN BIOTECHNOLOGY
(B.Sc. Biotechnology)

1. Preamble:

IIMT University is well known for its contributions to academics and research at the national and international levels in various disciplines. Department of Biotechnology runs under the School of Life Science and Technology. The main objective of the Biotechnology program is to study of life is at the core of it and the interdisciplinary networking potential of biotechnology has given it a separate status in fundamental research as well as in modern industrial enterprise. The focus of the century is to obtain knowledge and this shift attracts the Global and local on to technology development and development of various applications in life sciences. Biotechnology is an ideal platform to work, in the milieu of research and industrialization for economic development and social change.

The interdisciplinary aspects of biotechnology conforms living systems and their studies from basic to advance like from biostatistics to design of experiments, from cell and molecular biology to genomics, from biochemistry to biophysics, from protein engineering to proteomics, from genetic engineering to stem cell research, from bioinformatics to advanced genomics-proteomics, from environmental science to environment biotechnology, from microbiology to bioprocess engineering and reactor designing, from bioremediation to material transformation and so on.

1.1. Introduction to B.Sc. Biotechnology syllabus:

B.Sc. Biotechnology syllabus provides students with an in-depth understanding of various subjects like Cell Biology, molecular biology, bioinformatics, biochemistry, microbiology, agriculture biotechnology, genetics, analytical techniques, biostatistics, environment biotechnology, industrial biotechnology and other topics are included in the B.Sc. syllabus. This course's sole purpose is to provide students with advanced biological processes knowledge for industrial and other purposes.

2. Definitions and nomenclature related with University:

In these Regulations, unless the context otherwise requires:

1. "Program" means Degree Program like B.Sc. Biotechnology and M.Sc. Biotechnology,
2. "Course" means a theory or practical subject that is normally studied in a semester.
3. "Vice – Chancellor of IIMT-University" means the Head of the University.
4. "Registrar" is the Head of all academic and General Administration of the University.
5. "Dean" means the authority of the school who is responsible for all academic activities of various programs and implementation of relevant rules of these Regulations pertaining to the academic programs.
6. "Controller of Examinations" means the authority of the University who is responsible for all activities related to the University Examinations, publication of results, award of grade sheets and degrees.
7. "Dean – Student Welfare" is responsible for all student related activities including student discipline, extra and co-curricular activities, attendance and meetings with class representatives, Student Council, and parent – teacher meet.
8. "HoD" means the Head of the Department concerned.
9. "University" means IIMT-University, Meerut.

10. “TCH” means Total Contact Hours – refers to the teaching – learning periods.
11. “DEC” means Department Exam Committee.
12. “BoS” means Board of Studies.
13. “ACM” means Academic Council meeting the highest authoritative body for approval for all academic Policies.
14. “Class Co-ordinator” is a faculty of the class who takes care of the attendance, academic performance, and the general conduct of the students of that class.
15. “IA” is Internal Assessment which is assessed for every student for every course during the semester.
16. “ESE” is End Semester Examination conducted by the University at the End of the Semester for all the courses of that semester.

3. Vision and Mission of the Department of Biotechnology:

VISION: To become the finest institution and to create social, economic and intellectual wellbeing of the students through discovery, learning and innovations.

MISSION: To fulfill the educational needs of the students through imparting value based knowledge and innovative skills in an unbiased manner to meet greater challenges involving food, farming, fiber, feed, families, health, energy, water and environment.

Vision and Mission of the Department of Biotechnology:

Our vision is to produce proficient Biotechnologists having innovative concepts and capable to employ finest processes and applications which will intensely influence prevailing standards of environment, medical, industry, agriculture, and rebuilding of environment providing sustainable competitive approaches to present society.

Our mission is to provide Biotechnology educational Program with impetus to generate quality workforce.

- ❖ To generate awareness about potentials tools of Biotechnology for societal implications.
- ❖ To inculcate essence of innovation, entrepreneurship and creativity in young minds with sound research aptitude.
- ❖ To impart quality education in biotechnology program, both theoretical and practical, to students.
- ❖ To serve our students by schooling them leadership, problem solving, and teamwork skills, commitment to quality, ethical behavior, and respect for others and develop them as confident personages who are effective contributors towards growth of the nation.

4. Program Educational objectives:

Table 1: Program Educational Objectives

PEO1 The first objective of the Biotechnology is to prepare students to apply knowledge of basic concepts related with the subjects like Biotechnology and human welfare, Microbiology, biochemistry, analytical tools so that students can develop the better understanding of various domain of biotechnology.

PEO2 The laboratory aspects along with theoretical subjects are included to prepare students them for careers in academic, industries, agriculture and environmental sectors.

- PEO 3** Recent research in the areas of Genetics and molecular biology, Industrial Biotechnology, Bioreactor designing, Downstream processing, soil, Agriculture & Environmental Biotechnology, Green biotechnology and pollution control are included to develop students in the field of research.
- PEO4** The Bachelors in Biotechnology Programme will address the globally growing requirement for trained technical and methodical manpower with a considerate mindset of understanding the research ethics involving animals and humans.
- PEO5** To heighten career opportunities locally and globally in industrial sectors, pharmaceutical sectors, medical sector.
- PEO6** To produce students who establish a promise to life-long learning and to generate and protect the intellectual property and contribute to their own and countries' development through entrepreneurship.

5. Program Outcomes (POs)/Program Specific Outcome

Table 2: Program Outcomes (POs)/Program Specific Outcome

- PO1** Grasp of basic and advanced knowledge on various domains of biotechnology.
- PO2** Aptitude to assimilate technologies through an inter-disciplinary approach.
- PO3** Develop an independent thinking ability.
- PO4** Ability to communicate effectively.
- PO5** Equip the students with the laboratory skills in biotechnology.
- PO6** To develop students in such a way that they are able to provide biotechnological solutions to the underprivileged areas also helps in solving the problem of clean water and sanitation, waste treatment, food scarcity, agriculture, carbon reduction, climate change, energy etc.
- PO7** To develop understanding of their social, professional ethical specialized and ethical accountability also helps students in protection their intellectual property.
- PO8** Capability of design of experiment skill and also develops the skill of analyzing and evaluating the results.
- PO9** To generate Cognizance of contemporary issues of the time and provide appropriate solutions with biotechnological mindset and fulfillment of SDG.
- PO10** To develop the understanding to recognize the societal needs and to involve them in life-long learnedness.
- PO11** To inculcate the habit of team work to solve the industrial and environmental issues.
- PO12** To inculcate the value added entrepreneurship skills and convert them as professional and mindful individuals.

Programme Specific Outcome B.Sc. BT I year

- PSO₁** To teach an ability to apply biotechnology skills in various subjects studied during the course.
- PSO₂** To provide students with the concepts of Biotechnology to develop interest in science.
- PSO₃** Prepare candidates for starting/entry level positions with a specific focus on individual, social, global and environmental perspectives and After completion of the course students will be awarded with Certificate in Biotechnology

Programme Specific Outcome B. Sc. BT II year:

- PSO₁** To impart an ability to apply biotechnology skills and its applications in core and allied fields.
- PSO₂** Students are able to apply the concepts and research approaches.
- PSO₃** After completions of the two years course students will be awarded with Diploma in

Biotechnology and prepare students for the job after completion of diploma in Biotechnology.

Programme Specific Outcome B. Sc. BT III year:

- PSO₁** To prepare students in such a way that they understand the impact of the biotechnological solutions in social and environmental context and demonstrate the knowledge of the requirement for sustainable development
- PSO₂** To provide students with the conceptions from basics to advance research in the field of Biotechnology and enhance their career in higher studies.
- PSO₃** To impart exhaustive and thorough knowledge of Hands on practical to students in several thrust areas of biotechnology to meet out the interface of academia and industry and After completion of the three years course students will be awarded with Degree in Biotechnology.

6. Admission:

1. The number of seats shall be in accordance with the directives by the university. A Candidate who after having secured the Intermediate with at least 40% Marks from a recognized Board with a subject of life Science, shall be eligible for admission to the course. The admission to the course will be on the basis of the merit and according to the guidelines from the university and Government of Uttar Pradesh. After the term-end examination at the end of each semester, the student will be provisionally admitted to the next semester. Each semester will be followed by a break not exceeding 15 days.
2. The admission policy and procedure shall be decided from time to time by the Board of Studies (BOS) of the University based on the guidelines issued by the UGC/NEP and Ministry of Education (MoE), Government of India. Seats are also made for Non-Resident Indians and foreign nationals, who satisfy the admission eligibility norms of the University.

7. Eligibility in all year as NEP:

- ❖ The candidates must have passed class 10th and 12th from recognized Board.
- ❖ Candidates must have a core subject such as Physics, Chemistry, Biology, or Mathematics in class 10th and 12th.
- ❖ 10+2 PCB/PCM with min. 40 % marks
- ❖ PCB and PCM and dates are eligible to apply.
- ❖ The admission to the course will be on the basis of the merit and according to the guidelines from the university and Government of Uttar Pradesh.

8. Curriculum /Syllabus:

The Course curriculum would be as per CBCS & NEP 2020. The course of study shall contain the subjects of applied sciences in the form of core subjects, Discipline Specific Subjects, Generic Elective Subjects, Skill Enhancement and Ability Enhancement courses. The marks shall be awarded to the candidates pursuing the programme for the written papers, mini/ major project report/industrial visits/ presentation /viva-voce examinations, if any as specified in the scheme of Examinations.(Evaluation Scheme of each semester enclosed in Evaluation scheme chapter of Academic Handbook 1)

For the purpose of awarding degrees, the curriculum for all B.Sc. Biotechnology programs is structured to have a minimum of credits+ NCC (Non-credit Audit Courses) as specified in the evaluation scheme approved by Board of Studies and spread out across six semesters of study.

9. **Medium of Instruction:** The medium of instruction for the course shall be English.

10. **Choice base Credit system (CBCS)/LOCF/OBE:**

10.1. **Specific features of CBCS System**

Choice Based Credit System (CBCS) is a proven, flexible mode of learning in higher education which facilitates a student to have guided freedom in selecting his/her own choices of courses in the curriculum for completing a degree program.

CBCS offers a flexible system of learning.

The system permits a student to

- (i) Learn at their own pace through flexible registration process.
- (ii) Choose electives from a wide range of courses offered by parent and other departments.
- (iii) Undergo additional courses to acquire the required number of credits for obtaining B.Sc. degree in Biotechnology program.
- (iv) Undergo additional courses in their special areas of interest.
- (v) Adopt an interdisciplinary approach in learning.
- (vi) Avail transfer of Credits.
- (vii) Gain Non–CGPA credits to enhance skill/employability by taking up project work, entrepreneurship, co-curricular and vocational training.
- (viii) Make the best use of the expertise of available faculty.
- (ix) Learn and earn credits through MOOC, and Project Based Learning.
- (x) Enhance their Knowledge, Skill and Attitude through participation in innovative Curriculum Design, Delivery and Assessments.

The Curriculum is designed to take into the factors listed in the Choice Based Credit System (CBCS) with focus on Project Based Learning and Industrial Training to enable the students to become eligible and fully equipped for employment in industries choose higher studies or entrepreneurship in the field of Biotechnology.

10.2. **Definitions of Key Words related with CBCS:**

- i. **Academic Year:** Two consecutive semesters constitute one academic year. The CBCS provides choice for students to select from the prescribed courses (core, elective or minor or soft skill courses).
- ii. **Credit Based Semester System (CBSS):** Under the CBSS, the requirement for awarding a degree or diploma or certificate is prescribed in terms of number of credits to be completed by the students.
 - ❖ To get a certificate course in Biotechnology, a candidate has to qualify minimum 46 Credits as per NEP and the duration of certificate course is one year.
 - ❖ To get a Diploma in Biotechnology, a candidate has to qualify minimum 92

- ❖ Credits as per NEP and the duration of diploma course is two years.
❖ To get Bachelor degree in Biotechnology, a candidate has to qualify minimum 120 Credits as per NEP and the duration of diploma course is three years.

Table 3: Distribution of Credit system of Biotechnology program

B. Sc. (Biotechnology)	Certificate Course in Biotechnology	After one Year	qualify minimum 46 Credits
	Diploma in Bio technology	After Two Years	qualify minimum 92 Credits
	Bachelor of Science (Biotechnology)	After Three Years	qualify minimum 120 Credits
M.Sc. (Biotechnology)	P.G. Diploma in Biotechnology	After one Year	-
	Master of Science (Biotechnology)	After Two Years	-

- iii. **Credit:** A unit by which the course work is interpreted. It functions the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week.
- iv. **Cumulative Grade Point Average (CGPA):** It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the sum total of the credit points obtained by the student in various courses in all semesters and the sum of the total credits of all courses in all the semesters.
- V. **Semester Grade Point Average (SGPA):** It is index of performance of all performance of work in a semester. Its total credit points obtained by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.
- 10.3. Types of Courses:** Courses in the programme are of three kinds:
- 1) Core Course
 - 2) Elective Course
 - 2)a Generic Elective (GEC) Course
 - 2)b Discipline Specific Skill Elective (DSE) Course
 - 3) Ability Enhancement Course
 - 3)a Skill Enhancement Courses (SEC)
 - 3)b “AECC” courses
1. **Core Course:** A course, which should compulsorily be studied by a candidate as a basic requirement to complete the program, is termed as a Core course. There are Core Theory (CT) and Core Practical (CP) Courses in every semester.
2. **Elective Course:** A course which can be chosen from a very specific or advanced subject of study or which provides an extended scope or which enables exposure to some other domain or expertise, is called an Elective Course. Elective courses may be of two types.

- 2a. **Discipline Specific Skill Elective (DSE) Course:** Elective courses offered by the main subject of study are referred to as Discipline Specific Elective. The Institute may also offer discipline related Elective courses of interdisciplinary nature. An elective may be “Discipline Specific Electives (DSE)” gazing on those courses which add intellectual efficiency to the students.
- 2b. **Generic Elective (GEC) Course:** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.
3. **Ability Enhancement Courses (AEC):** The Ability Enhancement (AE) Courses may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC).
- 3a. **“AECC” courses:** are the courses based upon the content that leads to Knowledge enhancement (i) Environmental Science and ecology, (ii) English/MIL Communication, (iii) Human values and (iv) Professional skills. These are mandatory for all disciplines.
- 3b. **Skill Enhancement Courses (SEC):** SEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, Indian and foreign languages etc. These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge. NPTEL and Spoken courses are added as per program under Skill Enhancement Courses.
4. **Other courses**
 - ❖ Research Project-RP (Minor & Major)
 - ❖ Internship (Industrial/Research)
 - ❖ MOCCS
 - ❖ Minor Certification Integrated with UG Degree
 - ❖ NCC is added in each semester as per availability of seats
 - ❖ Sport is integrated in the curriculum as a non-credit compulsory course.
 - ❖ Generic Elective Courses are also added in the curriculum.
11. **Registration for course in a semester:**
In the beginning of the semester the candidate will choose the subjects of his choice and will register for the current semester within the three days of commencement of the semester.
11. **Attendance:**
Student shall not be permitted to appear in semester examination, unless he/she has regularly attended not less than 75% classes held in aggregate of all subjects. The university however may, condone the shortage in attendance upto 25% in each subject for any of the following reasons.
 - Participation in NCC/ NSS Camps.
 - Participation in University/ Inter-university/ State-level Games.
 - Participation in other extra-curricular activities at University/Inter-university/State level.
 - Prolonged Illness
 - The student is however permitted to avail Academic Leave up to 10% for attending academic related activities like, Industrial Visits, Seminars, Conferences, Competitions etc., with the prior approval of the HoD. After the event, the student should submit the relevant documents for proof to the HoD for approval of the Academic Leave.

12.1. Condonation for medical cases

For medical cases, submission of complete medical history and records with prior information from the parent / guardian to Dean (Students Welfare) is mandatory. The assessment of such cases will be done by the attendance sub-committee on the merit of the case and put-up recommendations to the Vice-Chancellor. Such condonation is permitted only twice for a student in the entire duration of the program.

12.2 Additional Condonation

The Vice-Chancellor, based on the recommendation of the attendance sub-committee may then give condonation of attendance, only if the Vice-Chancellor deems it fit and deserving. But in any case, the condonation cannot exceed 10%.

13. Assessment procedure:

A student is expected to follow the right conduct as per the ethical and socio-cultural norms set by the University for Day-to-day living. Also, student has to follow the rules and guidelines, set by the University for Different Activities. Each Core paper shall be of 100 marks, out of which internal and external assessments will carry 25 marks and 75 marks respectively. While the Ability Enhancement Courses will be of 50 marks out of which internal and external assessments will carry 15 marks and 35 marks respectively. Skill Enhancement Courses will carry the weight age of 50 marks.

13.1 Internal Assessment (IA) / External Assessment (EA)

Two set of question papers will be prepared by the external/internal examiners. Each set will contain three sections namely A, B and C. There would not be any repetition of questions in both the sets as well as the questions would be distributed throughout the entire syllabus so that a candidate can be judged on the basis of the knowledge of the entire subject

The Internal and external assessment marks awarded to the students should be forwarded to the Controller of Examinations at least one week before the commencement of the semester examination. The internal and external assessment marks shall be based on factors such marks secured in Sessional examinations, submission of written assignments, class room participation and attendance. The weightage given to each of these factors for a paper shall be decided and announced at the beginning of the semester.

Table: 4 Internal and External Assessment of Theory

INTERNAL AND EXTERNAL ASSESSMENT FOR THEORY			
Internal Assessment	Marks	External Assessment	Marks
Sessional	15	End Semester Final Examination	75
Assignment	5	-	-
Attendance	5	-	-
Total	25		75

13.2. Practical Assessment

Table 5: Internal and External Assessment of practical

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL			
Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

14. Research Project/Semester Project Assessment Criteria:

The general guidelines for assessment of Project/Internship are given in Table 4.

Table 6: Assessment pattern for Research Project / Semester Project

S. No.	Review / Examination Scheme	Broad Guidelines	Weightage
1	First Review	Concept/Abstract	10%
2	Second Review	Review literature	10%
3	Third Review	Experiment/Analysis	20%
4	Final Review	Project report and Viva – Voce, Results and Conclusion	60%

For the final year project and Viva – Voce end semester examination, the student shall submit a Project Report in the prescribed format issued by the University. The first three reviews will be conducted by a committee constituted by the Head of the Department. The end-semester assessment will be based on the project report and a viva on the project conducted by a committee constituted by the Controller of examination. This may include an external expert.

15. Internship – Research / Industrial Internship:

- ❖ A student has to compulsorily attend summer / at the end of Vth/VIth semester internship during 3rd year for a minimum period of 30 days. In lieu of summer/winter internship, the student is permitted to register for undertaking project work under a faculty of the Department and carry out the project for minimum period of 30 days. In both the cases, the internship report in the prescribed format duly certified by the faculty in-charge shall be submitted to the HoD. The evaluation will be done through presentation and viva. The course will have a weightage as defined in the respective curriculum.
- ❖ At the end of the internship completion, for end semester examination, the student shall submit a Project Report in the prescribed format issued by the University. The reviews will be conducted by a committee constituted by the Head of the Department. The end-semester assessment will be based on the project report and a viva on the project conducted by a committee constituted by Controller of examination. This may include an external expert.

- ❖ Internal Assessment and External Assessment would be of 25 and 75 marks respectively for the same. A Student can do Research Project under the guidance of any external faculty (outside of the university) also by maintain his/ her attendance. Assessment of the project will be done by the presentation and Viva Voce in the front of an External Examiner appointed by the IIMT University. The student shall submit a Project Report (3 Copies) in the prescribed format issued by the University.

16. For non – credit courses / audit courses:

The Assessment will be done based on the respective assessment as per rubrics issued by the Head of the Department (BOS). The University has provided USR (University Social Responsibility Course) and Sports as a Non- credit / Audit Courses.

16.1 Credit weightage: While there is flexibility for the department in allocation of credits to various courses offered, the general formula would be:

- All core courses will be restricted to a maximum of 4 credits
- All electives will be restricted to a maximum of 4 credits
- All ability enhancement courses will be restricted to a maximum of 3 credits
- Projects will be restricted to a maximum of 4 credits

Credits are the weightages, assigned to the courses based on the following general pattern:

For theory One Hour = 1 credit

For Lab Two Hours = 1 credit

Table 7: Credit Value per Course & Structure of Syllabus

Name of course	Number of Papers during entire Bachelor degree program	Credit per course	Total number of credit
Core (theory)	12	4	48
DSE (theory)	6	4	24
AECC	4	3	12
GE (theory)	2	4	08
SEC	3	2	06
Core (practical)	12	2	24
DSE (practical)	6	2	12
GE (practical)	2	2	4
Total Credit during the B.Sc. Biotechnology Program			138

17. Maximum duration of programme/promotion policy:

A student may complete the programme at a slower pace than the regular pace, but in any case, in not more than N+2 years. After the term-end examination at the end of each semester, the student will be provisionally admitted to the next semester. Each semester will be followed by a break not exceeding 15 days. A candidate shall be promoted to the next higher semester if he/she passes at least 50% of the papers prescribed in the semester failing which he/she shall be declared as fail in that semester and he/she shall be required to get re-admission in the failed semester and shall have to appear in all the papers currently in force.

A candidate shall have to pass all the six semesters examinations within a maximum period of Five Years of his/her admission to the first semester of B.Sc. programme respectively failing which he/she will be deemed to be unfit for the programme.

19. Maximum gaps between semester/year:

- A student may be permitted by the Vice- Chancellor to withdraw from the entire programme for a maximum of two semesters for reasons of ill health, start – up venture or other valid reasons as recommended by a committee consisting of Head of Department, Dean of School, and Dean (Student Welfare).
- If a candidate, who has passed the second semester examination, but could not continued his studies, for legitimate and justified reasons, may be permitted to join third semester within two years of his passing the second semester examination.
- The Internal Assessment awards of a candidate, who fails in any external exam, would be awarded the same marks a he/she has obtained when he/she was there in the semester.

20. Credit system & grading CGPA/SGPA:

Most institutions follow the absolute grading system which is a simple procedure wherein the marks obtained by students correspond to a specific grade and grade point. It reflects the individual performance in a particular subject without any reference to the group/class.

Table 8: Grading System

Letter Grade	Range
A+	$TM > M + 1.75SD$
A	$M + 1.25 SD \leq TM < M + 1.75SD$
B+	$M + 0.75 SD \leq TM < M + 1.25SD$
B	$M + 0.25 SD \leq TM < M + 0.75 SD$
C+	$M - 0.25 SD \leq TM < M - 0.25 SD$
C	$M - 0.75 SD \leq TM < M - 0.25 SD$
D+	$M - 1.25 SD \leq TM < M - 0.75 SD$
D	$M - 1.75 SD \leq TM < M - 1.25 SD$
E+	$M - 2.0 SD \leq TM < M - 1.75 SD$
E	$M - 2.25 SD \leq TM < M - 2.0 SD$
F	$M - 2.25 SD > TM$
CO	Carry Over (Summer / Winter) due to Attendance deficiency (between 40% and 75%) and/or I. Lack of minimum IA marks as specified in clause 10.0 Table 3.
RA	Repeat the course due to (i) Lack of minimum attendance (below 40%) in regular course.
--	DETAINED “RC” or “RA” or both in all registered theory courses of a semester. The student is detained and has to repeat the entire semester.

- ❖ GPA is the ratio of the sum of the product of the number of credits C_i of course “i” and the grade points P_i earned for that course taken over all courses “i” registered and

successfully completed by the student to the sum of C_i for all “i”. That is,

$$GPA = \frac{\sum_i C_i P_i}{\sum_i C_i}$$

- ❖ CGPA will be calculated in a similar manner, in any semester, considering all the courses enrolled from the first semester onwards.
- ❖ The Grade card will not include the computation of GPA and CGPA for courses with letter grade CO, RC and U until those grades are converted to the regular grades.
- ❖ A course successfully completed cannot be repeated.

21. Class / division:

The list of successful candidates after the six semesters examinations of **Bachelor of Science** course shall be arranged as under in two divisions on the basis of the aggregate marks obtained in all semester examinations taken together, and the division obtained by the candidate will be stated in his degree.

- (a) First Division those who obtain 60% or more of the aggregate marks.
- (b) Second Division those who obtain 50% or more but less than 60% of the aggregate marks.
- (c) Those who pass all semester examinations in the first attempt to training 75% or more marks in the aggregate shall be declared to have passed with **DISTINCTION**.
- (d) Each successful candidate shall receive a copy of detailed marks card on having passed the Semester Examination.
- (e) Any dispute arising on account of implementation of this ordinance shall be referred to a committee of three members to be appointed by the Vice-Chancellor and its decision shall be final and binding on all.

22. Transfer of credit /Academic Credit Bank

1. Within the broad framework of these regulations, the Academic Council, based on the commendation of the Credit Transfer Committee so constituted may permit students to transfer part of the credit earned in other approved Universities of repute & status in the India or abroad.
2. The Academic Council may also approve admission of students who have completed a portion of course work in another approved Institute of repute under Multiple entry & Exit system, based on the recommendation of the credit transfer committee on a case-to-case basis.
3. Students who have completed coursework, at least first year, at some university other than the university to which transfer is sought may request for transfer of admission to this university. A student may be granted admission only through an admission process

that will follow the same policy as for fresh admissions. However, a uniform credit system must be followed by all universities to effect transfer of credits.

4. Credit Transfer request can be submitted only after the student has been admitted in the concerned program and the following conditions are met:
 - i. The course work has been completed at a UGC approved and accredited University through fulltime formal learning mode.
 - ii. The university accreditation grade/ ranking are not lower than that of the university to which the transfer is sought.
 - iii. The courses prescribe to the common minimum syllabus under UGC CBCS system.
 - iv. The letter grade obtained in the courses is “B” or better.
 - v. The number of credits to be transferred does not exceed the prescribed limit.
 - vi. The program in question must have a similar credit system, in particular, modular or semester and the same numeric and letter grading system along with common meaning of the term “credit” in numerical terms.

The aspect of shelf life of courses needs to be considered while accepting credits as obsolescence of knowledge of certain field in terms of its current relevance needs to be investigated. The time lapsed between successful completion of certain courses of the program and the admission to which program transfer is sought needs to be considered. The maximum number of credit points that may be considered under a credit transfer needs to be specified. Contextual variables such as teaching-learning approach adopted, learning facilities offered, use of evaluation modes may also be considered while preparing the credit transfer policy.

23. **Change of discipline:**

If any Student of Biotechnology program wants to change from Biotechnology to any program/ any discipline as per their eligibility they are permitted to change on or before 30 calendar days from the first day of commencement of program as per academic calendar.

24. **Use of technological intervention**

The use of technology will reduce dependency on human intervention and be error free. The following functions will be automated:

- (a) Registration of students and generating unique PRN
- (b) Filling up of examination form,
- (c) Generation of seat numbers and admit cards/hall tickets,
- (d) Preparation of list of paper setter,
- (e) Use of question bank system to draw question sets, question paper generation,
- (f) Online distribution of question papers on the day of examination with system of encryption,
- (g) Barcode system for answer books (this will eliminate issues related to errors, avoid malpractices etc.),

- (h) Digitization of answer scripts and onscreen evaluation of answer sheets,
- (i) Tracking of student's performance,
- (j) Marks submission through online software,
- (k) Viewing of result through online system,
- (l) Online verification and revaluation system,
- (m) Digitization of certificates and mark sheets (to avoid tampering and easy retrieval)
- (n) Certificate authentication system,
- (o) Submission of various other applications through online system.
- (p) OBE framework has been incorporated and faculties are trained to update their work.
- (q) All the students have been taught through various technological apps such as Google classroom, Zoom, Google Meet, Microsoft team etc. Faculties as well as Students have been given regular training to acquaint with technology, its use and functions to work in a friendly manner.

The above will lead to conduct of functions of the examination system in an efficient and transparent manner and timely availability of information to students.

It also included workplace technology, intranet opportunities to provide a learning organizational culture, socio-material perspective on technology, and trust in virtual teams. It also included new technology plate-forms like massive open online courses (MOOCs) and open educational resources (OER), are opening up possibilities to make higher education more available, affordable, and responsive to audiences that would otherwise not have access. An MOOC is defined as an online course aimed at large-scale interactive participation and open access via the web. MOOCs have been one of the emerging themes in online learning in higher education. Many university libraries are finding OER to be a powerful tool for students and faculty. OER are defined as freely accessible and open licensed intellectual properties for teaching and learning, such as documents and media.

25. **Student Discipline:** A student is expected to follow the right conduct as per the ethical and socio cultural norms set by the University for Day-to-day living. Also, student has to follow the rules and guidelines, set by the University for Different Activities.
26. **Student Welfare:** Any act of indiscipline of a student reported to the Dean and Head of the Department will be referred to a Discipline Committee constituted for the purpose. The Committee will enquire into the charges and decide on a suitable punishment if the charges are substantiated. The committee will also authorize the Dean (Students Welfare) to recommend to the Vice-Chancellor for the implementation of the decision. The student concerned may appeal to the Vice-Chancellor, whose decision will be the final.
27. **Ragging:** Ragging in any form is a criminal and offence in our country. The current State and Central legislations provide stringent punishments including imprisonment. Once the involvement of a student(s) is established in ragging, offending fellow students/staff, harassment of any nature to the fellow students/staff etc. the student(s) will be liable to be dismissed from the University, as per the laid down procedures of the UGC / Govt. /Institute. Every senior student at the University, along with their parent, shall give an undertaking every year in
28. **Examination code of conduct:**

- a) Enter examination hall 15 minutes before the scheduled time. Students coming 30 minutes after the commencement of the examination will not be permitted to enter the examination hall or to write the examination.
- b) Occupy the assigned seats only.
- c) All the students must carry their University Identity Card and Admit Card along with them. Without I-card and Admit Card, no student will be permitted to enter the Exam Hall. In case if a student has lost college I-card, other valid identity proof (Aadhar Card / Driving License / Voter Card) can be used for the purpose of personal verification of the Student. On the day of next examination student must carry provisional college I-card issued from the Dean of the College.
- d) Read all instructions carefully written on the answer sheet & complete all entries of the cover page carefully. It is the responsibility of the student to fill all the particulars in the answer-sheet correctly. **In case of any discrepancy found on the cover page of answer sheet, which may lead to non-declaration or delay in the declaration of result, the student shall be solely responsible. To avoid any trouble in future the student must fill all the entries on the cover page of the answer sheet carefully.**
- e) Use of mobile phones and other electronic gadgets are prohibited in the examination hall.
- f) The students should not carry any other material which may directly or indirectly amount to use of unfair means in the examination.
- g) The students should bring their own pen, pencil, eraser, general or scientific calculator (if permitted), scale & other materials required for the examination.
- h) The students must behave decently & cooperate with the invigilator(s) or members of the flying squad in performing their duties.
- i) The flying squad members and invigilator are authorized to conduct a thorough physical check of clothes, shoes etc. during the examination.
- j) Murmuring or talking with fellow students comes under UFM rules.
- k) The Student shall not leave the examination room without the permission of the invigilator.
- l) The Student shall not write his/her name or leave any identification mark in the answer sheet. Any such act will be deemed to be use of unfair means.
- m) Calculation etc. can be done in the answer sheet itself. No separate sheet will be given for the same. Cancelled portion will not be marked by the evaluator.
- n) No student shall loiter around stairs, veranda and in front of the exam room, after the commencement of the examination.
- o) Students are not allowed to leave the examination room before the time is over. In case of emergent conditions, a Student may be allowed to leave examination hall with the special permission of Centre Superintendent after submitting question paper and answer sheet.
- p) Writing anything on the desks or walls of the exam hall/room is also considered as malpractice / UFM.
- q) If a Student is caught resorting to UFM, he/she will be provided with a new answer sheet to continue his/her examination. Students need not repeat answers which he/she had already answered in the first answer sheet. Evaluator will mark both answer sheets. But the result will be declared after the decision of the unfair means committee / examination discipline committee.

- r) Students must wear their I-Cards or keep them on their table during the time of examination.
 - s) Students must write their roll number on the top given right side of the question paper before starting to attempt the same. Except roll number nothing should be written on the question paper otherwise it will be a case of UFM.
- 29. Power of modify:** Notwithstanding all that has been stated above, the Academic Council is vested with powers to modify any or all the above regulations from time to time, if required, subject to the approval by the Board of Studies and Final approval by Vice-Chancellor.
- 30. Entry/Exit point**
- Entry points:**
- The students will enter the program on the basis of 12th percentage after completing the 10+2 curriculums.
 - The next entry point will be after the completion of 1-year Certificate in Biotechnology on the basis of academic credits completed required for the program.
 - The next entry point will be after the completion of 2-year Diploma in Biotechnology on the basis of academic credits completed required for the program.
- Exit Points:**
- The undergraduate degree will be of 3 year duration, with multiple exit options within this period, with appropriate certifications, e.g., a certificate after completing 1 year in a discipline or a diploma after 2 years of study, or a Bachelor's degree after a 3-year programme.
- 31. NC/Credit Course:**
USR (University Social Responsibility) and Sports.

Evaluation Scheme

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME REVISED SYLLABUS 2024-2025 AS PER NEP 2020

B.Sc. BIOTECHNOLOGY CERTIFICATE COURSE

Year: I Semester: I

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1.	Core 1	BBTC-NP-115	Introduction to Biotechnology	4	0	0	4	25	75	100
2.	Core 2	BBTC-NP-112	Microbiology	4	0	0	4	25	75	100
3.	DSE 1	DSE-NP-116a	Bioanalytical Techniques	4	0	0	4	25	75	100
		DSE-NP-113b	Computational biology and Design of Experiment							
4.	AECC 1	NHU-NPR-112	Environment & Ecology	4	0	0	4	25	75	100
5.	Gen E	GENCC-101	NCC	2			2			
6.	USEC	NECC-112	University Social Responsibility				0	25	0	NCC
7.	VAC 1	BNY-112	YOGA	2	0	0	2	15	35	50
PRACTICALS										
1.	Core 1	BBTC-NP-115P	Introduction to Biotechnology Lab	0	0	2	2	20	30	50
2.	Core 2	BBTC-NP-112P	Microbiology Lab	0	0	2	2	20	30	50
3.	DSE 1	DSE-NP-116aP	Bioanalytical Techniques Lab	0	0	2	2	20	30	50
		DSE-NP-113bP	Computational biology and Design of Experiment lab							
4	AECC 1	NHU-NPR-112	Environment & Ecology Lab	1	0	0	1	15	35	50
			TOTAL					215	460	650
4.	USEC	SPT-111	Sports	0	0	0	0	50	0	NC

Credits 25 (27 including NCC)

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME REVISED SYLLABUS 2024-2025 AS PER NEP 2020
B.Sc. BIOTECHNOLOGY CERTIFICATE COURSE
Year: I / Semester: II

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 3	BBTC-NP-121	Biochemistry and Metabolism	4	0	0	4	25	75	100
2	Core 4	BBTC-NP-124	Plant Tissue Culture and applications	4	0	0	4	25	75	100
3	DSE 2	DSE-NP-123a	Immunology	4	0	0	4	25	75	100
		DSE-NP-123b	Molecular Diagnostics							
4	AECC-2	NHU-N-121	English Communication	3	0	0	3	15	35	50
5	GE 1	BBTGE-NP-124	Entrepreneurship development	4	0	0	4	25	75	100
6	SEC 1	NECC-124	MOOCs/ SWAYAM	2	0	0	2	50	0	50
7	Gen E	GENCC-201	NCC	2			2			
8	USEC	NECC-122	University Social Responsibility	0	0	0	0	25	0	NC
PRACTICALS										
1.	Core 3	BBTC-NP-121P	Biochemistry and Metabolism Lab	0	0	2	2	20	30	50
2.	Core 4	BBTC-NP-124P	Plant Tissue Culture and applications Lab	0	0	2	2	20	30	50
3..	DSE 2	DSE-NP-123aP	Immunology lab	0	0	2	2	20	30	50
		DSE-NP-123bP	Molecular Diagnostics lab							
			TOTAL					250	425	650
4.	USEC	SPT-121	Sports	0	0	0	0	50	0	NC

Credits 27 (29 including NCC)

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME REVISED SYLLABUS 2024-2025 AS PER NEP 2020
B.Sc. BIOTECHNOLOGY DIPLOMA COURSE
Year: II / Semester: III

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 5	BBTC-NP-235	Basics of Molecular & Cell Biology	4	0	2	4	25	75	100
2	Core 6	BBTC-NP-232	Genetics	4	0	2	4	25	75	100
3	DSE 3	DSE-NP-233b	Enzyme Technology	4	0	2	4	25	75	100
		DSE-NP-236a	Sustainable approaches of Biotechnology for mankind							
4	AECC 3	UVE-301	Human Values	3	0	0	3	15	35	50
5	GE 2	BBTGE-NP-234a	Food Fermentation Technology	4	0	0	4	25	75	100
		BBTGE-NP-234b	Dairy and Agriculture Biotechnology							
6	Gen E	GENCC-301	NCC	2			2			
7	USEC	NECC-232	University Social Responsibility	0	0	0	0	25	0	NC
8	VAC 2		Sanskrit	2	0	0	2	15	35	50
PRACTICALS										
1.	Core 5	BBTC-NP-235P	Basics of Molecular & Cell Biology Lab	0	0	2	2	20	30	50
2.	Core 6	BBTC-NP-232P	Genetics Lab	0	0	2	2	20	30	50
3.	DSE 3	DSE-NP-233bP	Enzyme Technology Lab	0	0	2	2	20	30	50
		DSE-NP-236aP	Sustainable approaches of Biotechnology for mankind lab							
			TOTAL					215	460	650
4.	USEC	SPT-231	Sports	0	0	0	0	50	0	NC

27 (29 including NCC)

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME REVISED SYLLABUS 2024-2025AS PER NEP 2020
B.Sc. BIOTECHNOLOGY DEPLOMA COURSE
Year: II / Semester: IV

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 7	BBTC-NP-245	Bioprocess & Fermentation Technology	4	0	0	4	25	75	100
2	Core 8	BBTC-NP-242	Nano-Biotechnology	4	0	0	4	25	75	100
3	DSE 4	DSE-NP-243a	Biostatistics and Bioinformatics	4	0	0	4	25	75	100
		DSE-NP-246b	Algal Biotechnology							
5	AECC 4	UPS-401	Professional Skills	3	0	0	3	15	35	50
6	SEC 2	NECC-244	MOOCs/ SWAYAM	2	0	0	2	50	0	50
7	Gen E	GENCC-401	NCC	2			2			
8	USEC	NECC-242	University Social Responsibility	0	0	0	0	25	0	NC
PRACTICALS										
1.	Core 7	BBTC-NP-245P	Bioprocess & Fermentation Technology Lab	0	0	2	2	20	30	50
2.	Core 8	BBTC-NP-242P	Nano-Biotechnology Lab	0	0	2	2	20	30	50
3..	DSE 4	DSE-NP-243aP	Biostatistics and Bioinformatics/	0	0	2	2	20	30	50
		DSE-NP-246bP	Algal Biotechnology Lab							
			TOTAL					225	350	550
4.	USEC	SPT-241	Sports	0	0	0	0	50	0	NC

23 (25 including NCC)

IMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME REVISED SYLLABUS 2024-2025 AS PER NEP 2020

B.Sc. BIOTECHNOLOGY DEGREE COURSE

Year: III / Semester: V

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 9	BBTC-NP-351	Environmental Biotechnology	4	0	0	4	25	75	100
2	Core 10	BBTC-NP-355	Recombinant DNA Technology & Genetic Engineering	4	0	0	4	25	75	100
3	DSE 5	DSE-NP-356a	Omics Biotechnology	4	0	0	4	25	75	100
		DSE-NP-353b	Animal Biotechnology							
4	GE3	BBTGE-NP-247	IPR & Bioethics	4	0	0	4	25	75	100
5	Summer Training	BBT-ST-357	Summer Training	0	0	0	4	25	75	100
6	VAC 3		Indian Ethos and Modern Management	2	0	0	2	15	35	50
7	Gen E	GENCC-501	NCC	2			2			
8	USEC	NECC-352	University Social Responsibility	0	0	0	0	25	0	NC
PRACTICALS										
1.	Core 9	BBTC-NP-351P	Environmental Biotechnology Lab	0	0	2	2	20	30	50
2.	Core 10	BBTC-NP-355P	Recombinant DNA Technology & Genetic Engineering Lab	0	0	2	2	20	30	50
3..	DSE 5	DSE-NP-356aP	Omics Biotechnology Lab	0	0	2	2	20	30	50
		DSE-NP-353bP	Animal Biotechnology Lab							
			TOTAL					225	500	700
4.	USEC	SPT-351	Sports	0	0	0	0	50	0	NC

28 (30 including NCC)

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME REVISED SYLLABUS 2024-2025 AS PER NEP 2020
B.Sc. BIOTECHNOLOGY DEGREE COURSE
Year: III / Semester: VI

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 11	BBTC-NP-361	Industrial Biotechnology and Down Stream Processing/	4	0	0	4	25	75	100
2	Core 12	BBTC-NP-365	Approaches of Biotechnology in Medical and Forensic	4	0	0	4	25	75	100
3	DSE 6	DSE-NP-363a	Green Biotechnology and Pollution Control	4	0	0	4	25	75	100
		DSE-NP-363b	Biosensors and drug design							
4	Industrial Training/Research Project	BBT-RP-361	Industrial Training/Survey/Biotech In-house Project or Bio-Entrepreneurship				4	25	75	100
5	Gen E	GENCC-601	NCC	2			2			
6	USEC	NECC-362	University Social Responsibility	0	0	0	0	25	0	NC
7	SEC 3	NECC-364	MOOCs/ SWAYAM	2	0	0	2	50	0	50
PRACTICALS										
1.	Core 11	BBTC-NP-361P	Industrial Biotechnology and Down Stream Processing /	0	0	2	2	20	30	50
2.	Core 12	BBTC-NP-365P	Approaches of Biotechnology in Medical and Forensic Lab	0	0	2	2	20	30	50
			TOTAL					215	360	550
4.	USEC	SPT-361	Sports	0	0	0	0	50	0	NC

22 (24 including NCC)



Format-1

NEP-2020 IMPLEMENTATION 3 STEPS PLAN (FORMAT-1,2& 3)

CBCS: Statement of Credits distribution

College/School: School of Life Sciences & Technology

Programme: Biotechnology

Duration: B.Sc. (6 Sem.), M.Sc. (10 Sem.)

Annual/Semester: Semester

**Credit range: Minimum 120 for UG
160 for UG (Hons.), 80 for PG
(Suggested by CBCS-NEP Committee)**

Course	Credit	Semester	Core (Th 4+P 2)	DSE (Th 4+P 2)	AECC (Th 4+1 & 3)	SEC (Th 1+1)	GE (Th 4)	General Elective EC (2)	Value Added Course (VAC) (2)	Industrial Training/ Survey Project (4)	Total Credits
Certificate Course in Biotechnology	52	Ist	C1- Introduction to Biotechnology C 2- Microbiology	DSE 1- Bioanalytical Techniques Computational biology and Design of Experiment	AECC 1- Environment & Ecology			NCC	VAC-1 Yoga Education		25(Ex cludin g NCC)
		2nd	C3--Biochemistry and Metabolism C4- Plant Tissue Culture and applications	DSE 2- Immunology / Molecular Diagnostics	AECC 2- English communicatio n	SEC 1 – MOOCs/ NPTEL	GE1- Entreprene urship developme nt	NCC			27 Exclu ding NCC)
Diploma in Biotechnology	102	3rd	C5- Basics of molecular & Cell Biology C6-Genetics	DSE 3a- Enzyme Technology/ DSE3b- Sustainable approaches of Biotechnology for mankind.	AECC 3- Human Values		GE2-Food Fermentati on Technology / Dairy and Agriculture Biotechnol ogy	NCC	VAC-2 Sanskrit		27 (Exclu ding NCC)
		4th	C7- Bioprocess & Fermentation	DSE 4-Biostatistics and Bioinformatics/	AECC 4- Professional Skills	SEC 2- MOOCs/ NPTEL		NCC			23 (Exclu ding

			Technology C8-Nano-Biotechnology	Algal Biotechnology							NCC)
Degree in biotechnology	152	5th	C9-Environmental Biotechnology C10- Recombinant DNA Technology & Genetic Engineering	DSE 5- Omics Biotechnology /Animal Biotechnology			GE3 IPR & Bioethics	NCC	VAC-3 Indian Ethos & modern management	Summer Training	28(Excludin g NCC)
		6th	C11-Industrial Biotechnology and Down Stream Processing C12- Approaches of Biotechnology in Medical and Forensic	DSE 6-Green Biotechnology and Pollution Control/ Biosensors and Drug Design		SEC 3- MOOCs/ NPTEL		NCC		Industrial Training/ Survey Project/Biotech In-house Project or Bio-Entrepreneurshi p	22(Excludin g NCC)
	204	7th	C13- Biochemistry & metabolic pathway C14- Advance Immunology	DSE 7 -Bioinformatics & Biostatistics /Biophysics and Structural Biology	AECC 5- English Communicatio n			NCC	VAC-1 Yoga Education		23(Excludin g NCC)
		8th	C15-Industrial Biotechnology C16- Molecular Biology	DSE 8- Advanced Plant Biotechnology /Genomics & Proteomics	AECC 6- Research & Publication Ethics	SEC 4- MOOCs/ NPTEL	GE4-IPR, Patent, Trademarks & Bioethics/B io-entrepreneu rship developme nt	NCC	VAC-2 Sanskrit		29(Excludin g NCC)
	250	9th	C17-Bio-separation and downstream processing	DSE 9-Advancements in Recombinant DNA Technology/Animal			GE5- Nanobiotec hnology/Bi	NCC	VAC-3 Indian Ethos and modern	Industrial Training/ Survey/Researc	28(Excludin g

			C18- Environmental Biotechnology	Biotechnology			oenergetics and Metabolom ics		management	h Project (Credits-4)	NCC)
		10 th				SEC 5- MOOCs/ NPTEL		NCC		Industrial Training/ Survey/Researc h Project (16)	18(Ex cludin g NCC)

Format-2

DEPARTMENT OF BIOTECHNOLOGY
B.Sc. BIOTECHNOLOGY

Program me	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
CERTIFICATE COURSE IN BIOTECHNOLOGY (52 credits)	FIRST YEAR	SEMESTER -I	i) C1- Introduction to Biotechnology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i)C1- Introduction to Biotechnology	Unit=5/Period=60	N/A	N/A
			ii) C2- Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C2- Microbiology	Unit=5/Period=60	N/A	N/A
			iii) AECC-1- Environment & Ecology (Th.4 Cr+ P 1Cr)	4+1	6	60+30	iii) AECC-1- Environment & Ecology	Unit=5/Period=60	N/A	N/A
			iv) DSE-1- Bioanalytical Techniques / Computational biology and Design of Experiment (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iv) DSE-1- Bioanalytical Techniques / Computational biology and Design of Experiment	Unit=5/Period=60	N/A	N/A
			V) VAC-1 Yoga (Th 2 Cr)	2	2	30	V) Yoga	Unit=5/Period=30	N/A	N/A
		SEMESTER -II	i) C 3- Biochemistry and Metabolism (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i)C 3- Biochemistry and Metabolism	Unit=5/Period=60	N/A	N/A
			ii) C4- Plant Tissue Culture and applications (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C4- Plant Tissue Culture and applications	Unit=5/Period=60	N/A	N/A
			iii) AECC-2- English Communication (Th.3 Cr)	3	3	45	iii) AECC-2- English Communication	Unit=5/Period=45	N/A	N/A
			iv) Certification/MOOCs/Swayam (Th.1+1)	1+1	2	30	iv) SEC-1 Certification/MOOCs /Sw ayam	Unit=5/Period=30	N/A	N/A
			v) DSE-2-Immunology/Molecular Diagnostics (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	v) DSE-2- Immunology/Molecular Diagnostics	Unit=5/Period=60	N/A	N/A

			vi) GE 1- Entrepreneurship development (Th.4 Cr)	4	4	60	vi) GE 1- Entrepreneurship development	Unit=5/Period=60	N/A	Yes

Programme Outcome:

PO 1: Grasp of basic and advanced knowledge on various domains of biotechnology.
PO 2: Aptitude to assimilate technologies through an inter-disciplinary approach.
PO 3: Develop an independent thinking ability.
PO 4: Ability to communicate effectively.
PO 5: Equip the students with the laboratory skills in biotechnology.
PO 6: To develop students in such a way that they are able to provide biotechnological solutions to the underprivileged areas also helps in solving the problem of clean water and sanitation, waste treatment, food scarcity, agriculture, carbon reduction, climate change, energy etc.
PO 7: To develop understanding of their social, professional ethical specialized and ethical accountability also helps students in protection their intellectual property.
PO 8: Capability of design of experiment skill and also develops the skill of analyzing and evaluating the results.
PO 9: To generate Cognizance of contemporary issues of the time and provide appropriate solutions with biotechnological mindset and fulfillment of SDG.
PO 10: To develop the understanding to recognize the societal needs and to involve them in life-long learnedness.
PO 11: To inculcate the habit of team work to solve the industrial and environmental issues.
PO 12: To inculcate the value added entrepreneurship skills and convert them as professional and mindful individuals.

Programme Specific Outcome B.Sc. BT I year:

PSO₁ To teach an ability to apply biotechnology skills in various subjects studied during the course.
PSO₂ To provide students with the concepts of Biotechnology to develop interest in science.
PSO₃ Prepare candidates for starting/entry level positions with a specific focus on individual, social, global and environmental perspectives and After completion of the course students will be awarded with Certificate in Biotechnology.

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
DIPLOMA COURSE (102 Credits) IN BIOTECHNOLOGY	SECOND YEAR	SEMESTER -III	i) C5- Basics of Molecular & Cell Biology	4+2	8	60+60	i)C5- Basics of Molecular & Cell Biology	Unit=5/Period=60	N/A	N/A
			ii) C6-Genetics	4+2	8	60+60	ii) C6- Genetics	Unit=5/Period=60	N/A	N/A
			iii) AECC-3- Professional Skills/ Human Values	3	3	45	iii) AECC-3- Professional Skills/ Human Values	Unit=5/Period=45	N/A	N/A

			DSE-3: Enzyme Technology / Sustainable approaches of Biotechnology for mankind	4+2	8	60+60	iv) DSE-3- Enzyme Technology / Sustainable approaches of Biotechnology for mankind	Unit=5/Period =60	N/A	N/A
			V) VAC-2 Sanskrit (Th 2 Cr)	2	2	30	V) Sanskrit	Unit=5/Period=30	N/A	N/A
			GE-2: Food Fermentation Technology/ Dairy and Agriculture Biotechnology	4	4	60	vi) GE-2: Food Fermentation Technology/ Dairy and Agriculture Biotechnology	Unit=5/Period=60	N/A	Yes
		SEMESTER - IV	i)C 7- Bioprocess & Fermentation Technology	4+2	8	60+60	i)C 7- Bioprocess & Fermentation Technology	Unit=5/Period=60	N/A	N/A
			ii) C 8- Nano-Biotechnology	4+2	8	60+60	ii) C8- Nano-Biotechnology	Unit=5/Period=60	N/A	N/A
			iii) AECC-4- Professional Skills/ Human Values	3	3	45	iii) AECC-4- Professional Skills/ Human Values	Unit=5/Period=45	N/A	N/A
			iv) Certification/ MOOCs/Swayam (Th.1+1)	1+1	2	30	iv) Certification /MOOCs/Swayam (Th.1+1)	Unit=5/Period=30	N/A	N/A
			v) DSE-4 - Biostatistics and Bioinformatics /Algal Biotechnology	4+2	8	60+60	v) DSE-4 - Biostatistics and Bioinformatics / Algal Biotechnology	Unit=5/Period=60	N/A	N/A

Programme Outcome:

PO 1: Grasp of basic and advanced knowledge on various domains of biotechnology.
PO 2: Aptitude to assimilate technologies through an inter-disciplinary approach.
PO 3: Develop an independent thinking ability.
PO 4: Ability to communicate effectively.
PO 5: Equip the students with the laboratory skills in biotechnology.
PO 6: To develop students in such a way that they are able to provide biotechnological solutions to the underprivileged areas also helps in solving the problem of clean water and sanitation, waste treatment, food scarcity, agriculture, carbon reduction, climate change, energy etc.
PO 7: To develop understanding of their social, professional ethical specialized and ethical accountability also helps students in protection their intellectual property.
PO 8: Capability of design of experiment skill and also develops the skill of analyzing and evaluating the results.
PO 9: To generate Cognizance of contemporary issues of the time and provide appropriate solutions with biotechnological mindset and fulfillment of SDG.

Programme Specific Outcome B.Sc. BT II year:

PSO₁ To impart an ability to apply biotechnology skills and its applications in core and allied fields.
PSO₂ Students are ale to apply the concepts and research approaches.
PSO₃ After completions of the two years course students will be awarded with Diploma in Biotechnology and prepare students for the job after completion of diploma in Biotechnology.

PO 10: To develop the understanding to recognize the societal needs and to involve them in life-long learnedness.

PO 11: To inculcate the habit of team work to solve the industrial and environmental issues.

PO 12: To inculcate the value added entrepreneurship skills and convert them as professional and mindful individuals.

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
UNDER GRADUATE DEGREE IN BIOTECHNOLOGY (152 Credits)	THIRD YEAR	SEMESTER - V	i)C9- Environmental Biotechnology	4+2	8	60+60	i)C9- Environmental Biotechnology	Unit=5/Period=60	N/A	N/A
			ii) C10- Recombinant DNA Technology & Genetic Engineering	4+2	8	60+60	ii) C10- Recombinant DNA Technology & Genetic Engineering	Unit=5/Period=60	N/A	N/A
			iii) DSE-5- Omics Biotechnology/ Animal Biotechnology	4+2	8	60+60	iii) DSE-5- Omics Biotechnology/ Animal Biotechnology	Unit=5/Period=60	N/A	N/A
			iv) GE 3 IPR & Bioethics	4	4	60	iv) GE 3 IPR & Bioethics	Unit=5/Period=60	N/A	Yes
			V) VAC-3 Indian Ethos and Modern Management (Th 2 Cr)	2	2	30	V) Indian Ethos and Modern Management	Unit=5/Period=30	N/A	N/A
			*Summer Training	4						
		SEMESTER - VI	i)C 11- Industrial Biotechnology and Down Stream Processing	4+2	8	60+60	i)C 11- Industrial Biotechnology and Down Stream Processing	Unit=5/Period=60	N/A	N/A
			ii) C 12- Approaches of Biotechnology in Medical and Forensic	4+2	8	60+60	ii) C 12- Approaches of Biotechnology in Medical and Forensic	Unit=5/Period=60	N/A	N/A
			iii) SEC-3 Certification/MOOCs/Sw ayam (Th.1+1)	1+1	2	30	iii) SEC-6 Certification/MOOCs/Swa yam (Th.1+1)	Unit=5/Period=30	N/A	N/A

		iv) DSE-6 Green Biotechnology and Pollution Control/ Biosensors and drug design	4	4	60	iv) DSE-6 Green Biotechnology and Pollution Control / Biosensors and drug design	Unit=5/Period=60	N/A	N/A
		*Research project/ Industry Training/ Internship Survey	4	4	60				

*Research Topic may be selected from any one of 02 core papers.

Programme Outcome:

- PO 1: Grasp of basic and advanced knowledge on various domains of biotechnology.
- PO 2: Aptitude to assimilate technologies through an inter-disciplinary approach.
- PO 3: Develop an independent thinking ability.
- PO 4: Ability to communicate effectively.
- PO 5: Equip the students with the laboratory skills in biotechnology.
- PO 6: To develop students in such a way that they are able to provide biotechnological solutions to the underprivileged areas also helps in solving the problem of clean water and sanitation, waste treatment, food scarcity, agriculture, carbon reduction, climate change, energy etc.
- PO 7: To develop understanding of their social, professional ethical specialized and ethical accountability also helps students in protection their intellectual property.
- PO 8: Capability of design of experiment skill and also develops the skill of analyzing and evaluating the results.
- PO 9: To generate Cognizance of contemporary issues of the time and provide appropriate solutions with biotechnological mindset and fulfillment of SDG.
- PO 10: To develop the understanding to recognize the societal needs and to involve them in life-long learnedness.
- PO 11: To inculcate the habit of team work to solve the industrial and environmental issues.
- PO 12: To inculcate the value added entrepreneurship skills and convert them as professional and mindful individuals.

Programme Specific Outcome B.Sc. BT III year:

- PSO₁ To prepare students in such a way that they understand the impact of the biotechnological solutions in social and environmental context and demonstrate the knowledge of the requirement for sustainable development
- PSO₂ To provide students with the conceptions from basics to advance research in the field of Biotechnology and enhance their career in higher studies.
- PSO₃ To impart exhaustive and thorough knowledge of Hands on practical to students in several thrust areas of biotechnology to meet out the interface of academia and industry and After completion of the three years course students will be awarded with Degree in Biotechnology.

Format-3

IIMTU-NEP IMPLEMENTATION
Year: I / Semester: I

Programme: Biotechnology Certificate/Diploma/Degree/ UG Class: B.Sc. Biotechnology		Year: I Semester: I
Credits: 6 Theory: 4 Practical: 2		Subject: Introduction to Biotechnology
Course Code: BBTC-NP-115		Title: Introduction to Biotechnology
Course Objectives: Subject comprised of various fields of Biotechnology and their applications for the mankind. It meets the local requirement.		
CO 1	To aware students about introductory and chronological development of biotechnology, advancement and applications.	
CO 2	The objective of the first unit is to aware students about various industrial applications of biotechnology in production of bioproducts.	
CO 3	To aware students about application of biotechnology in agricultural sector to achieve SDG Zero hunger.	
CO 4	The course objective of third unit clearly define the role of biotechnology is to provide solution to environmental issue in sustainable way.	
CO 5	To aware students about the role and applications of biotechnology in medical and forensic science.	
CO 6	The overall course objective focused on the role of biotechnology in human welfare. The last unit also aims to define the human genome project and related case studies.	
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Prelude to biotechnology: A Brief History of Biotechnology, Products of Modern Biotechnology, Ethics and Biotechnology, Types of Biotechnology, Microbial Biotechnology, applications of biotechnology, Impact of Biotechnology, Future of Biotechnology, Biotechnology and Society.	10
II	Biotechnology for Industrial application: Types of Bioproduct, bioproducts development, bioprocess technology, ABE (Antibiotic, Butanol and Ethanol) formation, microorganisms for Industrial applications. Green biotechnology biofertilizer, biopesticides, biocomposting, functions	14

	of National Dairy Development Board (NDDB), case study on food industry and Zero hunger strategy. Food security.	
III	Biotechnology for Environment issues: Types of pollution, Global Climate change, pollutant degradation; wastewater treatment, solid waste management, biodegradation, green energy from waste, bioremediation, phytoremediation, knowledge towards SDG 6, 7 and 13.	12
IV	Application of Biotechnology in medical & forensic science: disease diagnosis and treatment, stem cell engineering, Proteins as Biotechnology Products biotech Drugs, applications of forensic biotechnology in solving violent crimes, claims of paternity and theft, DNA finger printing.	12
V	Biotechnology for human welfare: development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal antibody, human genome project, cancer diagnostics, gene therapy, GMO, Case study on Covid-19, Biosafety and IPR	12

Reference / Text Books:

1. BISWAS, SUBROTO (2020), Biotechnology and Human Welfare, McGraw-Hill Education India , 9789390177011
2. William J. Thieman, Introduction to Biotechnology (August 1st 2021) - Copyright © 2019 Published by Pearson
3. Naveen Dwivedi and Shubha Dwivedi (2013), Introduction to Biotechnology, University Science Press
4. Rup Lal, (2016) An Introduction to Biotechnology, a genetic manipulation perspective, Publisher Wiley.
5. Srivastava, Thakur and Kumar, (2021) Agricultural Biotechnology: Latest Research and Trends, Publisher Springer.
6. Richard Saferstein (2008), Forensic Science: An Introduction, Publisher Addison Wesley Longman

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Prerequisite: Intermediate/Basic knowledge of life science

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: Knowledge of Basics of Biotechnology (Intermediate level)

Course Learning Outcomes:

CLO1: Student will come up with the knowledge of field and various applications of biotechnology for manufacture of various bioproducts having industrial applications and benefit of mankind.

CLO2: Student will come up with the knowledge of biotechnology in agriculture sector.

CLO3: Student will come up with the knowledge of role of biotechnology in cleaning the environment.

CLO4: Student will be aware of application of biotechnology forensic investigations.

CLO5: Student will be aware of application of biotechnology in improving health and in diagnostics

CLO6: The overall course outcome focused on the role of biotechnology in human welfare. Outcome of last unit also aims to define the human genome project and related case studies.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics. .
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

BBTC-NP-115P: Introduction to Biotechnology Lab

Marks: 50

Duration: 60 hours (2 credits)

1. To perform the serial dilution
2. To learn the plant part infected through a microbe.
3. To Perform of microbial isolation
4. Case studies about Biosafety and IPR (any two).
5. Model preparation of role of Nitrogen cycle in atmosphere.
6. Model preparation of Bio-composting unit
7. Case study on solving claims of paternity and theft
8. Demonstration of Ammonification of soil

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme:Biotechnology Certificate/Diploma/Degree/ UG(R) Class:B.Sc. Biotechnology		Year: I Semester: I
Credits: 6 Theory: 4 Practical: 2	Subject: Microbiology	
Course Code: BBTC-NP-112	Title: Microbiology	
Course Objectives: CO1. To study the history of microbiology, the diverse groups of microbes and their classification, Scientist and their contributions. CO2. To learn about the cultivation, identification and preservation of the microbes., Tools and Techniques of microbiology. CO3. Equipped students with the skilled knowledge of different media developments methods and microbial technology. CO4. To aware students about microbial metabolism, growth cycle of microorganism and microbial reproduction. CO5. To aware students about how to control the growth of microbes by various methods. CO6. To educate students about the outcome of microbiology in public health and clean water technology.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Basic Introduction, History and Development of Microbiology: Scope and application of Microbiology, Contributions and role of scientists in the field of Microbiology (Pastuer’s contribution) Classification of microorganisms: Basic description of the different types of microorganisms, General feature of Gram +ve and Gram–vebacteria. Structure, Function and general application of Prokaryotic and Eukaryotic cells, Microbial taxonomy and Microbial phylogeny Bacterial Reproduction: Transformation, Transduction and Conjugation.	12
II	Tools and techniques used in Microbiology: Microscopy Microbial nutrition and Media: Definition, Components and types of media. Approaches and methods of Pure culture: Serial dilution, poring, plating, streaking and spreading of culture media. Maintenance and preservation of	12

	pure cultures. Staining techniques: Basic principal, applications and types of staining methods.	
III	Microbial growth and division: Transformation transduction and conjugation Growth Curve: Definition, expression and measurement of growth curve Factors affecting microbial growth (Temperature, pH, water activity, oxygen concentration, salt concentration, pressure and radiation). Metabolic Pathways: Amphi-catabolic and biosynthetic pathways	12
IV	Control of Microorganisms: Definition and types Chemotherapeutic Agents: Different groups of chemotherapeutic agents and their mechanism of action. Physical methods: Heat, filtration and radiation. Chemical method: Alcohols, aldehydes, phenols, halogen, metallic salts, quaternary ammonium salts and sterilizing gases as antimicrobial agent.	12
V	Public Health Microbiology: Food Microbiology: Principle, Preservation and different techniques used in food Microbiology, Importance of microorganism in food Microbiology, Major food born infections and intoxications, Different types and uses of Fermented Foods (Cheese, wine, acidophilus milk, yogurt and kefir) Water Microbiology: Bacterial pollutants of water (coliforms and non coliforms), Sewage composition and its disposal, Bacteriological analysis of water and MPN test, wastewater treatment.	12

Reference / Text Books:

1. Singh, R. P. General Microbiology. Kalyani Publishers, New Delhi (2007).
2. Aneja, K. R. Experiments in Microbiology, Plant pathology and Biotechnology, Fourth edition, New Age International publishers.
3. Dubey, R. C. and Maheshwary, D. K. Text book of Microbiology. S. chand and company (1999).
4. Powar, C. B. and Dagainawal, H. F. General Microbiology. Vol-I and Vol- II, Himalaya Publishing House.
5. Stuart Hogg, 2005 Essential Microbiology, ISBN 0 471 49753 3 (hbk), John Wiley & Sons Ltd
6. Prescott's microbiology, McGraw Hill; 11th edition (27 February 2019)
7. Microbiology: An Introduction 13th Edition, Publisher. Addison-Wesley, Publication date. 8 January 2018.
8. Tortora, G.J., Funke, B.R and Case, C.L. Microbiology: An Introduction. Pearson Education, Singapore, (2004).

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology	
	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	
5) ESE	75
Total:	100
Prerequisites for the course: Knowledge of Basics of microorganisms and micro-environment	

Course Outcomes:

CLO1: Student will study about the history of microbiology, the diverse groups of microbes and their classification.

CLO2: Student will able to cultivate, identify and preserve the microbes.

CLO3: The student will learn about how to control the growth of microbes by various methods.

CLO4: Students will understand about the growth pattern of microbes and the factors affecting their growth. They will also be aware of how microbes reproduce and form progeny.

CLO5: The student will learn about the function of microbes in public health sector and water.

CLO6: Student will educate about the outcome of microbiology in living being.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics. .
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

BBTC-NP-112P: MICROBIOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

1. To study the isolation and biochemical characterization of bacteria.
2. To study the Staining methods such as spore staining, negative staining.
3. To study the Preparation of media and their sterilization methods,
4. Bacteriological Examination of Water: Qualitative Tests
5. To determination of the bacterial cell size through micrometry.
6. To study the enumeration of microorganism - total and viable count.
7. Most probable number (MPN) test for estimation of bacteria in given sample.
8. Gram staining for identification and differentiation of bacteria.
9. Enumeration of microorganism: bacterial counts of food.
10. Identification of Microbial Spoilage of Canned Food.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology		Year: I Semester: I
Credits: 6 Theory: 4 Practical: 2	Subject: Bioanalytical Techniques	
Course Code:DSE-NP-116a	Title: Bioanalytical Techniques	
Course Objectives: CO1. To understand about the various instrumentation process to study different types of biomolecules. CO2. To understand about the working rule and application of microscope. CO3. To study about the working principle and application of centrifuge, 3-D and 4D printing in biotechnology CO4. To learn about the working principle and application of chromatography. CO5. To get the knowledge about the functioning standard and application of electrophoresis and blotting techniques. CO6. To study about the working principle and application of spectrophotometer.		
Nature of Paper: DSE-1a		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T:0 P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	NEW PROPOSED	No. of Lectures Allotted
I	Introduction, types, principle and working method of Optical microscopy, Electron microscopy (TEM, SEM), Atomic force Microscopy, confocal microscopy and Florescence microscopy, Florescence compounds with advantages and disadvantages.	12
II	Introduction to centrifugation and sedimentation. Types of centrifuges, Density gradient centrifugation, Analytical and Preparative centrifugation, Ultra centrifugation, Application of centrifugation, Introduction of Bio printing, properties and ideal materials for bio printing, Principles of 3-D printing of tissues, bacteria and organs, Introduction to 4D printing in biotechnology.	12
III	Introduction, principle, and application of chromatography, Types of chromatography: Column chromatography Paper chromatography, Thin layer chromatography, Ion exchange chromatography, Gel filtration chromatography, Affinity chromatography, Gas chromatography and HPLC.	12

IV	Introduction to Electrophoresis, Types of electrophoresis: Agarose gel electrophoresis, Polyacrylamide gel electrophoresis (Native and SDS-PAGE), Pulse field gel electrophoresis, Application of electrophoresis, ELISA, RIA Blotting techniques: Northern, Southern and Western blotting.	12
V	Electromagnetic radiation (EMW) and spectrum, Introduction, Principle and Application of Spectroscopy, Types of Spectroscopy: Atomic absorption and emission spectroscopy, UV-VIS, NMR, Mass Spectroscopy, Circular Dichorism (CD), Positron Emission Tomography(PET).	12

Reference / Text Books:

1. Wilson and Walker. Principles and Techniques in Practical Biochemistry. 5th Edition Cambridge University Press (2006).
2. Murphy D. B. Fundamental of Light Microscopy & Electron Imaging. 2nd Edition. Wiley - Liss. (2012).
3. K. L. Ghatak. Techniques and Methods in Biology PHI Publication (2011).
4. Pranav Kumar. Fundamentals and Techniques of Biophysics and Molecular Biology (2016).

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/ Attendance	
3) Assignments	5
4) Research Project Report	
Seminar On Research Project Report	4
5) ESE	75
Total:	100

Prerequisites for the course: Knowledge of Basics of different detection techniques in Biotechnology (Intermediate level)

Course Learning Outcomes:

- CLO1: Student will be aware about the working principle and application of microscope.
 CLO2: Student will be aware about the working principle and application of centrifugation and knowledge of 3-D and 4-D printing in biotechnology.
 CLO3: Student will be aware about the working principle and application of chromatography.
 CLO4: Student will be aware about the working principle and application of electrophoresis and detections of biomolecules by using different blotting techniques.
 CLO5: Student will get the basic knowledge of 3-D and 4-D printing in biotechnology.
 CLO6: Student will be aware about the working principle and application of spectroscopy.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.

8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

DSE-NP-116aP: Bioanalytical Techniques Lab

Marks: 50

Duration: 60 hours (2 credits)

1. To study instrumentation and principle of microscope.
2. To demonstrate the native gel electrophoresis of give sample.
3. To demonstrate the SDS-PAGE of given sample.
4. Separation of amino acids/plant pigments by paper chromatography.
5. To identify lipids/amino acids in a given sample by TLC.
6. To prepare a standard curve and determine the concentration of given test sample to validate Beer's law.
7. To Study and demonstration of 3-D printing in biotechnology
8. Demonstration of proposed layout of 4D printing in biotechnology.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class:B.Sc. Biotechnology		Year: I Semester: I	
Credits: 6 Theory: 4 Practical: 2		Subject: Computational biology and Design of Experiment	
Course Code: DSE-NP-113b		Title: Computational biology and Design of Experiment	
Course Objectives: CO1. To study about the history, scope of bioinformatics, Sequence Information Sources and its applications. CO2. To be aware the sequence alignment and BLAST using it on the web. CO3. To study the Databases, types, Data Submission tools and Genome Annotation CO4. To get the knowledge about Distributions such as Binomial Poisson Normal. CO5. To study about on chi-square test and t-test for goodness of fit. CO6. To study ANOVA and its applications.			
Nature of Paper: DSE-1b			
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits			
L:4 T: P:0(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)			
Unit	Contents	No. of Lectures Allotted	
I	Introduction, History and scope of Computational biology and Bioinformatics. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene.	10	
II	TREMBL, Nucleic acids sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, sampling, testing of hypothesis	15	
III	Introduction to BLAST, Multiple Sequence Alignment, Pairwise Alignments. Searching Databases: SRS, Entrez, and Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.	15	
IV	Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, level of significance Large sample test and small sample test. Elementary ideas of Binomial, Poisson and Normal distributions.	10	
V	Problems on test of significance, t-test, chi-square test For goodness of fit and analysis of variance (ANOVA) and its applications.	10	
Reference / Text Books: 1. Ghosh Z. and Bibekan and M. (2008) Bioinformatics: Principles and Applications. Oxford			

2. University Press.
3. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
4. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.
5. Glaser AN (2001) High Yield TM Biostatistics. Lippincott Williams and Wilkins, USA
6. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
7. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	-
5) ESE	75
Total:	100

Prerequisites for the course: Basic intermediate knowledge

Course Learning Outcomes:

CLO1: Student will be study on Distributions: Binomial Poisson Normal

CLO2: Student will be study on chi-square test and t-test and its applications.

CLO3: Student will be aware the history, scope of bioinformatics, Sequence Information Sources and its applications.

CLO4: Student will be aware the sequence alignment and BLAST using it on the web.

CLO5: Student will study the Databases, types, Data Submission tools and Genome Annotation

CLO6: Student will aware about goodness of fit and analysis of variance (ANOVA) and its applications.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics. .
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

DSE-NP-113bP: Computational biology and Design of Experiment lab

Marks: 50

Duration: 60 hours (2 credits)

1. Implementation of motif finding algorithms.

2. Finding patterns in genomes.
3. Demonstration of Database Search Tools.
4. To study the Pairwise sequence alignment.
5. To learn about multiple sequence alignment.
6. Construction of Phylogenetic trees.
7. Similarity search using BLAST.
8. Standard deviation

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION
Year: I / Semester: II

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology		Year: I Semester: II
Credits: 6 Theory: 4 Practical: 2	Subject: Biochemistry and Metabolism	
Course Code:BBTC-NP-121	Title: Biochemistry and Metabolism	
Course Objectives: CO1. To study about the different biomolecules present in cellular environment and role of water in their design CO2. To be aware of the structure and biological function of carbohydrate and protein. CO3. To study the structure and function of lipid and nucleic acid. CO4. To understand the role of enzymes, cofactors and coenzymes. CO5. To learn about carbohydrates and fatty acids Metabolism. CO6. The overall objective of the course to provide basic foundation of Biotechnology and impart knowledge of biomolecules and its significance in human physiology.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T:0 P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Biomolecules and Importance of buffer: Major classes of biomolecules, Water - Structure, non-covalent interactions, unusual properties, role in biological processes. Ionization of Water, Weak Acids, and Weak Bases, pH scale. Buffers and buffering mechanism, Henderson Hasselbalch equation. Bicarbonate buffer and Hemoglobin Buffer System.	10
II	Amino acids & Proteins: Structure and unique properties of Amino acids. Forces responsible for stabilizing protein structure and shape, Proteins and their classification. Denaturation and renaturation of proteins. Fibrous and globular proteins. Different Level of structural organization of proteins, Protein Purification. Carbohydrates: Monosaccharides, Disaccharides and Polysaccharides (Structure, Function and properties) Homo & Hetero Polysaccharides, Mucopolysaccharides, Glycoprotein's and their biological functions, Bacterial cell wall polysaccharides.	15
III	Lipids: Introduction to lipid, fatty acid and glycerol. Example of essential fatty acids. Glycolipids, Phospholipids, Cholesterol, sphingolipids,	15

	Prostaglandins. Structure, functions, Classification, nomenclature and properties of fatty acids. Nucleic acids: Physical, chemical properties, Structure and functions of Nucleic acids, purines & pyrimidines, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, Nucleosides & Nucleotides, Biologically important nucleotides,.	
IV	Nomenclature and classification of Enzymes: Introduction of Enzymology: Holoenzyme, Cofactors, coenzyme, apoenzyme, prosthetic groups, metalloenzymes, activation energy and transition state, monomeric & oligomeric enzymes, common features of active sites, enzyme activity, specific activity, Enzyme specificity: types & theories. Role of: NAD ⁺ , FMN/FAD, NADP ⁺ , coenzymes A, Pyridoxal phosphate, Tetrahydrofolate, Thiamine pyrophosphate, Biotin vitamin B12, and metallic ions.	10
V	Carbohydrate metabolism: Glycolysis (Reactions, energetics and regulation), Pentose phosphate pathway, Gluconeogenesis, Fate of pyruvate under aerobic and anaerobic conditions, glycogen synthesis, Glycogenolysis, Electron Transport Chain, TCA cycle, inborn error of metabolism, PPP. Metabolism of fatty acids -oxidation of saturated, unsaturated fatty acids Oxidation of amino acids and importance of urea cycle.	10

Reference / Text Books:

1. Tortora, G.J., Funke, B.R and Case, C.L. Microbiology: An Introduction. Pearson Education, Singapore, (2004).
2. Stanbury, Biochemistry.
3. Voet. Fundamentals of biochemistry Wiley.
4. M.M. Cox, D. L. Nelson Lehninger's principles of biochemistry. W H Freeman.
5. Stryer. Biochemistry W H Freeman.
6. Lehninger, Biochemistry

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	
4) Research Project Report	4
Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: Intermediate knowledge

Course Learning Outcomes:

- CLO1: Student will learn about the different biomolecules present in cellular environment and role of water in their design
- CLO2: Student will be aware of the structure and function of carbohydrate and protein.
- CLO3: Student will learn the structure and function of lipid and nucleic acid.
- CLO4: Student will understand the role of enzymes, cofactors and coenzymes.
- CLO5: Student will be capable to understand the metabolism of various biomolecules.
- CLO6: Students will aware about the basic-foundation of Biotechnology and that impart information of biomolecules and its significance in human physiology.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics. .
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

BBTC-NP-121: BIOCHEMISTRY AND METABOLISM LAB

Marks: 50

Duration: 60 hours (2 credits)

1. To study activity of enzyme (salivary amylase) under optimum conditions.
2. To study the effect of temperature, pH on the activity of salivary amylase enzyme.
3. Determination, K_m value, V_{max} value.
4. Estimation of blood glucose by glucose oxidase method.
5. Principles of Colorimetry: (i) Verification of Beer's law, estimation of protein. (ii) To study relation between absorbance and % transmission.
6. Preparation of buffers.
7. Separation of Amino acids by paper chromatography.
8. Qualitative tests for Carbohydrates, lipids and proteins.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION
Year: I / Semester: II

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology		Year: I Semester: II
Credits: 6 Theory: 4 Practical: 2	Subject: Plant Tissue Culture & Application	
Course Code: BBTC-NP-124	Title: Plant Tissue Culture & Application	
Course Objectives: CO1. To study the plant tissue culture, scope and its applicationsas well as media preparation. CO2. To study the importance and basic applications of micropopagation, Meristem, shoot tip culture and organ culture and its advantages, Organogenesis and its applications. CO3. To study the significance and applications of haploid plant culture. CO4. To study the protoplast isolation, Applications and Limitations of somatic hybridization. CO5. To study the elicitations, Biotransformation, production of disease free plants, cryopreservation CO6. To study about Production of Industrial phytochemicals and plant growth promotion through free-living bacteria.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Historical aspects in PTC, organization of PTC laboratory, study of basic instruments such as pH meter, laminar flow hood working principal, centrifugation, washing of glassware and various sterilization techniques, <i>In-Vitro</i> culture techniques, scopes and applications in India,	12
II	PTC Media, Types, its basic components, functions of Micro Macro and growth regulators, Important steps involved in PTC media preparations.	12
III	Micropopagation,Stages, Types, Applications, Benefits & Limitations of Tissue Culture, callus culture, suspension and its types, and protoplast culture, anther culture, Organ culture including Meristems and Shoot tips, and Embryo culture. haploid plant culture	12
IV	General introduction of Protoplast isolation and culture, Development and applications of protoplast isolation and culture, Significance and application of Somaclonal hybridization, Advantages and disadvantages of somatic hybridization. Identification and differentiation between hybrid and Cybrids,	12

V	Production of Industrial phytochemicals in vitro, steps extractions, elicitations, Biotransformation, production of disease free plants, cryopreservation, Shikonin, Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria.	12
Reference / Text Books: 1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice. 2. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press. 3. Plant Biotechnology: B.D. Singh, Kalyani Publishers (2014) 4. Plant Tissue Culture: An Introductory Text by Sant Saran Bhojwani, Prem Kumar Dantu (2013)		
If the course is available as Generic Elective then the students of following departments may opt it. NO		
Evaluation/Assessment Methodology		
		Max. Marks
1) Class tasks/ Sessional Examination		16
2) Presentations /Seminar /Attendance		5
3) Assignments		4
4) Research Project Report Seminar On Research Project Report		
5) ESE		75
Total:		100
Prerequisites for the course: Basic knowledge of plant cell and its functions		
Course Learning Outcomes: CLO1: Student will study the plant tissue culture its type, media, scopes and applications. CLO2: Student will aware the micropopagation, shoot tip and organ culture. CLO3: Student will be aware for haploid plant productions and its applications. CLO4: Student will study somatic hybridization and its applications. CLO5: Student will study the elicitations, Biotransformation, production of disease free plants, cryopreservation. CLO6: Student will get knowledge about the Production of Industrial phytochemicals and plant growth promotion through free-living bacteria. Bio control of pathogens and plant growth promotion via free-living bacteria.		
Instructional Method and Pedagogy 1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course. 2. Various teaching aids are used for smooth conduction of Lectures. 3. 75% attendance in academic sessions is mandatory. 4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics. 5. PPT presentation method is also incorporated in teaching. 6. Case-study based learning will also be used. 7. Promotion of Ex-situ and In-situ learning. 8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc. 9. Identification of slow and fast learners also done during the course commencement. 10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics. 11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.		

PRACTICALS			
BBTC-NP-124P: Plant Tissue Culture & Application			
Marks: 40		Duration: 60 hours (2 credits)	
1. To set up a plant tissue culture laboratory.			
2. To prepare basic complex nutrient medium for plant tissue culture.			
3. To study the selection, sterilize and preparation of an explants for tissue culture.			
4. To studies the shoot tip culture			
5. To demonstrate various steps of Micropropagation.			
6. To perform the Callus induction.			
7. To studies the isolation of protoplast from plants.			
8. To perform the cell suspension culture			
INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL			
Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology		Year: I Semester: II
Credits: 6 Theory: 4 Practical: 2	Subject: Immunology	
Course Code: DSE-NP-123a	Title: Immunology	
Course Objectives: CO1. To study the immune response, T and B lymphocyte and its structure and functions. CO2. To study the regulation of immunoglobulin gene expression, diversity and its functions. CO3. To study the Major Histocompatibility its types, B-cell and T-cell receptors and somatic recombination CO4. To study the Immunity to infection of various organisms, pathogen defense strategies, Immunodeficiency disease and autoimmune diseases. CO5. To study the vaccines, its types and immunodiagnostics methods. CO6. To study various case studies in the field of immunology.		
Nature of Paper:DSE-2a		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to immune system- An overview, components of mammalian immune system, innate and acquired immunity, Humoral& Cellular immune responses, lymphocytes, active and passive immunity, primary and secondary immune response and immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells)	14
II	Immunoglobulin gene, expression of antigen, antibody diversity, epitope, paratope, adjuvant, allo types & idio types, allelic exclusion, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation)	12
III	Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing, genetic basis of B-cell and T-cell maturation, T-cellreceptors, assembly of T-cell receptor genes, B-cellreceptors, assembly of B-cell receptor genes by somatic recombination	10
IV	Immunity against different organisms, pathogen defense mechanism, evasion of recognition. Autoimmune diseases, Immunodeficiency-AIDS, various types of allergy, hypersensitivity,	12

V	Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA, case study on Corona virus vaccines, its effectiveness, symptoms.	12
Reference / Text Books: 1. Abbas AK, Lichtman A H, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia. 2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford. 3. Goldsby RA, Kindt TJ, Osborne BA. (2007). 4. Kuby's Immunology. 6th edition W.H. Freeman and Company, New York. 5. Murphy K, Travers P, Walport M. (2008). 6. Janeway's Immunobiology 7th edition Garland Science Publishers, New York. 7. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology 2nd edition Churchill Livingstone Publishers, Edinberg. 9. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.		
If the course is available as Generic Elective then the students of following departments may opt it. NO		
Evaluation/Assessment Methodology		
		Max. Marks
1) Class tasks/ Sessional Examination		16
2) Presentations /Seminar/Attendance		5
3) Assignments		4
4) Research Project Report Seminar On Research Project Report		
5) ESE		75
Total:		100
Prerequisites for the course: Intermediate Pass		
Course Learning Outcomes: CLO1: Student will study the types of lymphocytes, and its structure and functions CLO2: Student will be aware for immunoglobulin gene expression, diversity and its functions. CLO3: Student will be aware for Major Histocompatibility and T-cell and B-cell receptors. CLO4: Student will study the infection of different organisms, pathogen defense strategies and Immunodeficiency disease. CLO5: Student will be aware for vaccines, its types and different immunodiagnostics methods. CLO6: Student will gain knowledge about the various case studies in the field of immunology.		
Instructional Method and Pedagogy 1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course. 2. Various teaching aids are used for smooth conduction of Lectures. 3. 75% attendance in academic sessions is mandatory. 4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics. 5. PPT presentation method is also incorporated in teaching. 6. Case-study based learning will also be used. 7. Promotion of Ex-situ and In-situ learning. 8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc. 9. Identification of slow and fast learners also done during the course commencement.		

10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS
DSE-NP-123aP: IMMUNOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

1. To study the differential leucocytes count
2. To study the total leucocytes count of sample
3. To study the total RBC count
4. To study the Haemagglutination assay method.
5. To study the Haemagglutination inhibition assay method.
6. To study the separation of serum through blood sample
7. To study the double immunodiffusion test through specific antigen and antibody.
8. Detection of antigen using ELISA.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme:Biotechnology Certificate/Diploma/Degree/UG(R)		Year: I
Class: B.Sc. Biotechnology		Semester: II
Credits: 6 Theory: 4 Practical: 2		Subject: Molecular Diagnostics
Course Code: DSE-NP-123b		Title: Molecular Diagnostics
Course Objectives: CO1. To learn about Enzyme Immunoassays. CO2. To study about heterogeneous and homogenous enzyme assay. CO3. To study about microbial susceptibility test. CO4. To study about automation procedure in molecular diagnostic field. CO5. To study about HPLC, Electron microscopy, flow cytometry. CO6. The overall course content aware students about the different advanced tools and techniques in the fields of Biotechnology and make them skilled, trained and technology friendly.		
Nature of Paper: DSE-2b		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P: 2 (In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Enzyme Immunoassays: Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immune-histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology	14
II	Molecular methods in clinical microbiology: Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology Laboratory tests in chemotherapy:	12
III	Automated procedures for antimicrobial susceptibility tests. Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Diffusion test procedures. Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.	11
IV	Concepts and methods in idiotypes. Anti-idiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests.	12

	Immuno florescence. Radioimmunoassay.	
V	GLC, HPLC, Electron microscopy, flow cytometry and cell sorting. Transgenic animals, Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies.	11

Reference / Text Books:

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
2. Bioinstrumentation, Webster
3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe, Kluwer Academic
4. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.
5. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: Basic of intermediate level

Course Learning Outcomes:

- CLO1: Students will study about Enzyme Immunoassays.
CLO2: Students will understand about heterogeneous and homogenous enzyme assay.
CLO3: Students will be aware about microbial susceptibility test.
CLO4: Students will learn about automation procedure in molecular diagnostic field.
CLO5: Students will learn about HPLC, Electron microscopy, flow-cytometry.
CLO6: Student will get knowledge about the various advanced tools and techniques in the fields of Biotechnology and make them skilled.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are

incorporated.

PRACTICALS

DSE-NP-123b: Molecular Diagnostics Lab

Marks: 50

Duration: 60 hours (2 credits)

1. To study about ELISA test for a given sample.
2. To study about micro-dilution broth procedure for *E.coli* sample.
3. To perform micro-dilution broth procedure for given microbial sample.
4. To study microbial activity using Disc diffusion method.
5. To isolate DNA using agarose gel electrophoresis.
6. Purification of protein using SDS PAGE.
7. Demonstration of HPLC.
8. To study about basic principle of electron microscopy.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: Biotechnology Certificate/Diploma/Degree/UG Class: B.Sc. Biotechnology		Year: I Semester: II
Credits: 4 Theory: 4 Practical: 0	Subject: Entrepreneurship Development	
Course Code:BBTGE-NP-124	Title: Entrepreneurship Development	
Course Objectives: This course aims at teaching and the skills of converting basic biotechnology understanding into sustainable and eco-friendly business by giving new solutions to the presented challenges in the biotechnology field and by providing good alternatives to the existing approach. The syllabus fulfills the requirement of SDG 8 and SDG 9. CO1 The course content aims to construct the student understand about entrepreneur and entrepreneurships. CO2 To get the knowledge about developing a new skills in entrepreneurship field also about women entrepreneurship. CO3 To study the development of various new technological advancements as bio entrepreneur, bio-economy and various organization of ED and their roles CO4 To study about various lucrative fields of entrepreneurships viz Bio entrepreneurship, green entrepreneurship, aids to attain SDG. CO5 To understand the working of technology incubators and startup firms. CO6 To aware students about proposal writing, project writing, drafting of grant for skill enhancement etc.		
Nature of Paper: GE-1		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 Theory - 1 Hr. = 1 Credit		
Unit	Contents	No. of Lectures Allotted
I	Introduction, Concept of Entrepreneur, Entrepreneurship and Enterprise, Definition of Entrepreneurship, Objectives of Entrepreneurship Development, Phases of Entrepreneurship Development, Role of Entrepreneurship, The Entrepreneurial Mindset (Route of knowing yourself, SWOT analysis), Time management, stress management, Characteristics of Entrepreneurship, Traits of Entrepreneurship, Introduction to Entrepreneurship Skills, preparation of CV, Group discussion	12
II	Business management skills: Preparation of Business plan for Biotech Start-up, Teamwork and leadership skills, Raising money from Venture Capitalists, Customer service skills, Financial skills, Analytical and problem-solving skills, Critical thinking skills, Strategic thinking and planning skills, Technical skill, Female Entrepreneurship, SDG targets for entrepreneurship development	12

III	Leadership and Governance, Bio economy, 3Rs and energy recovery in industrial waste management, Construction and demolition waste, implementation of waste recycling and treatment plants, functions of national bodies like DBT, DST, CPCB, BIRAC, BCIL, emerging biotechnology enterprise, Role of agencies assisting entrepreneurship: DICs, SSIs, NSICs, EDII, NIESBUD, NEDB, Entrepreneurship Development Institute (EDI)	12
IV	Rural enterprise, Bioinformatics service solutions, Tissue Cell culture lab establishment, Drug discovery, Concept of sustainability in Bio-entrepreneurship development, Green entrepreneurship, Human resource management, Cooperative Enterprises and Sustainable Development, Aids to the SDGs through Social and Eco entrepreneurship, green employment	12
V	Technology Incubators and Start-Ups, Current statistics of Biotechnology start-ups in India, case study on technology Incubators and Biotech Start-Up Companies and case studies of Biotech companies, biotechnology product development, biotechnology market development, grant writing, proposal writing, Entrepreneurship and International business	12

Reference / Text Books:

1. Biotechnology Entrepreneurship: Leading, Managing, and Commercializing Innovative Technologies by Craig Shimasaki ISBN 978-0-12-815585-1 Copyright © 2020 Elsevier Inc. All rights reserved 2020.
2. Entrepreneurship: New Venture Creation: David H. Holt.
3. Patterns of Entrepreneurship: Jack M. Kaplan.
4. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
5. Principles of Management - by P C Tripathi and P N Reddy, 6th Edition, 2017.
6. Developing Communication skills - by Krishna Mohan & Meera Banerji, 2nd Edition, 2017.

If the course is available as Generic Elective then the students of following departments may opt it.
YES

1. Department of Microbiology
2. Department of Zoology
3. Department of Botany
4. Department of Basic Science
5. Department of food and Nutrition

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	
3) Assignments	5
4) Research Project Report	
Seminar On Research Project Report	4
5) ESE	75
Total:	100

Prerequisites for the course: This is an applied self-developing course, student must aware about all the basics of professional skill and communication and Biotechnology. It comprised of the applicability of Biotechnology in business field and start-ups.

Course Learning Outcomes:

- CLO1. Students will learn about entrepreneur and entrepreneurship.
- CLO2. Students will gain knowledge about developing new skills in entrepreneurship field.
- CLO3. Students will understand about the development of various new technological advancements as bio entrepreneur.
- CLO4. Students will gain knowledge about various lucrative fields of biotechnology
- CLO5. Students will gain knowledge about the working of technology incubators and startup firms.
- CLO6. Student will aware about the proposal project writing, writing, drafting of grant etc.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: III

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology		Year: II Semester: III
Credits: 6 Theory: 4 Practical: 2	Subject: Cell Biology	
Course Code:BBTC-NP-231	Title: Cell Biology	
Course Objectives: CO1. To study about classification of organisms by cell, cell structure, compartmentalization of eukaryotic cells, Fluid Mosaic model, cell fractionation, and roll of cell structure study in modern Biotechnology CO2. To get knowledge about cytoskeleton ,Membrane Vacuolar system, cell motility, study and function of microtubules, Golgi complex, Endoplasmic reticulum etc CO3. To learn about Structure and various functions of cell organelles. CO4. To get knowledge about Extracellular Matrix. CO5. To learn the basic knowledge of cancer and its different types. CO6. To study about the carcinogenesis.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	History of establishment of the concept of cell biology, History of cell, contribution of cell biologists, Introduction of cell, Classification of organisms by structure of cell, cytosol, compartmentalization of eukaryotic cells. Basic of Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport, Role of cell in modern biotechnology	15
II	Cytoskeleton and cell motility Membrane, Vacuolar system: Golgi complex: Structure, functions and biogenesis including role in protein secretion. Structure and function of Intermediate filaments, microtubules and Microfilaments. Structure and of function Endoplasmic reticulum including role in protein segregation.	15
III	Ribosomes: Structures, function and its role in protein synthesis. Lysosomes: Micro bodies: Structure and functions, Nucleus: Structure and function, chromosomes and their structure, Mitochondria: Structure and function,	12

	Genomes, biogenesis. Chloroplasts: biogenesis, Structure, function and genomes organization.	
IV	Extracellular Matrix: Composition, membrane receptors for extra cellular matrix, molecules that mediate cell adhesion, regulation of receptor expression and function, macromolecules, Signal transduction.	10
V	Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.	08

Reference / Text Books:

1. Karp, G. 2019. Cell and Molecular Biology: Concepts and Experiments. 9th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2010. Cell and Molecular Biology. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2013. The Cell: A Molecular Approach. 6th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Dr. P.S Verma and Dr. S.K. and V.K. Aggrawal, 2016. Cell Biology. 1st Edition. S Chand Publication.
5. Dr. Veer Bala Rastogi: 2020, A Text Book of Cell Biology And Genetics. 1st Edition. Kedar Nath Ram Nath Publication.
6. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Assignment	5
3) Assignments	
4) Research Project Report Seminar On Research Project Report	4
5) ESE	75
Total:	100

Prerequisites for the course: Knowledge of Basics of cell structure, its functions and genetic material (Intermediate or Certificate in Biotechnology level)

Course Learning Outcomes:

- CLO1: Student will learn about classification of organisms by cell, compartmentalization of eukaryotic cells, cell structure, and cell fractionation.
- CLO2: Student will get knowledge about Membrane Vacuolar system, cytoskeleton and cell motility.
- CLO3: Students will get knowledge about Structure and functions of cell organelles.
- CLO4: Students will able to understand about Extracellular Matrix.
- CLO5: Student will have the basic information of cancer and its different steps.
- CLO6: Student will aware about the carcinogenesis and its various types.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.

6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS
BBTC-NP-231P: CELL BIOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

Course Objective:

1. Students will get to know about the effect of organic solvents and temperature on semi permeable membrane.
2. They will able to gain knowledge about dialysis plasmolysis and de- plasmolysis.
3. Students will able to perform the enzyme activity function on sprouted seed or any other suitable source.
4. They can able to understand the structure and various function of any Prokaryotic or Eukaryotic cell.
5. Students will able to perform Microtome, Cell Division etc.
6. Students will able to prepare Nuclear, Mitochondrial and cytoplasmic fractions.

LIST OF EXPERIMENTS

1. Study the effect of organic solvents and temperature on semi permeable membrane.
2. To demonstration of the dialysis.
3. Study of the plasmolysis and de-plasmolysis.
4. To study the Cell fractionation and the determination of enzyme activity in various organelles by sprouted seed or any other suitable source.
5. Study of structure of any Prokaryotic and Eukaryotic cell.
6. Microtomy: section cutting, Fixation, block making, double staining of plant tissues like, leaf stems, vegetables weed, shrubs and spine needles etc.
7. To study the cell division in onion root tip.
8. Preparation of cytoplasmic, Nuclear & Mitochondrial fractions.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: III

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology		Year: II Semester: III
Credits: 6 Theory: 4 Practical: 2	Subject: Genetics	
Course Code:BBTC-NP-232	Title: Genetics	
Course Objectives: CO1. To study fundamental principles of genetics, Mendelian genetics, gene interaction, multiple alleles and concept of inheritance. CO2. To impart knowledge of Genetic linkage, crossing over and chromosome mapping. CO3. To impart knowledge of various repetitive sequences, structures etc. CO4. To understand about prokaryotic and eukaryotes genetic structures- special features such as genome organization, gene structure and organization of eukaryotic and also the structure and morphology as well as characteristics of bacterial and eukaryotic chromosome. CO5. To impart knowledge of Chromosome and gene mutations, Sex determination and sex linkage. CO6. To study about Evolution, population genetics and natural selection quantitative genetics.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Mendelian genetics: Introduction of Mitosis and Meiosis. Mendel’s experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of inheritance.	12
II	Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Crossing over at four strand stage, Multiple crossing overs Genetic mapping. Extra chromosomal inheritance.	11
III	Genomic organization: Eukaryotic nuclear genome nucleotide sequence composition–unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, middle repetitive multiple copy genes, noncoding DNA. Genetic organization of prokaryotic and viral genome. Structure and morphology and characteristics of bacterial	15

	and eukaryotic chromosome, genetic code, and gene function.	
IV	Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure and numbers Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory	12
V	Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law, allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, and natural selection quantitative genetics.	10
- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons. - Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc. - Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. - Benjamin Cummings. - Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings. - Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to - Genetic Analysis, W. H. Freeman & Co. - Quantitative genetics by DS FALCONER.		
If the course is available as Generic Elective then the students of following departments may opt it.NO		
Evaluation/Assessment Methodology		
		Max. Marks
1) Class tasks/ Sessional Examination		16
2) Presentations /Seminar/ Attendance		
3) Assignments		5
4) Research Project Report		4
Seminar On Research Project Report		
5) ESE		75
Total:		100
Prerequisites for the course: Knowledge of Basics of cell structure and genetic material (Intermediate or Certificate in Biotechnology level)		
Course Outcomes: CLO1: Students will learn about fundamental principles of genetics, multiple alleles and gene interaction. CLO2: Students will get knowledge about eukaryotes - special features such as genome organization and gene structure of eukaryotic. CLO3: Students will learn about Chromosome and gene mutations, Sex determination and sex linkage. CLO4: Students will understand about Genetic linkage, crossing over and chromosome mapping. CLO5: Students will understand about Evolution and population genetics. CLO6: Student will gain knowledge about the To study about natural selection, Evolution, population genetics and quantitative genetics.		
Instructional Method and Pedagogy - Preconditioning of the course and its blueprint shall be discussed in the beginning of the course. - Various teaching aids are used for smooth conduction of Lectures. 75% attendance in academic sessions is mandatory.		

4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS
BBTC-NP-232P: GENETICS LAB

Marks: 50

Duration: 60 hours (2 credits)

1. To prepare the temporary and Permanent mount of mitosis.
2. To prepare the temporary and Permanent mount of meiosis.
3. To study the Mendelian deviations in the dihybrid crosses.
4. To demonstration of the Barr Body –*Rhoeo* translocation.
5. To study the Karyotyping with the help of photograph
6. Pedigree charts of some common characters like color blindness, PTC and blood group Testing.
7. To study the polyploidy in the onion root tip through colchicine treatment.
8. Model preparation on Evolution and population genetics.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: III

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology		Year: II Semester: III
Credits: 6 Theory: 4 Practical: 2		Subject: Industrial Fermentation
Course Code: DSE-NP-233a		Title: Industrial Fermentation
Course Objectives: CO1. To study the basics of fermentation process, types and fermenter. CO2. To study the upstream and downstream processing, Purification and characterization of proteins, experimental model for design of fermentation systems. CO3. To study the rate equations for enzyme kinetics and simple as well as complex reactions, Inhibition kinetics and mathematical derivation of growth kinetics. CO4. To study the Enzyme and cell immobilization techniques in industrial processing, CO5. To understand production of various metabolites and scaling up process. CO6. The overall objective of the course to aware about various cost-effective designs of fermenters with specificity of production of bio products and meet the sustainable development goal, unit operation and cost effective DSP.		
Nature of Paper: DSE-3a		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to fermentation process, History of development of fermentation process, types of fermentation, design of fermenter, Types of fermenter, Characteristics of microorganism suitable for industrial process, strain improvement.	12
II	Introduction to Upstream and downstream processing, Purification & characterization of proteins, centrifugation, filtration, extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems.	12
III	Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions. Significance of microorganism in industrial fermentation, microbial growth, batch and continuous culture operations	12
IV	Over production of microbial metabolite, Secondary metabolism – its significance and products. Enzyme and cell immobilization techniques in	12

	industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food fermentation	
V	Single cell protein production, production of industrial biochemical, production of amylase, lactic acid, citric acid, Ethanol, butanol, Microbial polysaccharides; antibiotics, anti-cancer agents, amino acids, vaccines. Scale up principle and different methods of scaling up, set-up for fermentation industry.	12

Reference / Text Books:

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
5. Salisbury, Whitaker and Hall. Principles of fermentation Technology

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	5
3) Assignments	4
4) Research Project Report	
Seminar On Research Project Report	-
5) ESE	75
Total:	100

Prerequisites for the course: Knowledge of Basics of role of Biotechnology in Industry (Intermediate level or Certificate in Biotechnology level).

Course Learning Outcomes:

- CLO1: Student will come up with the knowledge of fermentation and its types.
CLO2: Student will aware the upstream and downstream processing for maximum efficiency and various experimental models for design of fermentation systems.
CLO3: Student will study the rate equations for enzyme kinetics, Inhibition kinetics, factor affecting for enzyme kinetics and mathematical derivation of growth kinetics.
CLO4: Student will come up with the knowledge of Enzyme and cell immobilization techniques in industrial processing,
CLO5: Student will come up with the knowledge of production of various metabolites and scaling up process.
CLO6: Student will understand about the various cost-effective designs of fermenters with specificity of production of bio products and meet the sustainable development goal.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.

7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS
DSE-NP-233aP: Industrial Fermentation Lab

Marks: 50

Duration: 60 hours (2 credits)

1. Model preparation or Demonstration of Laboratory scale fermenter.
2. Isolation techniques of microbes for fermentation industry.
3. Media Formulation and design for optimized fermentation process.
4. Microbial production of amylase.
5. Fermentation for citric acid production.
6. Production of ethanol.
7. Production of wine from black grapes.
8. Case study on development of Fermentation Industry.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: III

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology		Year: II Semester: III
Credits: 6 Theory: 4 Practical: 2	Subject: Enzyme Technology	
Course Code:DSE-NP-233b	Title: Enzyme Technology	
Course Objectives: CO1. To study about interaction between substrate and enzyme through models like induced fit model and lock and key model. CO2.To study about various factors affecting such as , enzyme concentration, temperature, substrate concentration and pH for the velocity of enzyme catalyzed reaction. CO3. To understand about extraction of crude enzyme from microbial, plant and animal sources. CO4. To understand about enzyme Immobilization such as adsorption, Encapsulation, Covalent binding, Matrix entrapment, Cross linking, and their examples. CO5. To study about enzyme Biosensors including elements of biosensors as well as the three generations of biosensors. CO6. To study Types of biosensors.		
Nature of Paper: DSE-3b		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to enzymes: Holoenzyme, apoenzyme, prosthetic group. Interaction between enzyme and substrate, lock and key model, induced fit model. Features of active site, activation energy. IUB system of classification and nomenclature of enzymes. Kinetics of single substrate reactions; Derivation of Michaelis-Menten equation, turnover number; determination of Km and Vmax (LB plot, ED plot), Importance of Km & V max.	14
II	Factors affecting the velocity of enzyme catalyzed reaction- enzyme concentration, temperature, pH, substrate concentration, inhibitors and activators. Enzyme inhibition: irreversible; reversible (competitive, uncompetitive and non-competitive inhibition).	12
III	Extraction of crude enzyme from plant, animal and microbial source. Purification of enzymes by the help of different methods. Methods of characterization of enzymes; criteria of purity. Unit of enzyme activity -	12

	definition and importance.	
IV	Enzyme Immobilization: Adsorption, Matrix entrapment, Encapsulation, Cross linking, Covalent binding and their examples; Advantages and disadvantages of different immobilization techniques. Structure & stability of immobilized enzymes, kinetic properties of immobilized enzymes-partition effect, diffusion effect. Overview of applications of immobilized enzyme systems.	12
V	Enzyme Biosensors: elements of biosensors. Types of biosensors: calorimetric, potentiometric, amperometric, optical and piezoelectric.	10

Reference / Text Books:

1. Enzymes: Dixon and Webb. (IRL Press)
2. Enzyme technology by Chaplin and Bucke. Cambridge University Press
3. Biochemical engineering fundamentals, second edition. James E Bailey, David F., Ollis, McGraw Hill Intl. Edition

If the course is available as Generic Elective then the students of following departments may opt it.NO

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	4
4) Research Project Report	
Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: Intermediate Level Knowledge/ basics of cell structures

Course Learning Outcomes:

CLO1: Student will learn about interaction between substrate and enzyme with reference to and lock and key model.

CLO2: Students will get the knowledge about various factors such as temperature, substrate concentration, enzyme concentration and pH affecting the velocity of enzyme catalyzed reaction

CLO3: Student will get knowledge of extraction of crude enzyme from plant, animals.

CLO4: Student will learn about enzyme Immobilization such as adsorption, Covalent binding, Encapsulation, Matrix entrapment, Cross linking.

CLO5: Student will gain the knowledge about enzyme Biosensors, component of bios biosensors as well as the three generations of biosensors.

CLO6: Student will aware about Types of biosensors and its applications.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial

classes for their improvement in academics.

11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

DSE-NP-233bP: ENZYME TECHNOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

1. To study the Purification of an enzyme through any natural resources.
2. Identification of enzymes in different sources.
3. Bradford/Lowry's method use for Quantitative estimation of proteins.
4. Perform the assay for the purified enzyme.
5. Calculation of enzyme kinetic parameters such as Kcat, Km and Vmax.
6. Effect of pH and temperature on enzyme activity.
7. Effect of various metal ions on enzyme activity.
8. Study of different methods of enzyme immobilization.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: III

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology		Year: II Semester: III
Credits: 4 Theory: 4 Practical: 0	Subject: Food Fermentation Technology	
Course Code:BBTGE-NP-234a	Title: Food Fermentation Technology	
Course Objectives: The main objective of this course paper is to enable students to increase understanding of food fermentation technology and the various functions of microorganisms in the industrial manufacture and they could also be acquainted with the attractive and undesirable behavior of microorganisms in connection with foods and their applications in the food manufacturing industry. CO1. To study the fermentation, fermenter and fermented food advantages and its health benefits. CO2. To study the food as a substrate for microorganism growth. CO3. To study the dairy based fermented foods and its preparation processes. CO4. To study the grain Based and non-dairy Fermented Foods and its preparation processes. CO5. To study the methods of food preservation. CO6. To study the Quality control in fermentation processes.		
Nature of Paper: GE-2b		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T: P:(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Food fermentation History, Development and Scope of food fermentation technology; Concept of food and nutrients; Physiochemical properties of food; Importance and types of microorganisms in food (bacteria, mold and yeast); natural flora and source of contamination of foods in general. Types and cost effective design of fermenters for food industry, layout of food industry.	12
II	Food as a substrate for microbial growth and food-borne diseases Intrinsic and extrinsic parameters that affect microbial growth in food. Microbial spoilage of food: milk, bread and canned foods. Food intoxication by <i>Clostridium botulinum</i> . Food infection by Salmonella. Traveller's diarrhea.	12
III	Dairy fermented products and Probiotics Dahi, yogurt, buttermilk, kefir, acidophilus milk and Cheese: preparation of inoculums, types of fermentation and production process. Probiotics-definition, examples and benefits.	10

IV	Grain based and other non-dairy fermented foods Soy sauce, bread, idli and Dosa: preparation of inoculum, types of microorganisms and fermentation process: Vegetable/meat/fish based fermented foods (Pickels, Saeukraut, meat and fish).	12
V	Principles and methods of food preservation: Physical methods: high temperature, low temperature, irradiation, aseptic packaging. Chemical methods: salt, sugars, benzoates, citric acid, ethylene oxide, nitrate, and nitrite. Food quality control management: HACCP. Quality control in fermentation processes: Principles of validation for pharmaceutical industry; Quality assurance tests of finished product- Sterility testing, Pyrogen testing, Ames test, toxicity testing, Shelf life testing.	14

Reference / Text Books:

1. Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press.
2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Wood head Publishing.
3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan.
4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer.
5. Adams, M.R. and Moss, M.O. (2000). Food Microbiology. 2nd edition. New Age International Publishers, India.
6. Banwart, G.J. (2004). Basic Food Microbiology. 2nd edition. CBS Publishers and Distributors, India.
7. Casida, L.E. (2019). Industrial Microbiology. 2nd edition. New Age International, India.
8. Crueger, W., Crueger, A. and Aneja, K.R. (2017). Biotechnology: A Textbook of Industrial Microbiology. 3 rd edition. Medtech Publisher, India.
9. Frazier, W.C., West hoff, D.C. and Vanitha, N.M. (2013). Food Microbiology. 5th edition. Tata McGraw-Hill Publishing Company Ltd, India.
10. Jay, J.M., Loessner, M.J. and Golden, D.A. (2006). Modern Food Microbiology. 7th edition. CBS Publishers and Distributors, India.
11. Patel, A.H. (1996). Industrial Microbiology. 1 st edition. Macmillan India Limited.
12. Stanbury, P.F., Whitaker, A. and Hall, S.J. (2016). Principles of Fermentation Technology. 3rd edition. Elsevier Science, Netherlands.

If the course is available as Generic Elective then the students of following departments may opt it.

1. Department of Microbiology
2. Department of Food and nutrition
3. Department of nursing
4. Pharmacy

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3)Assignments	4
4) ESE	75
Total:	100

Prerequisites for the course: Knowledge of Basics of role of Biotechnology in food Industry (Intermediate level or Certificate in Biotechnology level)

Course Learning Outcomes:

On successful completion of the course, the student:

CLO1: Student will have gained knowledge about history, development and scope of food fermentation technology.

CLO2: They will also be aware with various types of fermenters and the typical components of the fermenter. Student will also have learnt the types of techniques involved in the isolation, screening and preservation as well as the maintenance of industrial strains.

CLO3: The student will learn and understanding the significant parameters for affecting the microbial growth in foods and Spoilage of foods by microorganisms as well as various food borne diseases.

CLO4: Will be conversant with the use of microorganisms in the production of dairy fermented foods and microorganisms as food supplements.

CLO5: Students will understanding the various microorganisms used in the manufacture of grain based as well as other non-dairy fermented products.

CLO6: They will understand the different chemicals and physical methods applied in food preservation as well as aware about the quality control of food.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: III

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology		Year: II Semester: III	
Credits: 4 Theory: 4 Practical: 0		Subject: Dairy and Agriculture Biotechnology	
Course Code:BBTGE-NP-234b		Title: Dairy and Agriculture Biotechnology	
Course Objectives: CO1. To exemplify the quality of milk and milk products. CO2. To demonstrate the manufacturing various dairy products. CO3. To study about the various Byproducts of the Dairy Industry and their useful utilization. CO4. To study about General principles of Crop production. CO5. To get knowledge about Importance of Breeds, livestock in Agriculture, and various Breeding methods of livestock. CO6. Help students by making them familiar and trained in dairy and agriculture biotechnology.			
Nature of Paper: GE-2a			
Minimum Passing Marks/Credits: 40% Marks / 4 Credits			
L:4 T: P:(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)			
Unit	Contents	No. of Lectures Allotted	
I	Composition of milk and factor affecting it. Physico-chemical characteristics of milk and milk constituents. Production and collection, cooling and transportation of milk. Packaging storage and distribution of pasteurized milk. Milk quality test.	12	
II	Definition, Classification, Composition and physico-chemical properties of cream. Production processes and quality control. Butter: Definition, Classification, Composition and methods of manufacture, Packaging and storage. Butter oil/Ghee. Ice cream: Definition, Classification and Composition, Constituents and their role.	12	
III	Byproducts of Dairy Industry and their effective utilization. Manufacture of casein, Whey protein, Lactose from milk and their use in formulated foods. Quality Control tests in Dairy industry	10	
IV	Definition and scope of Agronomy, Classification of Crops on Different basis, General principles of Crop production: Climate, soil and its preparation, seed and seed sowing, post-sowing tillage, water management, nutrition, plant protection measures, harvesting, threshing and storage, Crop sequences and systems with emphasis on mixed cropping and inter cropping, etc.	15	

V	Importance of livestock in Agriculture, Breeds, and Breeding methods of livestock and their consequences, Pasture management, Importance of scientific Feeding, etc.	10
Reference / Text Books: 1. Ramesh C. Chandan: Dairy-based Ingredients, Eagan Press, 1997. 2. Sukumar De: Outlines of Dairy Technology, Oxford University Press, 1980. 3. Aneja, Mathur, Chandan & A.K. Bannerji: Technology of Indian Milk Products: Dairy India Publication.		
If the course is available as Generic Elective then the students of following departments may opt it. 1. Department of Agriculture 2. Department of Zoology 3. Department of Life Science 4. Department of Microbiology		
Evaluation/Assessment Methodology		
		Max. Marks
1) Class tasks/ Sessional Examination		16
2) Presentations /Seminar/Attendance		
3) Assignments		5
4) Research Project Report		
Seminar On Research Project Report		4
5) ESE		75
Total:		100
Prerequisites for the course: Basic knowledge of microbiology and food biotechnology		
Course Learning Outcomes: CLO1: Student will understand about different methods of milk quality analysis. CLO2: Student will get knowledge about the developed of different dairy products. CLO3: Student will learn in relation to Byproducts of Dairy Industry and their effective utilization. CLO4: Student will learn about General principles of Crop production. CLO5: Student will get knowledge about significance of Breeds, livestock in Agriculture and various Breeding methods of livestock CLO6: .Student will aware about the dairy and agriculture biotechnology.		
Instructional Method and Pedagogy 1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course. 2. Various teaching aids are used for smooth conduction of Lectures. 3. 75% attendance in academic sessions is mandatory. 4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics. 5. PPT presentation method is also incorporated in teaching. 6. Case-study based learning will also be used. 7. Promotion of Ex-situ and In-situ learning. 8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc. 9. Identification of slow and fast learners also done during the course commencement. 10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics. 11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.		

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: IV

Programme: Biotechnology Certificate/Diploma/Degree/ UG Class: B.Sc. Biotechnology	Year: II Semester: IV	
Credits: 6 Theory: 4 Practical: 2	Subject: Bioprocess Technology	
Course Code: BBTC-NP-241	Title: Bioprocess Technology	
Course Objectives: CO1. To learn the bioprocess technology, types of microbial culture and applications. CO2. To impart knowledge regarding microbial growth kinetics and different types of reactor. CO3. To study the Design of vessels and production for bioprocess. CO4. To study the Principles of upstream processing and types of microbial culture and its growth kinetics. CO5. To study the oxygen requirement in bioprocess, measurement of process parameters and automation. CO6. To study the industry efficient bioprocess control effluent treatment and specific types of bioreactors.		
Nature of Paper: Cor		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Preamble to bioprocess technology. Bioprocess Range and its sequential development; in-order approach. Integrated bioprocess approach. Growth Kinetics of Microbial species: In diverse modes of process of reactors, batch, continuous and fed batch and product formation. Criteria for bioreactors scale up.	12
II	Design of ideal bioprocess vessels and different types of bioreactors-implications and applicability of Baffles, Impeller, Sparger; Special types of Bioreactor, Airlift; Packed bed reactor, fluidized bed reactor, Chemostat with recycle, cost effective designing, Design equations for batch reactor	12
III	Upstream processing: An introduction, Media preparation, starter culture/inocula development and sterilization. Characteristics of antifoaming agents. Sterilization: Methods and types, sterilization of media, thermal death kinetics of microbes, design criteria for sterilization process in batch and continuous mode. Mechanism, of Air Sterilization.	12

IV	Preface to oxygen requirement in mass transfer; theories of mass transfer, Measurement of Volumetric O ₂ , mass transfer coefficient; factors affecting transfer of oxygen. Oxygen transfer in bioreactor.	12
V	Computer aided bioprocess process control. Manual control of bioprocess, Use and applicability of biosensors for bioprocess control, Off-line and on-line bioprocess control. Effluent treatment. CETP, Types of procedure for effluent treatment. Specific types of bioreactors for animal and plant cell culture.	12

Reference / Text Books:

1. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology 2nd edition. Panima Publishing Co. New Delhi.
3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd. Benjamin Cummings.
5. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
6. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.
7. Shuler M L, Kargi F, “ Bioprocess Engineering- Basic Concepts” , 2nd ed, Prentice Hall of India Ltd. (2002)
8. Aiba S, Humphrey A E and Millis N F, “Biochemical Engineering”, Academic Press (1973)
9. Bailey J E and Ollis D F, “Biochemical Engineering Fundamentals”, Mc Graw Hill (1986)
10. Harvey W. Blanch and Douglas S. Clark, “Biochemical Engineering”, Marcel Dekker (1996).
11. Lee J M, “Biochemical Engineering” , Prentice Hall (1992)

If the course is available as Generic Elective then the students of following departments may opt it.

1. NO

COURSE OUTCOMES

After completing the syllabus/course students would be able to:

1. Explain the bioprocess technology, types of microbial culture and applications.
2. Impart knowledge regarding microbial growth kinetics and different types of reactor.
3. Ability to develop Design of vessels and production for bioprocess.
4. Understand the Principles of upstream processing and types of microbial culture and its growth kinetics.
5. Calculate the oxygen requirement in bioprocess, measurement of process parameters and automation.
6. Develop industry efficient bioprocess control, effluent treatment and specific types of bioreactors.

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: Intermediate Pass and knowledge of microbiology, basics of biotechnology/ certificate in Biotechnology.

Course Learning Outcomes:

- CLO1: Student will study the bioprocess technology, microbial culture and its applications.
CLO2: Student will be aware for design of vessels and production for bioprocess.
CLO3: Student will study the media preparation, inocula development and sterilization and types of microbial culture and its growth kinetics.
CLO4: Student will study oxygen requirement, measurement and control system in bioprocess.
CLO5: Student will be aware for effluent treatment, plant cell bioreactor and animal cell bioreactor.
CLO6: Student will be aware about plant cell bioreactor and animal cell bioreactor.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures 75% attendance in academic sessions is mandatory.
3. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
4. PPT presentation method is also incorporated in teaching.
5. Case-study based learning will also be used.
6. Promotion of Ex-situ and In-situ learning.
7. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
8. Identification of slow and fast learners also done during the course commencement.
9. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
10. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

BBTC- NP-241P: BIOPROCESS TECHNOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

Course Objectives:

The course aims at providing an overview of bioprocess technology operations, designing of bioreactor, sterilization etc. To comprehend the basics of design of bioreactor for cost-effective production of biomolecules and automation of bioprocesses in industry.

List of Experiments:

1. To study the growth kinetics of microorganism.
2. Estimate the thermal death point (TDP) of a microorganism sample.
3. Demonstration of Sterilization of bioreactor.
4. To estimate growth kinetic parameters of Escherichia coli.
5. Production and analysis of ethanol.
6. To measure Oxygen Transfer Coefficient in bioprocess system
7. Model development of bioreactor
8. Preparation of Bio adsorbent for bio adsorption process
9. Demonstration of waste water treatment plant
10. Studies on the kinetics of immobilized cell with bio adsorbents.

Course Outcomes:

1. Ability to calculate and examine mechanism of microbial growth
2. The student would comprehend the functioning of bioreactors
3. The student can operate bioreactors.
4. The students can predict the growth kinetics in bioreactor.
5. The students can predict the requirement of oxygen for growth of microorganism.
6. Students can able to produce various metabolites in bioreactor.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL			
Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: IV

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology	Year: II Semester: IV	
Credits: 6 Theory: 4 Practical: 2	Subject: Nano biotechnology	
Course Code:BBTC-NP-242	Title: Nano biotechnology	
Course Objectives: CO1. To study about the Introduction, History and Applications: different definitions and perception of Nano-biotechnology. CO2. To gain knowledge about Microbial Nanoparticle Production, drug delivery etc. CO3. To understand about different classes of biomedical polymers and its production and application. CO4. The second objective of the paper to give knowledge regarding application of Nano biotechnology in environment and biomedical fields. CO5. To impart knowledge related with Nano biosensors. CO6. The whole goal of the course is to meet the sustainable requirement in terms of providing easy solutions to mankind.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: 2 P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Nano biotechnology approaches of Nano biotechnology, characterization and properties of nanoparticles, Basic biology principles and physical and chemical of micro fabrication techniques, and biological production of metal nano particles /nanomaterials/bio nanomaterials, macro molecular assemblies, preparation of nanoparticle from waste.	12
II	Quantum dots technology and its application Developing drug delivery tools through nano biotechnology, nano particle based immobilization assays.	12
III	Synthesis and characterization of different classes of biomedical polymers-their uses in pharmaceutical, cardiovascular ophthalmologic orthopedic areas.	12
IV	Application in Biomedical and biological research, nano particles, viruses as nano-particles, Carbon nano tubes, nano chemicals, tumor targeting and other diagnostic, Environmental issues and energy sectors.	12
V	Biosensors and nano biotechnology principles used in construction of	12

microelectronic devices sensors and macro mechanical structures and their functioning, immune-nanotechnology.	
Reference / Text Books: 1. Nano biotechnology: Concepts, Applications and Perspectives, Christ of M. Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley Publishers, April 2004. 2. Nanotechnology: A Gentle Introduction to Next Big Idea, Mark Ratner and Daniel Ratner, Low Price edition, Third Impression, Pearson Education 3. Bio nanotechnology towards Sustainable Management of Environmental Pollution by Naveen Dwivedi and Shubha Dwivedi, CRC Press 2022. 4. Nanotechnology, William Illsey Atkinson, JAICO Publishing House, Second Impression-2008. 5. Bio nanotechnology towards Green Energy: Innovative and Sustainable Approach by Shubha Dwivedi and Naveen Dwivedi CRC Press 2023. 6. Bio molecular computation for Bio nanotechnology, Liu and Shimohara, Artech House-London, 2007	
If the course is available as Generic Elective then the students of following departments may opt it.NO	
Evaluation/Assessment Methodology	
	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/ Attendance	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	75
5) ESE	
Total:	100
Prerequisites for the course: Basic knowledge of Biotechnology/ Certificate in Biotechnology	
Course Learning Outcomes: At the end of the course the student will be: CLO1: To understanding and Develop a fundamental of basic concepts of nano-biotechnology and its applications in the field of life sciences. CLO2: To learn about the applications of different concepts and methods of nano-biotechnology to make easy biotechnological improvement and innovations. CLO3: To learn about the various interactions of biomolecules with surfaces of various physical and chemical species. CLO4: To learn about the production and the uses of different types of nanostructured resources. CLO5: To learn about various methods for the design of biosensors and other second carriers and bio conjugates on surfaces. CLO6: Student will understand about the sustainable requirement which providing the easy solutions to mankind.	
Instructional Method and Pedagogy 1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course. 2. Various teaching aids are used for smooth conduction of Lectures. 3. 75% attendance in academic sessions is mandatory. 4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics. 5. PPT presentation method is also incorporated in teaching. 6. Case-study based learning will also be used. 7. Promotion of Ex-situ and In-situ learning. 8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.	

9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics. .
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS
BBTC-NP-242P: NANO- BIOTECHNOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

Course Objective: The objective of the lab to provide method of development of nanoparticles and aware students about various production approaches of nanoparticles.

1. To Preparation of the Gold nanoparticles through chemical method.
2. To Preparation of Gold nanoparticles via Green chemistry method.
3. To determine the Size of nanoparticles through UV-Vis spectrophotometer and FTIR study.
4. To estimation of the antimicrobial properties of nanoparticles.
5. To study the toxicity measurement of the nanomaterials.
6. To study the biocompatible of Silver and Gold nanoparticles.
7. To study the fabrication of electrochemical biosensor.
8. Instrumentation of Immuno sensor.
9. Preparation of PEG based liposome.
10. Immobilization of antibody over the nano porous film.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: IV

Programme: Biotechnology Certificate/Diploma/Degree/UG(R) Class: B.Sc. Biotechnology	Year: II Semester: IV	
Credits: 6 Theory: 4 Practical: 2	Subject: Biostatistics and Bioinformatics	
Course Code: DSE-NP-243a	Title: Biostatistics and Bioinformatics	
Course Objectives: CO1. To study the types of data, test of significance ANOVA and its applications CO2. To study the Probability, Binomial, Normal distributions and Poisson and methods of sampling and its various analysis. CO3. To study introduction, scope and applications of bioinformatics. CO4. To study the biological Databases its type and applications. CO5. To study the searching Databases, Genome Annotation Phylogeny analysis. CO6. To study the Phylogeny analysis.		
Nature of Paper:DSE-4a		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Classification and Graphical Representation of Statistical data, Collection of data, Types of Data, Primary & Secondary data. Measures of Skewness and Kurtosis. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA) and its applications, Measures of central tendency and Dispersion.	12
II	Theorems on total and compound Probability, Probability classical and axiomatic definition of probability, Elementary ideas of Normal, Poisson and Binomial distributions. Methods of sampling, critical region, confidence level, testing of hypothesis and standard error, small sample test and large sample test. Basics of experimental design.	12
III	Introduction: Definition, Basic concept and components of bioinformatics, Scope and application of bioinformatics in biological research. History of Bioinformatics: Historical development, the notion of homology. Introduction of Data Generating Techniques and Bioinformatics problem posed by them (Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry).	12

IV	General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (PIR, PROSITE, Pfam, PDB, SWISSPROT, TREMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDBsum). Understanding the structure of each source and using it on the web	12
V	Searching Databases: Entrez, SRS, Sequence Similarity Searches – FASTA and BLAST Genome Annotation: Gene identification tools, Pattern and repeat finding. Phylogeny analysis: Detecting Open Reading Frames, Mutation/Substitution Matrices, Outline of sequence Assembly, Pairwise Alignments, and Introduction to BLAST with the help of web, Interpreting results, Multiple Sequence Alignment and Phylogenetic Analysis.	10

Reference / Text Books:

1. Le CT (2003) introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High Yield TM Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Danial W (2004) Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.
5. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
6. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
7. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.
8. Sharma, Munjal and Shankar, A Text Book of Bioinformatics, Rastogi Publication, New Delhi, Meerut.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/ Attendance	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: Certificate in Biotechnology or Intermediate pass

Course Learning Outcomes:

- CLO1: Student will be study data and their measurement, test of significance ANOVA and its applications
- CLO2: Student will be aware the probability, Binomial, Normal distributions, Poisson and methods of sampling and its various analysis.
- CLO3: Student will know about the concept and components of bioinformatics and the historical development of the subject, along with its scope and application.
- CLO4: Student will be capable to understand the types of data and know about important biological databases.
- CLO5: Student will be learning to read and understand the file formats of various databases and method of data submission and retrieval.

CLO6: Student will aware about the Phylogeny analysis of various organisms.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

DSE-NP-243aP: BIOSTATISTICS AND BIOINFORMATICS LAB

Marks: 50

Duration: 60 hours (2 credits)

1. Demonstration Based on measures of Central Tendency & Dispersion
2. To detection of the Open Reading Frames via ORF Finder
3. Based on t, z, f and Chi-square
4. To use of SNP databases at NCBI and other sites
5. Multiple sequence alignment via Clustal W.
6. Using different BLAST and interpretation of results.
7. Retrieval of information from nucleotide databases.
8. Sequence alignment through BLAST.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: IV

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc.		Year: II Semester: IV	
Credits: 6 Theory: 4 Practical: 2		Subject: Medical and Forensic Biotechnology	
Course Code: DSE-NP-243b		Title: Medical and Forensic Biotechnology	
Course Objectives: CO1.Students to learn about modern medical biotechnology and forensic science. CO2. To aware students about basic concept of medical biotechnology. CO3. To study about different applications of forensic biotechnology in various fields. CO4. To aware students about tools and technology used for identification and solving crime. CO5. To aware students about role of forensic scientist, protocols of investigation of crime. CO6. To aware students about latest advancement of technology for investigation of the forensic cases.			
Nature of Paper: DSE-4b			
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits			
L:4 T: P: 2 (In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)			
Unit	Contents	No. of Lectures Allotted	
I	Biomolecules and metabolism, identification of diseases, metabolomics, drug design, Rules and examples of Mendelian and Non-Mendelian Inheritance, Animal virus, Genetics Counseling and Human Genome Project, Homeostasis, control system, Types of cells for transplantation, Translational developmental biology.	12	
II	Multiple drug resistant bacteria, Microbial diseases of skin and eye, nervous system, cardiovascular & lymphatic system, respiratory, and digestive system, Cytogenetics and linkage mapping, Vaccine Technology, primary cell culture, secondary cell culture, cell lines, Cell factories.	12	
III	History and Development of Forensic Science - Locard's exchange principle, Definition of Forensic Science, Scope of Forensic Science, Need of Forensic Science, Basic Principles of Forensic Science, Tools and Techniques of Forensic Science, application of biotechnology in Forensic sciences.	12	
IV	Organizational setup of Forensic Science Laboratories, CFSL, FSL, GEQD, FPB, NICFS, Central Detective Training School, NCRB (Maintenance of Crime Records), Alcohol & it relationship to human	12	

	anatomy & metabolism, Branch of Forensic Science, types of evidences, types of injuries and death.	
V	Modus Operandi , Criminal Profiling, Profile of the victim and culprit, investigative strategy, crime scene characteristics, criminal behavior on the internet, limitations, Duties of Forensic Scientist, History and Development of Finger Print, DNA fingerprinting.	12

Reference / Text Books:

1. Nanda, B.B. and Tewari, R.K. (2001): Forensic Science in India: A vision for the twenty first century Select Publisher, New Delhi.
2. James, S.H and Nordby, J.J. (2003) Forensic Science: An introduction to scientific and investigative techniques CRC Press,
3. An Introduction to Forensic DNA Analysis, 1st Edition by Norah Rudin and Keith Inman, Publisher: CRC Press; ISBN-13: 978-0849381171, 2011
4. Forensic Odontology , Principles & Practice by Taylor & Keiser, 1st Edition, Reprint 2016
5. The essentials of Forensic Medicine and Toxicology, by K S Narayan Reddy, 34th Edition 2017.

If the course is available as Generic Elective then the students of following departments may opt it.
No

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: Knowledge in biochemistry, genetics & molecular biology is essential to take the course

Course Learning Outcomes:

CLO1: Student will learn about various dimensions of Forensic science
CLO2: Student will get knowledge and apply medical biotechnology knowledge in various fields of forensic biotechnology.
CLO3: Student will learn about various tools of medical and forensic biotechnology.
CLO4: Student will Apply modern techniques in forensics such DNA finger printing and blood stain analysis
CLO5: Student will aware about role of forensic scientist and protocols of investigation of crime.
CLO 6. Student will get knowledge about latest advancement of technology for investigation of the forensic cases.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.

9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

DSE-NP-243bP: MEDICAL AND FORENSIC BIOTECHNOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

Course Objectives

1. Aware students about testing and analysis procedures related with medical and forensic biotechnology.
2. Aware students about preparation of various types of Buffer.
3. Trained students with blood testing procedures.
4. Equipped students with various laboratory skills related with course.
5. Trained students regarding hair sample analysis, DNA analysis, microbial analysis, blood group testing, fingerprint analysis.

List of Experiments

1. Verification of Beer Lambert's law and determination of λ_{max} by colorimetric method.
2. Determination of blood glucose by GOD/POD method.
3. To prepare the Tris buffer saline (TBS), Phosphate buffer saline (PBS) and Tris acetate buffer.
4. To study and aware the process of dialysis.
5. Analysis of ABO blood groups in human beings.
6. To isolate plasmid DNA through bacteria and perform the agarose gel electrophoresis.
7. To study and detect the fingerprint using ninhydrin and compare fingerprints of two different individuals.
8. To Study hair sample of different origin/species under microscope.

Course Outcomes: After completion students obtain

1. Knowledge in the field of forensic biotechnology.
2. Knowledge in the field of basic experiments of medical biotechnology.
3. Innovation, idea to identify the suspect hair and fingerprint examination.
4. Knowledge of blood sampling.
5. Acquire knowledge of hair sample analysis and DNA analysis.
6. Acquire knowledge of analysis and fingerprint analysis.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: III / Semester: V

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology	Year: III Semester: V	
Credits: 6 Theory: 4 Practical: 2	Subject: Environmental Biotechnology	
Course Code:BBTC-NP-351	Title: Environmental Biotechnology	
Course Objectives: CO1. To teach different types of environmental pollution due to various anthropogenic activities. CO2. To build up understanding of environment biotechnology in treating various kind of waste to produce valuable products. CO3. To convey knowledge of core designing principle of bioreactor for waste management and treatment uses biological process. CO4. To build up statistical and analytical skills requisite for designing and operation of source-based waste treatment. CO5. To aware students about waste to wealth technology in terms of treatment and green energy production. CO6. To aware students about various national/international environmental legislative framework, Working of EIA.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Environmental pollution: An overview, Land, water, air, and noise, Marine (introduction, sources, effects and measurements). Thermal Pollution, Nuclear and Radiation Pollution, Radioactivity in nature, Toxic Hydrocarbon, Radioactive waste sunk, Genetic Consequences. Impact of environmental pollution on human, plants, animals and aquatic life. Impact of climate change on living organism, Carbon sequestration: solution to climate change.	12
II	Biotechnology for waste treatment: Scenario of waste production worldwide Biological waste treatments and biofuel production. Anaerobic digestion process for Methanogenesis: methanogenic, acetogenic, and fermentative microbe. Minimal national standards for waste disposal.	11
III	Advanced bioreactor configuration for environmental clean-up: activated sludge process, trickling filter, fluidized expanded bed reactor, upflow	11

	anaerobic sludge blanket reactor, contact process, fixed / packed bed reactor, hybrid reactor, sequential batch reactor	
IV	Waste to wealth: bioconversion of agricultural and other highly organic waste materials into lucratively utilizable products like Bioenergy, biogas, green hydrogen, celluloses and food and feed stocks. Bioremediation & Biomineralization, Bioleaching of ores, Recovery of metals, Economical and social aspects of waste treatment.	11
V	Environmental Impact Assessment: Relation between development and environment. Sustainable development and carrying capacity. Public participation. Methodologies. Environmental Protection Act, 1986, Water Prevention and Control of Pollution Act, 1974, Water Prevention and Control of Pollution Act, 1974, Air Prevention and Control of Pollution Act, 1981, Hazardous Wastes (Management and Handling) Rules. International environmental laws.	15

Reference / Text Books:

1. Wastewater Engineering Metcalf & Fuddy, 3rd ed. 2013.
2. Bionanotechnology towards Sustainable Management of Environmental Pollution by Naveen Dwivedi and Shubha Dwivedi, CRC Press 2022.
3. Environmental Biotechnology B.C. Bhattacharya & Ritu Banerjee, Oxford Press 2007.
4. Bionanotechnology towards Green Energy: Innovative and Sustainable Approach by Shubha Dwivedi and Naveen Dwivedi CRC Press 2023.
5. Naveen Dwivedi, Shubha Dwivedi and Maulin P Shah. "Integrated biotechnological solutions for the treatment of industrial wastewater for a healthy and sustainable environment" (Edited book- Publisher: Elsevier).
6. Charles Oluwaseun Adetunji, Julius Kola Oloke, Naveen Dwivedi, Sabeela Beevi Ummalyma, Shubha Dwivedi and Daniel Ingo Heff. "Next-Generation Algae, Volume 1: Applications in Agriculture, Food and Environment" (Publisher: Wiley–Scrivener, ISBN: 9781119857273, 2023).
7. Phytoremediation: novel approaches and sustainable solutions for environmental cleanup by Deepa Sharma and Shubha Dwivedi, Bluerose publishers, 2023. (ISBN: 978-93-5819-002-1).
8. Role of biotechnology for global strides in just transitions and innovation ecosystem by Shubha Dwivedi, Navneet Sharma and Deepa Sharma, Bluerose publishers, 2023. (ISBN: 978-93-5819-020-5) Essentials of Ecology & Environmental Science, S.V.S. Rana, Prentice Hall India, 2006.
9. Environmental Sciences – Purohit, Shammi & Agrawal, New Age International Publishers, Student Edition 2004.

If the course is available as Generic Elective then the students of following departments may opt it.

1.No

Evaluation/Assessment Methodology	
	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	
4) Research Project Report Seminar On Research Project Report	4
5) ESE	75
Total:	100
Prerequisites for the course: Basic knowledge of bioreactors, environment science is required.	

Course Learning Outcomes:

After completion of the course, the student will be able to:

CLO1: Differentiate the precise root cause of environmental pollution related problems.

CLO2: Relevancy and applicability of the environment biotechnology core ideology in waste treatment system.

CLO3: Design the novel biological waste-water treatment system at university as well as industrial scale. (Lab to pilot study)

CLO4: To understand and analyze the waste to wealth procedures.

CLO5: Able to develop the EIA framework and Environmental auditing.

CLO6: Students will be able to define various national/international environmental legislative frameworks for environment protection.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

BBTC-NP-351P: ENVIRONMENT BIOTECHNOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

1. Estimation of total dissolved solids (TDS) in tap water.
2. Analysis of acidity from wastewater.
3. Analysis of alkalinity in wastewater.
4. Calculation of Total solids in wastewater.
5. Removal of contaminants from wastewater: case study.
6. Proximate analysis of waste sample.
7. Proximate analysis of waste adsorbents.
8. Analysis of methyl orange alkalinity from wastewater

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: III / Semester: V

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology	Year: III Semester: V	
Credits: 6 Theory: 4 Practical: 2	Subject: Recombinant DNA Technology	
Course Code: BBTC-NP-352	Title: Recombinant DNA Technology	
Course Objectives: CO1. To study the tools, techniques for gene manipulations, cloning vectors, Microinjection, Electroporation and types of PCR and its applications. CO2. To study the various methods for recombinant gene detections, c DNA Library preparation, Genome mapping, DNA Finger Printing and its applications. CO3. To study the genetic engineering in animals and its uses. CO4. To study the mutagenesis, its various types and detection method as well as Protein engineering CO5. To study the Genetic engineering in plants, strategies for gene transfer to plant cells and its applications. CO6. To study the plant viruses used as episomal expression vectors.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Molecular tools and applications- alkaline phosphatase restriction enzymes, polymerases, ligases. Gene Recombination and Gene transfer: Episomes, Transformation, Plasmids and other cloning vectors (artificial chromosomes, Bacteriophage-derived vectors), Electroporation, Microinjection and Ultrasonication. Reverse transcription Polymerase chain reaction (PCR) and Principle and applications of PCR. Ethical issues in cloning.	12
II	Restriction and modification system, restriction mapping. Northern, Southern and Western hybridization. Screening of recombinants, reverse transcription, DNA fingerprinting, Genome mapping, Expression libraries. Preparation and comparison of cDNA and Genomic library.	12
III	Genetic engineering in animals: Production and applications of transgenic mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, Applications of Genetic Engineering.	12

IV	Random and site-directed mutagenesis: Primer designing, Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples	12
V	Genetic engineering in plants: Use of <i>Agrobacterium tumefaciens</i> and <i>A. rhizogenes</i> , Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors, Case study reported in RDT.	12

Reference / Text Books:

1. Brown TA. (2020). Gene Cloning and DNA Analysis. 8th edition. Blackwell Publishing, Oxford, U.K.
2. Keya Chaudhuri. Recombinant DNA Technology 1st Edition 2012, The Energy and Resources Institute, TERI.
3. Glick, B.R., Pasternak, J.J. (2017). 5th Edition Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. B.D Singh Molecular Biology and Recombination DNA Technology 2019, Kalyani Publications.

If the course is available as Generic Elective then the students of following departments may opt it.
No

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: Knowledge of cell biology, genetics/ Certificate and diploma in Biotechnology.

Course Learning Outcomes:

CLO1: Student will be aware various tools, techniques for gene manipulations and its applications.
CLO2: Student will study the various methods for recombinant gene detections and its uses in genetic Engineering of organisms.
CLO3: Student will be aware the genetic engineering in animals, therapeutic products and its applications.
CLO4: Student will be aware mutagenesis, its types, detection method and applications
CLO5: Student will study the genetic engineering in plants, strategies for gene transfer to plant cells and its applications.
CLO6: Student will get the knowledge about the various plant viruses used as episomal expression vectors.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.

7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

Instructional Method and Pedagogy

PRACTICALS

BBTC-NP-352P: Recombinant DNA Technology Lab

Marks: 50

Duration: 60 hours (2 credits)

Course Objective:

1. Students will able to isolate DNA from plant cell as well as from bacterial cell.
2. They will develop their skills in learning various laboratory instruments like spectrophotometer, PCR etc.
3. Students will also achieve knowledge in plasmid isolation, Restriction Digestion etc.
4. They will able to develop their laboratory skills in various other techniques.
1. To study the isolation method of chromosomal DNA through plant cells
2. To study the chromosomal DNA isolation method from *E.coli*
3. To study the quantitative and Qualitative methods of DNA via spectrophotometer
4. To study the Plasmid DNA isolation method
5. To study the Restriction digestion of the DNA
6. To study construction of competent cells
7. To study the Transformation of the competent cells.
8. Demonstration of the PCR.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: III / Semester: V

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology		Year: III Semester: V
Credits: 6 Theory: 4 Practical: 2	Subject: Genomics and Proteomics	
Course Code: DSE-NP-353a	Title: Genomics and Proteomics	
Course Objectives: CO1. To study the sequencing methods different types and advantage of NGS, basics of the course. CO2. To study the Genome assembly and annotation, Trascriptome preparation, Gene annotation and gene prediction methods as well as mapping Pathway. CO3. To study the Gene cloning expression methods and Gene function technologies and its application CO4. To study the protein structure, sequencing, protein structure prediction and protein functions CO5. To study the Molecular phylogeny, Maximum likelihood methods, EST sequence. CO6. To study the Scoring and distance matrix and DNA bar-coding techniques		
Nature of Paper: DSE-5a		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Genome sequencing techniques (Sanger and Pyrosequencing methods), NGS sequencing techniques (Roche/454 FLX, Illumina Genome Analyzer, SOLiD™ sequencing, Ion Torrent™, Nanopore), NGS data quality Control methods, NGS data structure, Resources and repositories.	12
II	Genome assembly and annotation, Gene prediction methods, Comparative genomics, Trascriptome preparation and annotation, Transcriptome abundancy calculation and Pathway mapping.	10
III	Global Gene cloning expression platforms & technologies (Microarrays, cDNA-AFLP), Image segmentation, Normalization techniques and expression analysis, RT-PCR, SNP technologies: Platforms and analysis; Haplotyping: concepts and applications, Gene function technologies (Gene targeting, Gene silencing (RNAi).SNP Consortium.	14
IV	Proteomics: Protein-Protein interactions; Protein sequencing; Global analysis of protein modifications, Protein structure prediction (Homology, Ab initio and Threading), Protein arrays, Protein structure determination (X-ray and NMR), Protein biomarkers: Identification and utilization,	12

	Prediction of protein function.	
V	Molecular phylogeny (Phylogenetic tree and terminology, Methods of phylogenetic tree prediction: Maximum likelihood methods, Bootstrapping, Distance (UPGMA, NJ) Maximum parsimony), Types of DNA bands, DNA barcoding techniques, EST sequence and mining of simple repeats, Scoring and distance matrix,	12

Reference / Text Books:

1. Brown T. A. 2007, Genomes 3. Garland Science Publishing, New York. 2
2. Dunham, I., 2003. Genome Mapping and sequencing. Horizon Scientific
3. Graur, D and W H Li, 2000. Fundamentals of molecular evolution. Sinauer Associates.
4. Hartwell, L. H., L. Hood, M. L. Goldberg, A. E. Reynolds, L. M. Silver and R. G. Veres. 2004. Genetics from Genes to Genomes. McGraw Hill.
5. Lewin B. 2003. Genes VIII. Oxford University Press. Oxford.
6. The Human Genome 2001, Nature Vol. 409.
7. The Drosophila Genome. 2000, Science Vol. 267.
8. The Arabidopsis Genome 2000 Nature vol. 408.
9. Primrose, S. B., and R. M. Twyman 2006. Principles of gene manipulation and Genomics, Blackwell Publishing MA. USA.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	
4) Research Project Report Seminar On Research Project Report	4
5) ESE	75
Total:	100

Prerequisites for the course: Certificate in Biotechnology/Diploma in Biotechnology/ Knowledge of Gene, DNA, Protein etc.

Course Learning Outcomes:

- CLO1. Student will study the sequencing types and applications of NGS.
- CLO2. Student will learn about Genome annotation, Gene prediction methods, Transcriptome preparation and mapping.
- CLO3. Student will be aware Gene cloning expression methods and Gene function technologies and its applications
- CLO4. Student will study the protein structure, protein structure prediction and its functions
- CLO5. Student will be aware Molecular phylogeny, Maximum likelihood methods, Scoring and distance matrix and DNA barcoding techniques.
- CLO6. Student will get knowledge about the Scoring, DNA bar-coding and distance matrix techniques

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

DSE-NP-353aP: GENOMICS AND PROTEOMICS LAB

Marks: 50

Duration: 60 hours (2 credits)

1. To identify the different genes present in the genomic sequence.
2. To predict the protein secondary structure.
3. To write a blast program that translates protein query sequence into the nucleotide sequences.
4. To analysis of Human Genome through web based bioinformatics tools.
5. To isolation of DNA from Cheek cells.
6. To perform the Agarose gel Electrophoresis procedure.
7. To Retrieving information through biomolecular databases.
8. Retrieving information from the Entrezwith NCBI databases.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: III / Semester: V

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology	Year: III Semester: V	
Credits: 6 Theory: 4 Practical: 2	Subject: Animal Biotechnology	
Course Code: DSE-NP-353b	Title: Animal Biotechnology	
Course Objectives: CO1. To study the various types of gene transfer methods in Animals CO2. To study the introduction of transgenes in various Animals and diseases CO3. To study the Artificial insemination, Animal propagation, methods, clones conservation and Stem Cell Technology and its application. CO4. To study the Genetic modification in Medicine, gene therapy its types, molecular engineering, problems & ethics. CO5. To study the organ culture, artificial skin and hybridoma technology CO6. To study about the trioma & thymoma.		
Nature of Paper: DSE-5b		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Gene transfer methods in Animals – Microinjection, Calcium-phosphate precipitate, gene transfer, Gene transfer, Embryonic Stem cell& Retrovirus, various types of cultures.	10
II	Introduction to transgenesis. Transgenic Animals – Mice, Sheep, Cow, Goat, Bird and Pig, Animal diseases need help of Biotechnology – Theileriosis, Coccidiosis, Foot-and mouth disease, Trypanosomiasis.	15
III	Animal propagation – Animal Clones, Artificial insemination, Introduction to Stem Cell Technology and its applications. Conservation Biology – Embryo transfer techniques.	10
IV	Genetic modification in Medicine - gene therapy and its types, molecular engineering, vectors in gene therapy, problems & ethics, human genetic engineering, animal diseases therapy. Use of cytokine in therapy.	15
V	Introduction to organ culture, media for organ culture, hybridoma technology, artificial skin, brief concept of trioma & thymoma.	10
Reference / Text Books: 1. Brown, T.A. (1998). Molecular biology Lab fax II: Gene analysis. II Edition. Academic Press,		

California, USA.

- Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.
- Prof. P.K. Gupta Animal Biotechnology 2017, Rastogi Publications
- Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An introduction to genetic analysis. IX Edition. Freeman & Co., N.Y., USA.
- B.Singh Text book of Animal Biotechnology 2013, The Energy and Resources Institute, TERI

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	15
2) Presentations /Seminar/ Attendance	5
3) Assignments	5
4) Research Project Report Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: Certificate in Biotechnology/Diploma in Biotechnology

Course Learning Outcomes:

CLO1: Student will study the various types of gene transfer methods in Animals.

CLO2: Student will be aware for transgenic Animals and diseases.

CLO3: Student will study the Animal propagation methods and stem Cell Technology.

CLO4: Student will be aware for genetic modification in Medicine, gene therapy and molecular engineering.

CLO5: Student will study the Organ culture its media, artificial skin and hybridoma technology.

CLO6: Students will understand about the trioma and thymoma.

Instructional Method and Pedagogy

- Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
- Various teaching aids are used for smooth conduction of Lectures.
- 75% attendance in academic sessions is mandatory.
- Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
- PPT presentation method is also incorporated in teaching.
- Case-study based learning will also be used.
- Promotion of Ex-situ and In-situ learning.
- Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
- Identification of slow and fast learners also done during the course commencement.
- For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
- For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

DSE-NP-353bP: Animal Biotechnology Lab

Marks: 50

Duration: 60 hours (2 credits)

- Packing and sterilization of glass and plastic wares for cell culture.
- Study of effect of toxic chemicals on cultured mammalian cells.
- Isolation and analysis of DNA from minimal available biological samples

4. Preparation of minimal essential growth medium
5. Isolation of lymphocytes for culturing
6. Quantification of isolated DNA.
7. Resolving DNA on Agarose Gel.
8. To analyses the DNA finger printing data.
9. Study of effect of virus on mammalian cells.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION
Year: III / Semester: VI

Programme: Biotechnology Certificate/Diploma/Degree/UG(R) Class: B. Sc. Biotechnology	Year: III Semester: VI	
Credits: 6 Theory: 4 Practical: 2	Subject: Industrial Biotechnology and Down Stream Processing	
Course Code: BBTC-NP-361	Title: Industrial Biotechnology and Down Stream Processing	
Course Objectives: CO1. To study about the history of industrial biotechnology, basic of fermentation, microbial strain improvement and different types of bioreactors CO2. To get the understanding of SCP, wine, beer and vinegar; bio-preservatives cheese, vitamins production from microbes. CO3. To learn about Cell disruption and Removal of insoluble biomass and cell debris methods. CO4. To get knowledge about Purification by Precipitation Methods with salts - organic solvents. CO5. To aware students about unit operation procedures of production. CO6. To aware students about cost-effective downstream processing and provide industry efficient technology.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to industrial biotechnology, history, basic of fermentation, Improvement of microbial strain, Different type of bioreactors and mode of operation, Industrial Biotechnology requirement for set-up operational plants.	10
II	Production of SCP, microbial production of wine, beer and vinegar; bio preservatives (Nisin), cheese, vitamins; ethanol, acetone, butanol, citric acid, dextran and amino acids, Production of industrial enzymes such as proteases, amylases, lipases. Applications of bioconversion, transformation of steroids and sterols.	15
III	Cell disruption methods: Physical, chemical and mechanical. Removal of insoluble biomass and cell debris methods: flocculation - sedimentation-centrifugation and filtration methods.	10
IV	Purification by Precipitation Methods of precipitation with salts - organic solvents. Polymers - Membrane based separations: Micro and ultra-filtration – theory, principle, design and configuration of membrane	10

	separation equipments and its applications.	
V	Basic principles of Chromatographic separations -gel filtration, ion-exchange- affinity- reverse phase and hydrophobic interaction chromatography-Electrophoretic separation techniques Crystallization: Principles, Drying: Principles and equipments' rotary dryer-Freezer dryer-Spray dryer.	15
Reference / Text Books:		
1. Ladisch. M. R, "Bioseparation Engineering: Principles, Practice and Economics", John Wiley & sons, New York. 2001. 2. Bailey & Ollis, Biochemical Engg. Fundamentals, McGraw-Hill 1990. 3. Keith Wilson and John Walker, Practical Biochemistry—Principles and Techniques, Cambridge, 5th Ed. 2000. 4. C. Vogel and C.L. Tadaro, Fermentation and Biochemical Engineering Handbook: Principles, Process, Design and Equipment, Noyes Publications 1996. 5. Malden MA: Industrial Microbiology: An introduction; Blackwell Science 2001.		
If the course is available as Generic Elective then the students of following departments may opt it. NO		
Evaluation/Assessment Methodology		
		Max. Marks
1) Class tasks/ Sessional Examination		16
2) Presentations /Seminar/Attendance		5
3) Assignments		4
4) Research Project Report Seminar On Research Project Report		
5) ESE		75
Total:		100
Prerequisites for the course: Certificate and diploma in Biotechnology/knowledge of biochemistry, microbiology, analytical tools in biotechnology and Bioprocess technology		
Course Learning Outcomes:		
CLO1: Students will learn about the history of industrial biotechnology, basic of fermentation, how to improve microbial strain.		
CLO2: Students will get the knowledge of SCP, wine, beer and vinegar; bio-preservatives (Nisin), cheese, vitamins production from microbes.		
CLO3: Student will learn about Cell disruption and Removal of insoluble biomass and cell debris methods.		
CLO4: Students will get knowledge about Purification by Precipitation Methods with salts - organic solvents.		
CLO5: Student will be able to understand about unit operation procedures of production.		
CLO6: Students aware about cost-effective downstream processing and provide industry efficient technology.		
Instructional Method and Pedagogy		
1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course. 2. Various teaching aids are used for smooth conduction of Lectures. 3. 75% attendance in academic sessions is mandatory. 4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics. 5. PPT presentation method is also incorporated in teaching. 6. Case-study based learning will also be used.		

7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

BBTC-NP-361P: INDUSTRIAL BIOTECHNOLOGY AND DOWN STREAM PROCESSING LAB

Marks: 50

Duration: 60 hours (2 credits)

1. Mechanical separation: Centrifugation
2. Membrane based separation
3. Product preservative methods -chemical, physical and natural
4. Protein precipitation and its separation: Ultra filtration and Adsorption
5. Chromatography: Charge and size based separation
6. Production of Citric acid using *Aspergillus* species
7. Specific activity determination of amylase.
8. Purification of Enzyme by salt ammonium sulphate fractionation.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION
Year: III / Semester: VI

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology		Year: III Semester: VI
Credits: 6 Theory: 4 Practical: 2	Subject: Intellectual Property Rights, Bioethics and Biohazard Management	
Course Code: BBTC-NP-362	Title: Intellectual Property Rights, Bioethics and Biohazard Management	
Course Objectives: This course meets the local to global requirements in terms of protection of intellectual property. It provides the way to file the patent, to protect GI at local level. This subject also deals with the ethical issues of biotechnological inventions and also provides the sustainable framework. Biohazard management part of this subject meets the industry requirement and provides the legislative framework to environment protection also follow the policies and standards of national bodies like CPCB, SPCB and international bodies like EPA, WHO etc. CO1. To study the introduction on Intellectual Property, Patents, GI its protection, Remedies Licensing and its types. CO2. To study the International Scenario of intellectual property rights and Indian Patent Act. CO3. To study the Patents, Requirement of patentable novelty, Procedure for applying for patent and Biological Patentability. CO4. To study the Biosafety, Good Lab Practices, Biosafety Levels GMOs, their environmental impact and agriculture Risk analysis. CO5. To study the IPR in Biotechnology, Bioethical issues and agriculture genetic engineering. CO6. To study Biohazard management deals with the procedure to manage hazards from industries, hospitals, radioactive units etc.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Intellectual Property: Concept of intellectual property, kinds of intellectual property patents, Copyrights, design, Trademarks, Geographical Indication, Infringement of IPR, Its protection and Remedies Licensing and its types.	10
II	International Scenario: Introduction to the leading international instruments concerning intellectual property rights, The Berne Convention GATT, WTO, Indian Patent Act, Universal Copyright Convention.	14

	The Paris Convention TRIPS, The World Intellectual Property Rights Organization (WIPO)	
III	Patents: Requirement of patentable novelty, Inventive step, Prior art Classifying products as patentable and non-patentable, Procedure for applying for patent, Patent Infringement and related case studies Biological Patentability	12
IV	Biosafety: Good Lab Practices, Introduction to Biological Safety Cabinets, Primary Containment for Biohazards Biosafety Levels GMOs and their environmental impact, Roles of Institutional Biosafety Committee, RCGM, GEAC etc. For GMO applications in food and agriculture Risk analysis, assessment and management.	12
V	IPR and Biotechnology: Biopiracy and Bioprospecting Farmers Rights and Plant breeders rights Biodiversity Bioethics: Bioethical issues related to healthcare and medicine, food and agriculture genetic engineering	12

Reference / Text Books:

1. Indian Patent Law and Practice, Kalyan C. Kankanala, Arun K. Narasani, Vinita Radhakrishnan, Oxford University Press, 2010
2. Patent Law in India, Medury Bhaskara Rao, Manjula Guru, Kluwer Law International, 2010.
3. Intellectual Property Laws (Acts, Rules & Regulations) (Latest Bare Act) Universal Law Publishing Co. , Edition : Latest Bare Act, ISBN : 9788175349308,
4. PATENTS for Chemicals, Pharmaceuticals and Biotechnology - Fundamentals of Global Law, Practice and Strategy, Author : Philip W. Grubb & Peter R. Thomsen , 5th edition, 2010, Media: Hard Back, ISBN : 9780199575237,
5. Law Relating to Intellectual Property (in 3 Vols.) Author: Dr. Raghbir Singh (V-Chairman, Intellectual property Appellate Board) ,Edition : 3rd edition, 2014, ISBN : 9789350354247,
6. Protection of Plant Varieties and Farmers' Rights Act, 2001 & Rules, 2003 & Regulations, 2006 (Latest Bare Act), Author : Private Publication, Edition : Latest Bare Act ,
7. Bioethics and Biosafety, Author : Prof. Ramamurthi Rallapalli & Prof. Geetha Bali, Edition : 2007 ,ISBN : 9788131302651
8. Bioethics and Biosafety, Author: M.K. Sateesh ,Edition : 2008, Media : Paper Back ISBN : 9788190675703

If the course is available as Generic Elective then the students of following departments may opt it.NO

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: Diploma certificate in Life Science/ Biotechnology/Microbiology

Course Learning Outcomes:

CLO1: Student will study the introduction on **Intellectual Property, Trademarks**, Geographical Indication and Infringement of IPR.

CLO2: Student wills aware the **Berne Convention GATT, WTO, Indian Patent Act and Paris Convention TRIPS**.

CLO3: Student will study the requirement of patentable novelty, Inventive step and Procedure for applying for patent.

CLO4: Student will aware the **Biohazards Biosafety Levels GMOs, their environmental impact, Biosafety Committee and applications in food and agriculture Risk analysis.**

CLO5: Student will aware the **IPR in Biotechnology, Plant breeders rights Biodiversity and Bioethics** in healthcare, food and agriculture genetic engineering.

CLO6: The overall course content meets the industry requirement and provides the legislative framework to IPR protection also follow the policies and standards of national bodies like CPCB, SPCB and international bodies like EPA, WHO, **WIPO** etc.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

BBTC-NP-362P: Intellectual Property Rights, Bioethics and Biohazard Management Lab

Marks: 50

Duration: 60 hours (2 credits)

1. To acquire specialized knowledge of law and practice relating to Insurance.
2. Demonstration of Law and Policy of patents and its Consideration essentials of Patentability.
3. Modus operandi for Patent Filing Application and its types.
4. Methods of Invention Disclosures.
5. Procedure for Registration of Trademarks.
6. Case study on Biosafety laboratory risk assessment
7. Demonstration of methods of filing patent and IPR.
8. Demonstration of methods of filing GI.
9. Case study on human cloning/animal cloning with bioethics viewpoint.
10. A case study on clinical trials of drugs in India with emphasis on ethical issues.
11. Case study on biohazard management from radioactive/hospital site.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION
Year: III / Semester: VI

Programme: Biotechnology Certificate/Diploma/Degree/UG(R) Class: B.Sc. Biotechnology	Year: III Semester: VI	
Credits: 6 Theory: 4 Practical: 2	Subject: Green Biotechnology and Pollution Control	
Course Code:DSE-NP-363a	Title: Green Biotechnology and Pollution Control	
Course Objectives: It meets the global requirements in terms of solving various issues of environment. This subject based on environment adaptation and resilient framework. It works to formulate the policy of environment. CO1: Students will gain knowledge about how to maintain the environment, waste-water treatment. CO2: They will also gain the knowledge to use biotechnology for waste management, bioremediation. CO3: Students will gain knowledge about Bioremediation, Bioremediation and phytoremediation CO4: Understand the green conversion of biomass and useful product production. CO5: Understand the environmental rules and legislations. CO6: Overall objective of the course is to aware students regarding remediation or solution procedures through various case studies in the field of green biotechnology.		
Nature of Paper: DSE-6a		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Biological Waste Treatment: Biological wastewater treatment, Principles and design aspects of various waste-water treatment methods with advanced bioreactor configuration: Solid waste management: landfills, recycling and processing of organic residues, Role of Bio nanotechnology in management of environmental pollution and wastewater treatment, Minimal national standards for waste disposal, Functioning of CPCB.	12
II	Biodegradation of Xenobiotic Compounds: Xenobiotic compounds–Definition, examples and sources. Factors affecting biodegradation, microbial assisted degradation of hydrocarbons.	12
III	Bioremediation, Bio restoration and phytoremediation: Introduction and types. Restoration of coal mines a case study. Bio restoration: reforestation through micro propagation, use of <i>mycorrhizae</i> in reforestation, use of microbes for improving soil fertility, reforestation of soils contaminated with heavy metals, Bio transformations.	12

IV	Eco-Friendly Bioproducts from Renewable Sources: Bioinspired material, Fundamentals of composting process: scientific aspects and prospects of green energy; bio fertilizers and bio pesticides. Biotechnology in Environment Protection: Current-status of biotechnology in environment protection and its future.	12
V	Case studies on water/soil/sediment contamination and remediation by excavation and disposal, Case study: polluted river near NCR regions, Sustainability and Life Cycle Analysis of biotechnological solutions or processes.	12

Reference / Text Books:

1. Bio nanotechnology towards Green Energy: Innovative and Sustainable Approach by Shubha Dwivedi and Naveen Dwivedi CRC Press 2023.
2. Bio nanotechnology towards Sustainable Management of Environmental Pollution by Naveen Dwivedi and Shubha Dwivedi, CRC Press 2022.
3. Naveen Dwivedi, Shubha Dwivedi and Maulin P Shah. “Integrated biotechnological solutions for the treatment of industrial wastewater for a healthy and sustainable environment” (Edited book, Publisher: Elsevier).
4. Charles Oluwaseun Adetunji, Julius Kola Oloke, Naveen Dwivedi, Sabeela Beevi Ummalyma, Shubha Dwivedi and Daniel Ingo Heff. “Next-Generation Algae, Volume 1: Applications in Agriculture, Food and Environment” (Publisher: Wiley–Scrivener, ISBN: 9781119857273, 2023).
5. Role of biotechnology for global strides in just transitions and innovation ecosystem by Shubha Dwivedi, Navneet Sharma and Deepa Sharma, Bluerose publishers, 2023. (ISBN: 978-93-5819-020-5)
6. Phytoremediation: novel approaches and sustainable solutions for environmental cleanup by Deepa Sharma and Shubha Dwivedi, Bluerose publishers, 2023. (ISBN: 978-93-5819-002-1)
7. Environmental Processes I-III, J. Winter, 2nd ed., Wiley Publications
8. Introduction to Wastewater Treatment- R. S. Ramalho, Academic Press.
9. Elements of Water Pollution Control Engineering – O.P. Gupta, Khanna books.
10. Energy Technology – O.P. Gupta, Khanna books, 2018.
11. Environmental Biotechnology, B.C. Bhattacharya & Ritu Banerjee, Oxford Press, 2007.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	
3) Assignments	5
4) Research Project Report	
Seminar On Research Project Report	4
5) ESE	75
Total:	100

Prerequisites for the course: To enter in the course students must aware with the basic of environmental science, environmental biotechnology and Industrial biotechnology

Course Learning Outcomes: After completion of the course students will able to:

CLO1. The first outcome of the course content aims to make the student comprehend towards biotechnology and can help in monitoring or removing the pollutants from water and, help in understanding the basic framework and working of CPCB and provide the standards to meet the waste disposal. Course also provides the sustainable management of wastewater treatment methods and solid waste disposal techniques.

CLO2. To aware students about the bio-degradation of hydrocarbons and xenobiotic compounds.

CLO3. Student comes up with the advance knowledge about various bioremediation, biotransformation and phytoremediation techniques for converting harmful waste into less harmful waste and its disposal.

CLO4. Understand about ecofriendly production, generation of various forms of bioenergy from renewable resources.

CLO5. Know about role of biotechnology in environment protection; also specify the role of genetically engineered species in environment protection.

CLO6. The course deals with the various biotechnological solutions to protect environment from destructions, students come up with the detail understanding of the subject in practical way by doing analysis of various case studies.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

DSE-NP-363aP: Green Biotechnology and Pollution Control Lab

Marks: 50

Duration: 60 hours (2 credits)

1. Analysis of presence of microorganism in water.
2. Determination of chloride in known wastewater sample.
3. Production of bioproducts.
4. To determine the Dissolved Solid content of waste water.
5. To determine the BOD of given water sample.
6. To determine the COD of given water sample.
7. Case study on polluted river near NCR regions.
8. Model development of MFC.
9. Case study on EIA audit of any Biotechnology industry.
10. Model development: Waste to energy.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL			
Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

**IIMTU-NEP IMPLEMENTATION
Year III /Semester VI**

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc.		Year: III Semester: VI
Credits: 6 Theory: 4 Practical: 2		Subject: Biosensors and Drug Design
Course Code: DSE-NP-363b		Title: Biosensors and Drug Design
Course Objectives: CO1. To learn about role of enzyme in biosensor. CO2. To study about basic concept of biosensor preparation. CO3. To study about different sources of drug designing. CO4. To study about enzyme kinetics and its role in drug designing. CO5. To study about rational drug designing. CO6. To aware students about new biotherapeutics, application of biosensors in Environment, health, energy production, wastewater treatment.		
Nature of Paper: DSE-6b		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P:(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical-		
Unit	Contents	No. of Lectures Allotted
I	Introduction of Biosensor, Components of biosensor, Different types of analytes, Structure and Function of Transducers, Function of amplifiers and detection methods, nanostructured biosensor, Assembly and production of a nanobiosensor, Amperometric Biosensors, Potentiometric Biosensors, Optical Biosensors	12
II	Immobilization of the Receptor Component in Biosensors, Methods of Immobilization: Adsorption, Gel Entrapment, Covalent Coupling, Crosslinking. Characterization of Immobilized Enzymes in Biosensors. Glucose Sensors, Affinity biosensor, Determination of Ascorbic Acid, Determination of Acetylcholine.	12
III	Introduction to The Drug Discovery/Development: Source of Drugs, Structural effects on drug action, drug metabolism, toxicity and pharmacokinetics, Methods involved in the development of new drugs, Acute, subacute and chronic toxicity studies, Therapeutic index, Ethical guidelines in utilizing animals for experimental purposes	12
IV	Approaches to New Drug Discovery: Drugs Derived from Natural Products, Existing Drugs as a Source for New Drug Discovery, Screening for New	12

	Drug Leads, Modern “Rational Approach” to Drug Design, Approaches to Lead Optimization, Drugs and Cosmetics Act, Application for Investigational New Drug (IND), Indian Control Authority & USFDA guidelines	
V	Concepts of Bio availability, Process of drug absorption, Drug delivery considerations for the new biotherapeutics, application of biosensors in Environment, health, energy production, wastewater treatment	12

Reference / Text Books:

- Copper J. M. and Cass E. G. A., “Biosensors”, Oxford University Press, 2004.
- Brian Eggins, “Chemical Sensors and Biosensors”, John Willey & Sons, 2002.
- Copper J. M. and Cass E. G. A., “Biosensors”, Oxford University Press, 2004.
- Blum L. J. and Coulet P. R., “Biosensor Principles and Applications”, Marcel Dekker Inc., 1991.
- Kerns, E.H.; Di, L. Drug-Like Properties: Concepts, Structure Design and Methods: from ADME to Toxicity Optimization, Academic Press, Oxford, 2008.
- Principles of Medicinal Chemistry, 7th Edition, edited by T.L. Lemke, D. A. Williams, V. F. Roche, and S.W. Zito, Williams and Wilkins: Philadelphia, 2013.

If the course is available as Generic Elective then the students of following departments may opt it.
No

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	5
3) Assignments	
4) Research Project Report Seminar On Research Project Report	4
5) ESE	75
Total:	100

Prerequisites for the course: Knowledge of protein, enzyme, and cell functions are required.

Course Learning Outcomes:

CLO1: Student will learn about role of enzyme in biosensor.
CLO2: Student will get knowledge about basic concept of biosensor preparation.
CLO3: Student will learn about different sources of drug designing.
CLO4: Student will get knowledge about enzyme kinetics and its role in drug designing.
CLO5: Student will get knowledge about rational drug designing.
CLO6: Student will get knowledge about new biotherapeutics, application of biosensors in Environment, health, energy production, wastewater treatment.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial

classes for their improvement in academics.

11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

DSE-NP-363b: BIOSENSORS AND DRUG DESIGN LAB

Marks: 50

Duration: 60 hours (2 credits)

Course Objectives:

This course provides basic knowledge of biosensor and insight of the principles to fabricate biosensors for analytical detection purpose. The significance of the course also defines different types of biosensors, their designing and evaluating performance for clinical and biomedical applications.

List of Experiments:

1. Construction of glucose biosensor
2. Preparation of bionanosensor
3. Measurement pH using pH meter
4. To Measure blood pressure using Sphygmomanometer and compare with digital blood pressure meter
5. Characterization of purified protein using enzymatic activity.
6. A case study on ethical issues related with clinical trials of drugs in India.
7. Enzyme purification by different methods
8. Production of commercially important enzymes biosensors

Course Outcomes: After completion students obtain

1. Knowledge in the field of biosensor technology.
2. Awareness in the area of drug design and delivery
3. Innovation, idea to developed biosensors
4. Knowledge of applications of biosensors and drug design in different fields
5. Gain knowledge to learn about protein purification.
6. Attain understanding related with ethical issues and clinical trials of drugs in India.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme:Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology	Year: I Semester:II	
Credits: 6 Theory: 4 Practical: 2	Subject: Biochemistry and Metabolism	
Course Code:BBTC-NP-121	Title: Biochemistry and Metabolism	
Course Objectives: CO1. To study about the different biomolecules present in cellular environment and role of water in their design CO2. To be aware of the structure and biological function of carbohydrate and protein. CO3. To study the structure and function of lipid and nucleic acid. CO4. To understand the role of enzymes, cofactors and coenzymes. CO5. To learn about carbohydrates and fatty acids Metabolism. CO6. The overall objective of the course to provide basic foundation of Biotechnology and impart knowledge of biomolecules and its significance in human physiology.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T:0 P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Biomolecules and Importance of buffer: Major classes of biomolecules, Water - Structure, non-covalent interactions, unusual properties, role in biological processes. Ionization of Water, Weak Acids, and Weak Bases,pH scale. Buffers and buffering mechanism, Henderson Hasselbalch equation. Bicarbonate buffer and Hemoglobin Buffer System.	10
II	Amino acids & Proteins: Structure and unique properties of Amino acids. Forces responsible for stabilizing protein structure and shape, Proteins and their classification. Denaturation and renaturation of proteins. Fibrous and globular proteins. Different Level of structural organization of proteins, Protein Purification. Carbohydrates: Monosaccharides, Disaccharides and Polysaccharides (Structure, Function and properties) Homo & Hetero Polysaccharides, Mucopolysaccharides, Glycoprotein's and their biological functions, Bacterial cell wall polysaccharides.	15

III	Lipids: Introduction to lipid, fatty acid and glycerol. Example of essential fatty acids. Glycolipids, Phospholipids, Cholesterol, sphingolipids, Prostaglandins. Structure, functions, Classification, nomenclature and properties of fatty acids. Nucleic acids: Physical, chemical properties, Structure and functions of Nucleic acids, purines & pyrimidines, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, Nucleosides & Nucleotides, Biologically important nucleotides,.	15
IV	Nomenclature and classification of Enzymes: Introduction of Enzymology: Holoenzyme, Cofactors, coenzyme, apoenzyme, prosthetic groups, metalloenzymes, activation energy and transition state, monomeric & oligomeric enzymes, common features of active sites, enzyme activity, specific activity, Enzyme specificity: types & theories. Role of: NAD⁺, FMN/FAD, NADP⁺, coenzymes A, Pyridoxal phosphate, Tetrahydrofolate, Thiamine pyrophosphate, Biotin vitamin B12, and metallic ions.	10
V	Carbohydrate metabolism: Glycolysis (Reactions, energetics and regulation), Pentose phosphate pathway, Gluconeogenesis, Fate of pyruvate under aerobic and anaerobic conditions, glycogen synthesis, Glycogenolysis, Electron Transport Chain, TCA cycle, inborn error of metabolism, PPP. Metabolism of fatty acids-oxidation of saturated, unsaturated fatty acids Oxidation of amino acids and importance of urea cycle.	10

Reference / Text Books:

1. Tortora, G.J., Funke, B.R and Case, C.L. Microbiology: An Introduction. Pearson Education, Singapore, (2004).
2. Stanbury, Biochemistry.
3. Voet. Fundamentals of biochemistry Wiley.
4. M.M. Cox, D. L. Nelson. Lehninger's principles of biochemistry. W H Freeman.
5. Stryer. Biochemistry W H Freeman.
6. Lehninger, Biochemistry

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	
4) Research Project Report Seminar On Research Project Report	4
5) ESE	75
Total:	100

Prerequisites for the course: Intermediate knowledge

Course Learning Outcomes:

CLO1: Student will learn about the different biomolecules present in cellular environment and role of

water in their design
CLO2: Student will be aware of the structure and function of carbohydrate and protein.
CLO3: Student will learn the structure and function of lipid and nucleic acid.
CLO4: Student will understand the role of enzymes, cofactors and coenzymes.
CLO5: Student will be capable to understand the metabolism of various biomolecules.
CLO6: Students will aware about the basic foundation of Biotechnology and that impart information of biomolecules and its significance in human physiology.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics. .
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

BBTC-NP-121: BIOCHEMISTRY AND METABOLISM LAB

Marks: 50

Duration: 60 hours (2 credits)

1. To study activity of enzyme (salivary amylase) under optimum conditions.
2. To study the effect of temperature, pH on the activity of salivary amylase enzyme.
3. Determination, K_m value, V_{max} value.
4. Estimation of blood glucose by glucose oxidase method.
5. Principles of Colorimetry: (i) Verification of Beer's law, estimation of protein. (ii) To study relation between absorbance and % transmission.
6. Preparation of buffers.
7. Separation of Amino acids by paper chromatography.
8. Qualitative tests for Carbohydrates, lipids and proteins.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION
Year I /Semester II

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology	Year: I Semester: II	
Credits: 6 Theory: 4 Practical: 2	Subject: Plant Tissue Culture & Application	
Course Code: BBTC-NP-124	Title: Plant Tissue Culture & Application	
Course Objectives: CO1. To study the plant tissue culture, scope and its applicationsas well as media preparation. CO2. To study the importance and basic applications of micropopagation, Meristem, shoot tip culture and organ culture and its advantages, Organogenesis and its applications. CO3. To study the significance and applications of haploid plant culture. CO4. To study the protoplast isolation, Applications and Limitations of somatic hybridization. CO5. To study the elicitations, Biotransformation, production of disease free plants, cryopreservation CO6. To study about Production of Industrial phytochemicals and plant growth promotion through free-living bacteria.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Historical aspects in PTC, organization of PTC laboratory, study of basic instruments such as pH meter, laminar flow hood working principal, centrifugation, washing of glassware and various sterilization techniques, <i>In-Vitro</i> culture techniques, scopes and applications in India,	12
II	PTC Media, Types, its basic components, functions of Micro Macro and growth regulators, Important steps involved in PTC media preparations.	12
III	Micropropagation, Stages, Types, Applications, Benefits & Limitations of Tissue Culture, callus culture, suspension and its types, and protoplast culture, another culture, Organ culture including Meristems and Shoot tips, and Embryo culture. haploid plant culture	12
IV	General introduction of Protoplast isolation and culture, Development and applications of protoplast isolation and culture, Significance and application of Somaclonal hybridization, Advantages and disadvantages of somatic hybridization. Identification and differentiation between hybrid and Cybrids,	12

V	Production of Industrial phytochemicals in vitro, steps extractions, elicitation, Biotransformation, production of disease free plants, cryopreservation, Shikonin, Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria.	12
Reference / Text Books: 1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice. 2. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press. 3. Plant Biotechnology: B.D. Singh, Kalyani Publishers (2014) 4. Plant Tissue Culture: An Introductory Text by Sant Saran Bhojwani, Prem Kumar Dantu (2013).		
If the course is available as Generic Elective then the students of following departments may opt it. NO		
Evaluation/Assessment Methodology		
		Max. Marks
1) Class tasks/ Sessional Examination		16
2) Presentations /Seminar /Attendance		5
3) Assignments		4
4) Research Project Report Seminar On Research Project Report		
5) ESE		75
Total:		100
Prerequisites for the course: Basic knowledge of plant cell and its functions		
Course Learning Outcomes: CLO1: Student will study the plant tissue culture its type, media, scopes and applications. CLO2: Student will aware the micro propagation, shoot tip and organ culture. CLO3: Student will be aware for haploid plant productions and its applications. CLO4: Student will study somatic hybridization and its applications. CLO5: Student will study the elicitation, Biotransformation, production of disease free plants, cryopreservation. CLO6: Student will get knowledge about the Production of Industrial phytochemicals and plant growth promotion through free-living bacteria. Bio control of pathogens and plant growth promotion via free-living bacteria.		
Instructional Method and Pedagogy 1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course. 2. Various teaching aids are used for smooth conduction of Lectures. 3. 75% attendance in academic sessions is mandatory. 4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics. 5. PPT presentation method is also incorporated in teaching. 6. Case-study based learning will also be used. 7. Promotion of Ex-situ and In-situ learning. 8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc. 9. Identification of slow and fast learners also done during the course commencement. 10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics. .		

11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

BBTC-NP-124P: Plant Tissue Culture & Application

Marks: 40

Duration: 60 hours (2 credits)

1. To set up a plant tissue culture laboratory.
2. To prepare basic complex nutrient medium for plant tissue culture.
3. To study the selection, sterilize and preparation of an explants for tissue culture.
4. To studies the shoot tip culture
5. To demonstrate various steps of Micropropagation.
6. To perform the Callus induction.
7. To studies the isolation of protoplast from plants.
8. To perform the cell suspension culture

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION
Year: I /Semester: II

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology		Year: I Semester: II
Credits: 6 Theory: 4 Practical: 2		Subject: Immunology
Course Code: DSE-NP-123a		Title: Immunology
Course Objectives: CO1. To study the immune response, T and B lymphocyte and its structure and functions. CO2. To study the regulation of immunoglobulin gene expression, diversity and its functions. CO3. To study the Major Histocompatibility its types, B-cell and T-cell receptors and somatic recombination CO4. To study the Immunity to infection of various organisms, pathogen defense strategies, Immunodeficiency disease and autoimmune diseases. CO5. To study the vaccines, its types and immunodiagnostics methods. CO6. To study various case studies in the field of immunology.		
Nature of Paper: DSE-2a		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to immune system- An overview, components of mammalian immune system, innate and acquired immunity, Humoral& Cellular immune responses, lymphocytes, active and passive immunity, primary and secondary immune response and immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells)	14
II	Immunoglobulin gene, expression of antigen, antibody diversity, epitope, paratope, adjuvant, allotypes&idiotypes, allelic exclusion, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation)	12
III	Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing, genetic basis of B-cell and T-cell maturation, T-cell receptors, assembly of T-cell receptor genes, B-cell receptors, assembly of B-cell receptor genes by somatic recombination.	10
IV	Immunity against different organisms, pathogen defense mechanism, evasion of recognition. Autoimmune diseases, Immunodeficiency-AIDS,	12

	various types of allergy, hypersensitivity,	
V	Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA, case study on Corona virus vaccines, its effectiveness, symptoms.	12

Reference / Text Books:

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007).
4. Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
5. Murphy K, Travers P, Walport M. (2008).
6. Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
7. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinburgh.
8. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: Intermediate Pass

Course Learning Outcomes:

- CLO1 Student will study the types of lymphocytes, and its structure and functions
CLO2 Student will be aware for immunoglobulin gene expression, diversity and its functions.
CLO3 Student will be aware for Major Histocompatibility and T-cell and B-cell receptors.
CLO4 Student will study the infection of different organisms, pathogen defense strategies and Immunodeficiency disease.
CLO5 Student will be aware for vaccines, its types and different immunodiagnostics methods.
CLO6: Student will gain knowledge about the various case studies in the field of immunology.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.

7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics. .
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS
DSE-NP-123aP: IMMUNOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

1. To study the differential leucocytes count
2. To study the total leucocytes count of sample
3. To study the total RBC count
4. To study the Haemagglutination assay method.
5. To study the Haemagglutination inhibition assay method.
6. To study the separation of serum through blood sample
7. To study the double immunodiffusion test through specific antigen and antibody.
8. Detection of antigen using ELISA.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) Class: B.Sc. Biotechnology		Year: I Semester: II
Credits: 6 Theory: 4 Practical: 2		Subject: Molecular Diagnostics
Course Code: DSE-NP-123b		Title: Molecular Diagnostics
Course Objectives: CO1. To learn about Enzyme Immunoassays. CO2. To study about heterogeneous and homogenous enzyme assay. CO3. To study about microbial susceptibility test. CO4. To study about automation procedure in molecular diagnostic field. CO5. To study about HPLC, Electron microscopy, flowcytometry. CO6. The overall course content aware students about the different advanced tools and techniques in the fields of Biotechnology and make them skilled, trained and technology friendly.		
Nature of Paper: DSE-2b		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P: 2 (In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Enzyme Immunoassays: Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immune-histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays. Applications of enzyme immunoassays in diagnostic microbiology.	14
II	Molecular methods in clinical microbiology: Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology Laboratory tests in chemotherapy:	12
III	Automated procedures for antimicrobial susceptibility tests. Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Diffusion test procedures. Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.	11

IV	Concepts and methods in idiotypes. Anti-idiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.	12
V	GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals, Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies.	11

Reference / Text Books:

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
2. Bioinstrumentation, Webster
3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe, Kluwer Academic
4. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.
5. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: Basic of intermediate level

Course Learning Outcomes:

CLO1: Students will study about Enzyme Immunoassays.
CLO2: Students will understand about heterogeneous and homogenous enzyme assay.
CLO3: Students will be aware about microbial susceptibility test.
CLO4: Students will learn about automation procedure in molecular diagnostic field.
CLO5: Students will learn about HPLC, Electron microscopy, flow-cytometry.
CLO6: Student will get knowledge about the various advanced tools and techniques in the fields of Biotechnology and make them skilled.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.

9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics. .
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

DSE-NP-123b: Molecular Diagnostics Lab

Marks: 50

Duration: 60 hours (2 credits)

1. To study about ELISA test for a given sample.
2. To study about micro-dilution broth procedure *for E.coli* sample.
3. To perform micro-dilution broth procedure for given microbial sample.
4. To study microbial activity using Disc diffusion method.
5. To isolate DNA using agarose gel electrophoresis.
6. Purification of protein using SDS PAGE.
7. Demonstration of HPLC.
8. To study about basic principle of electron microscopy.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION
Year I/ Semester II

Programme:Biotechnology Certificate/Diploma/Degree/ UG Class:B.Sc. Biotechnology	Year: I Semester: II	
Credits: 6 Theory: 4 Practical: 0	Subject: Entrepreneurship Development	
Course Code:BBTGE-NP-124	Title:Entrepreneurship Development	
Course Objectives: This course aims at teaching and theskills of converting basic biotechnology understanding into sustainable and eco-friendly business by giving new solutions to the presented challenges in the biotechnology field and by providing good alternatives to the existing approach.The syllabus fulfills the requirement of SDG 8 and SDG 9. CO 1 The course content aims to construct the student understand about entrepreneur and entrepreneurships. CO 2 To get the knowledge about developing a new skills in entrepreneurship field also about women entrepreneurship. CO 3 To study the development of various new technological advancements as bio entrepreneur, bio-economy and various organization of ED and their roles CO 4 To study about various lucrative fields of entrepreneurships viz Bio entrepreneurship, green entrepreneurship, aids to attain SDG. CO 5 To understand the working of technology incubators and startup firms. CO 6 To aware students about proposal writing, project writing, drafting of grant for skill enhancement etc.		
Nature of Paper: GE-1		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 Theory - 1 Hr. = 1 Credit		
Unit	Contents	No. of Lectures Allotted
I	Introduction, Concept of Entrepreneur, Entrepreneurship and Enterprise, Definition of Entrepreneurship, Objectives of Entrepreneurship Development, Phases of Entrepreneurship Development, Role of Entrepreneurship, The Entrepreneurial Mindset (Route of knowing yourself, SWOT analysis), Time management, stress management, Characteristics of Entrepreneurship, Traits of Entrepreneurship, Introduction to Entrepreneurship Skills, preparation of CV, Group discussion	12
II	Business management skills: Preparation of Business plan for Biotech Start-up, Teamwork and leadership skills, Raising money from Venture	12

	Capitalists, Customer service skills, Financial skills, Analytical and problem-solving skills, Critical thinking skills, Strategic thinking and planning skills, Technical skill, Female Entrepreneurship, SDG targets for entrepreneurship development	
III	Leadership and Governance, Bio economy, 3Rs and energy recovery in industrial waste management, Construction and demolition waste, implementation of waste recycling and treatment plants, functions of national bodies like DBT, DST, CPCB, BIRAC, BCIL, emerging biotechnology enterprise, Role of agencies assisting entrepreneurship: DICs, SSIs, NSICs, EDII, NIESBUD, NEDB, Entrepreneurship Development Institute (EDI)	12
IV	Rural enterprise, Bioinformatics service solutions, Tissue Cell culture lab establishment, Drug discovery, Concept of sustainability in Bio-entrepreneurship development, Green entrepreneurship, Human resource management, Cooperative Enterprises and Sustainable Development, Aids to the SDGs through Social and Eco entrepreneurship, green employment	12
V	Technology Incubators and Start-Ups, Current statistics of Biotechnology start-ups in India, case study on technology Incubators and Biotech Start-Up Companies and case studies of Biotech companies, biotechnology product development, biotechnology market development, grant writing, proposal writing, Entrepreneurship and International business	12

Reference / Text Books:

1. Biotechnology Entrepreneurship: Leading, Managing, and Commercializing Innovative Technologies by Craig Shimasaki ISBN 978-0-12-815585-1 Copyright © 2020 Elsevier Inc. All rights reserved 2020
2. Entrepreneurship: New Venture Creation : David H. Holt
3. Patterns of Entrepreneurship : Jack M. Kaplan
4. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons
5. Principles of Management - by P C Tripathi and P N Reddy, 6th Edition, 2017.
6. Developing Communication skills - by Krishna Mohan & Meera Banerji, 2nd Edition, 2017

If the course is available as Generic Elective then the students of following departments may opt it.
YES

1. Department of Microbiology
2. Department of Zoology
3. Department of Botany
4. Department of Basic Science
5. Department of food and Nutrition

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	
3) Assignments	5
4) Research Project Report	
Seminar On Research Project Report	4
5) ESE	75

Total:	100
Prerequisites for the course: This is an applied self-developing course, student must aware about all the basics of professional skill and communication and Biotechnology. It comprised of the applicability of Biotechnology in business field and start-ups.	
Course Learning Outcomes: CLO1. Students will learn about entrepreneur and entrepreneurship. CLO2. Students will gain knowledge about developing new skills in entrepreneurship field. CLO3. Students will understand about the development of various new technological advancements as bio entrepreneur. CLO4. Students will gain knowledge about various lucrative fields of biotechnology CLO5. Students will gain knowledge about the working of technology incubators and startup firms. CLO6. Student will aware about the proposal project writing, writing, drafting of grant etc.	
Instructional Method and Pedagogy 1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course. 2. Various teaching aids are used for smooth conduction of Lectures. 3. 75% attendance in academic sessions is mandatory. 4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics. 5. PPT presentation method is also incorporated in teaching. 6. Case-study based learning will also be used. 7. Promotion of Ex-situ and In-situ learning. 8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc. 9. Identification of slow and fast learners also done during the course commencement. 10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics. . 11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.	

School of Life Science & Technology

ACADEMIC HAND BOOK

SCHOOL OF LIFE SCIENCES AND TECHNOLOGY
Undergraduate Program (MICROBIOLOGY)
Ordinance & Academic Regulations

1. PREAMBLE

The biological field of microbiology covers five different types of microorganisms: bacteria, protozoa, algae, fungi, and viruses. It investigates how they interact with their habitats, how these organisms are explored by humans, and how they have a detrimental as well as beneficial effect on living beings. By using microbes as study models, the study has extensions in numerous other conventional and cutting-edge domains of biology. Microbiology has been a branch of science since its inception, and it continues to be a rapidly developing area of active research that can be generally divided into pure and applied science. Since the discovery of microorganisms more than 350 years ago, a vast variety is believed to still be unexplored. Understanding various facets of microbiology has become essential and necessary to society as evident by the utilization of microbes in synthesis plethora of commercially important products and the recent outbreaks of various microbial disasters that shattered the mankind in every aspect. Hence microbiology research is now an essential component of education and the advancement of humanity. Microbiologists are constantly in demand in the fields of education, industry, and research. Graduate students have equal career options in both industry and academia.

2. DEFINITIONS AND NOMENCLATURE

- a) **“Program”** indicates Degree Program like “Degree Program in Microbiology”
- b) **“Course”** denotes a subject that is studied in a semester, either theoretical or practical.
- c) **“Vice – Chancellor of IIMT-University”** denotes the Head of the University.
- d) **“Registrar”** is the University's chief academic and general administrative officer.
- e) **“Dean”** means the in charge of all academic activities for different programmes and the execution of pertinent regulations pertaining to the academic programme.
- f) **“Controller of Examinations”** signifies the University official in charge of all matters pertaining to university exams, including the release of results, the awarding of grade reports and degrees.
- g) **“Dean – Student Welfare”** is accountable for all activities involving students, such as student discipline, extracurricular and co-curricular pursuits, participation in and attendance at meetings with class representatives, the Student Council, and parent-teacher conferences.
- h) **“HOD”** means the Head of the Department concerned.
- i) **“University”** represents IIMT-University, Meerut.
- j) **“TCH”** means Total Contact Hours – refers to the teaching – learning periods.
- k) **“DEC” means Department Exam Committee.**
- l) **“BOS”** means Board of Studies.
- m) **“ACM”** indicates that the Academic Council will meet with the highest-ranking authority to approve all academic policies.
- n) **“Class Co-ordinator”** is a teacher who oversees the class's students' attendance, academic achievement, and behavior in general.
- o) **“IA”** is Internal Assessment which is evaluated for each student in every course throughout the semester.
- p) **“ESE”** is End Semester Examination administered in the University at the End of the Semester for all the courses.
- q) **“UGC”** is University grant Commission.

r) “MHRD” meaning Ministry of Human Resources and Management, India

3. **VISION AND MISSION OF THE SCHOOL**

VISION: To become the finest institution and to create social, economical and intellectual well-being of the students through discovery, learning and innovations.

MISSION: To fulfill the educational needs of the students through imparting value based knowledge and innovative skills in an unbiased manner to meet greater challenges involving food, farming, fiber, feed, families, health, energy, water and environment.

4. **PROGRAM EDUCATIONAL OBJECTIVES FOR B.SC MICROBIOLOGY**

The program has been designed in such a way so that the students get exposed to strong theoretical and practical background on various domains of Microbiology.

PEO1: In order to apply microbiology for the sustainable development of human society, the programme includes information on significant microorganisms involved in medical, agricultural, and industrial applications, enzymes, biomolecules structure and function, various tools and techniques, immunology, molecular biology, cell biology, and genetic engineering.

PEO2: The practical classes are intended to give the students laboratory expertise in microbiology. In addition to designing and carrying out experiments, students will be able to analyze and understand scientific data.

PEO3: The programme will help students with the knowledge and skills necessary for them to pursue further education in the fields of microbiology and related fields, as well as in multidisciplinary fields including, biochemistry, biotechnology, and molecular biology. It will also assist in the development of a variety of generic skills important for fostering student entrepreneurship.

PEO4: The students will be exposed to a wide range of occupations and professions that mix the skills taught during the programme and this will help them to use them for environmental remediation, setting up of a startup, in development of medicine, pharmaceuticals, drug discovery and many more related disciplines

5. **PROGRAM OUTCOME FOR B. SC MICROBIOLOGY**

On successfully completing the Graduate programme (B.Sc Microbiology), the student will be eligible to -

PO1: Apply the knowledge acquired and comprehension of the principles of Microbiology as they relate to a variety of disciplines, including Medicine, Industry, the Environment, Genetics, Agriculture, Food, and others.

PO2: Use skills learned during the programme with fluency that will allow students to pursue higher education, find employment in a variety of industries, and build their entrepreneurship capabilities.

PO3: Exhibit essential practical abilities when dealing with microbes for research and application both in and out of the lab, including the application of sound microbiological principles.

PO4: Clearly and concisely express scientific ideas, experimental findings, and analytical arguments related to the field of microbiology

PO5: Correlate the subject to society and explain the benefit of Microbiology in development and welfare of the mankind

PO6: Keep themselves skilled and advanced in the subject as the course includes more practical, which helps the students get hands on experience about the subjects taught

6. PROGRAM SPECIFIC OUTCOME

Certificate Course in Microbial Techniques

B. Sc. I Year Programme Specific Outcomes (PSOs)

- **PSO1:** Students will be able to pick up specific knowledge and abilities related to microbiology and apply them.
- **PSO2:** Students will be able to recognize the range of microbes and microbial communities that live in a variety of habitats and comprehend both their pathogenic and beneficial roles in the environment and in human health.
- **PSO3:** Students will learn and be able to demonstrate mastery in acceptable laboratory procedures in a microbiological laboratory, as well as the theoretical underpinnings and practical abilities of the equipment and technologies typically used to investigate this discipline.
- **PSO4:** The fundamentals of agricultural and environmental microbiology and associated concepts will be taught to the students.
- **PSO5:** Students who complete the certificate programme will be able to apply for technical jobs at public and private research facilities.

Diploma in Microbial Technology

B. Sc. II Program Specific Outcomes (PSOs)

- **PSO1:** Students will gain acquaintance with and understanding of the ideas of microbiology as they relate to diverse fields, including biochemistry, microbial physiology, molecular biology, and genetics.
- **PSO2:** Students will demonstrate adequate proficiency in the use of tools, technological advancements, and microbiology-related procedures. They will also use theory testing and logical reasoning to plan and administer exams.

- **PSO3:** Students will have the knowledge and skills necessary to use microbiology to identify problems involving microorganisms, discuss these with colleagues, and take corrective action.
- **PSO4:** Students will be able to explain the processes, through which microorganisms acquire energy, carry out their metabolism, reproduce, survive, and interact with their surroundings, hosts, and host populations.
- **PSO5:** The biological and medical sciences, environmental groups, public health, pharmaceutical, the food, dairy, and biotechnology industries are just a few of the career options available to students after completing this programme.

Degree in Bachelor of Science in Microbiology **B. Sc III Program Specific Outcomes (PSOs)**

- **PSO1:** Students enrolled in the B.Sc. Microbiology Program will develop their ability to reason scientifically as they research a wide range of modern topics, including Virology Bacteriology, Biochemistry, Immunology, Microbial Physiology, Cell Biology, Molecular Biology, Genetics and Microbial Genetics, as well as the significance of environmental microbiology.
- **PSO2:** Students will gain knowledge of the numerous biotechnological uses of microorganisms as well as the compounds produced by microbes that are significant to industry. They will discover the unique function bacteria have in genetic modification techniques.
- **PSO3:** Students will gain knowledge of proper lab procedures in a microbiological lab and be able to describe the theoretical underpinnings and practical applications of the equipment and technologies frequently employed in this field. Students can become proficient in the quantitative abilities required to study biological issues.
- **PSO4:** Students will gain knowledge of experimental techniques, the development and testing of hypotheses, and the planning and carrying out of experiments. Students can improve both their capacity for critical thought and for reading and interpreting scientific texts. Students can develop strong oral and writing communication skills by presenting experimental results persuasively and by participating in workshops.
- **PSO5:** The degree programmes will prepare students for advanced study in microbiology and related fields that lead to postgraduate and doctoral degrees.

7. ADMISSION

- The UGC/NEP/AICTE and Ministry of Education (MOE), Government of India, have released guidelines on which the admission policy and method shall be decided.
- The number of seats must be in conformity with the university's regulations.
- Seats are also available for non-resident Indians and foreigners who meet the university's requirements for admission.

8. ELIGIBILITY IN ALL YEAR AS NEP (ENTRY & EXIT)

A candidate will be eligible for admission to the programme if they obtained at least 40% in their life science-related intermediate course from an accredited Board. Admission to the programme will be based on merit and in accordance with the University's and the state of Uttar Pradesh's policies. The student will be provisionally admitted to the following semester following the term-end examination at the conclusion of each semester. There will be a 15-day break following each semester.

According to the NEP 2020, after the completion of each year the candidate will be awarded Certificate/Diploma/Degree as per the table 1.

Table 1

S. No.	Academic Year	Semester	Certificate/Diploma/Degree
1	I	I and II	Certificate Course in Microbial Techniques
2	II	III and IV	Diploma in Microbial Technology
3	III	V and VI	Bachelor of Science in Microbiology

9. CURRICULUM

For the purpose of awarding degrees, the grading scheme established by the University's Board of Studies specifies that the curriculum for B. Sc. Microbiology programmes must have a minimum of credits + NCC (Non-credit Audit Courses) and be spaced out across six semesters of study.

The degree programme under CBCS will include the following types of courses:

- Core course
 - Skill Enchantment Course – SEC
 - Generic Elective Course – GEC
 - Discipline Specific Elective - DSE
 - Ability Enhancement Compulsory Courses – AECC
 - NPTEL and Spoken courses are added as per program under Skill Enhancement Courses.
 - NCC is added in each semester as per availability of seats
 - Sport is integrated in the curriculum as a non-credit compulsory course.
 - Generic Elective Courses are also added in the curriculum.
- To get a Certificate course in Microbial Techniques, a candidate has to qualify minimum 48 Credits as per NEP and the duration of certificate course is one year.
 - To get a Diploma in Microbial Technology, a candidate has to qualify minimum 96 Credits as per NEP and the duration of certificate course is two years.
 - To get a Degree of Bachelor of Science in Microbiology, a candidate has to qualify minimum 142 Credits as per NEP and the duration of certificate course is three years.

10. MEDIUM OF INSTRUCTION

All classes, exams, seminar presentations, and project reports are conducted in English.

11. **CHOICE BASE CREDIT SYSTEM (CBCS)/LOCF/OBE**

The university follows a flexible Choice based Credit System. Degree program will consist of the different groups of courses including Core course, Skill Enchantment Course, Generic Elective Course, Discipline Specific Elective, and Ability Enhancement Compulsory Courses. The student has the choice of how many credits to take each semester, subject to the minimum and maximum requirements of the curriculum.

12. **REGISTRATION FOR COURSE IN A SEMESTER**

In the beginning of the semester the candidate will choose the subjects of his choice and will register for the current semester with in the 3 days of commencement of the semester.

13. **ATTENDANCE**

Regular students are not allowed to take the semester exam unless they have consistently attended at least 75% of the total number of classes offered across all topics. However, the institution may allow a 10% reduction in attendance in each subject for any of the following reasons.

- a) Participation in NCC/ NSS Camps.
- b) Participation in University/ Inter-university/ State-level Games.
- c) Participation in other extra-curricular activities at University/ Inter-university/ State level.
- d) Prolonged Illness

13.1 **Condonation of Medical cases**

For medical circumstances, it is required that the Dean (Students Welfare) get a thorough attendance sub-committee will evaluate these instances based on their merit and make recommendations to the Vice-Chancellor. If the Vice-Chancellor finds it appropriate and meritorious, he or she may then excuse absence based on the attendance subcommittee. The condonation cannot, however, be greater than 10%. For the duration of the programme, a student may receive such a pardon just twice.

13.2 **Additional Condonation**

In rare and real instances, additional condonation may be taken into consideration, including authorised leave for:

- a) Participation in NCC/ NSS Camps.
- b) Participation in University/ Inter-university/ State-level Games.
- c) Participation in other extra-curricular activities at University/Inter-university/State level.

Prior approval for leave must be acquired from the relevant authorities for such specific NCC / Sports Camps by the appropriate faculty coordinator / Director of Sports before deputising the students.

14. **ASSESSMENT PROCEDURE**

Two components of evaluation are required for the graduate course, namely

Internal Assessment: “IA”: This evaluation will take place according to the academic schedule during the semester.

External Assessment/End Semester assessment “ES”: In accordance with the academic calendar, this assessment will take place at the end of the semester.

14.1 Theory Assessment:

Each Core paper shall be of 100 marks, out of which internal and end semester assessments will carry 25 marks and 75 marks respectively. While the Ability Enhancement Courses will be of 50 marks out of which internal and external assessments will carry 15 marks and 35 marks respectively. Skill Enhancement Courses will carry the weight age of 50 marks.

Table 2

INTERNAL AND EXTERNAL ASSESSMENT FOR THEORY			
Internal Assessment	Marks	External Assessment	Marks
Sessional	15	End Semester Final Examination	75
Assignment	5	-	-
Attendance	5	-	-
Total	25		75

14.2 Practical Assessment

Table 3

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL			
Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

15. RESEARCH PROJECT/SEMESTER PROJECT ASSESSMENT CRITERIA

Students will have Industrial training/Research project/Survey project during V and VI semester. Only Internal assessment of 25% and External assessment of 75% will be done. The project can be under any external faculty too (outside the university) maintaining their attendance with the prior permission of the Dean of the said school.

For the assessment of the project work, student has to deliver a presentation regarding his work and give viva voce in front of the external examiner appointed by the University. Three copies of the project report must be submitted by the student in the format required by the university.

16. INTERNSHIP – RESEARCH / INDUSTRIAL INTERNSHIP

A student may do an internship during summer and winter break.

17. FOR NON – CREDIT COURSES / AUDIT COURSES

The university has provided USR (University Social Responsibility) course and sports as non-credit/Audit course.

18. CREDIT WEIGHTAGE

Credits are the weightage, assigned to the courses based on the following general pattern:
One Hour: 1 credits (Theory)

Two Hour: 1 Credit (Practical)

19. MAXIMUM DURATION OF PROGRAM/PROMOTION POLICY

B. Sc. Microbiology will be a full time three year program to be covered in six semesters each of six months duration. The yearly structure of the program would be as given below:

I Year – I and II Sem.

II Year – III and IV Sem

III Year –V and VI Sem

The curriculum and syllabi for the three-year B. Sc. Microbiology Degree Programs will be in accordance with the CBCS and NEP 2020, as approved by the relevant Board of Studies and Academic Council of the University.

A student may proceed through the curriculum more slowly than usual, but in no case longer than N+2 years. A student who completes their degree programme in the extra time will not be ranked by their university.

A student will be promoted if he/she fulfills the criteria of minimum percentage of marks to pass the examination in each Semester which will be as given below:

- 40 percent Marks in each written paper with internal and external assessment separately;
- 50% Marks in aggregate of each semester examination.
- A candidate will advance to the next higher semester if he or she receives at least a passing grade on 50% of the semester's compulsory papers; otherwise, the applicant will be judged to have failed the semester and will need to reapply and take all currently required exams.

20. MAXIMUM GAPS BETWEEN SEMESTER/YEAR

The Vice Chancellor may grant a student permission to withdraw from the full programme for a maximum of two semesters due to illness, a start-up business, or other good cause as suggested by the committee made up of the department head, school dean, and dean of student welfare.

21. CREDIT SYSTEM & GRADING CGPA/SGPA

The IIMT-University adopted the UGC directives for implementation of the Choice-Based Credit System in 2015 to allow students the possibility to complete a programme by earning credits at a pace decided by them. According to their learning needs, interests, and aptitude, the technique allowed students to choose inter- or intra-disciplinary courses. It was viewed as a cafeteria approach and was expected to allow students mobility.

Since the current credit system used in institutions offers very little flexibility, choice, and is less learner-centric, extensive improvements are required. Today's degrees are more self-contained, concentrate on a certain field of study, and heavily rely on the faculty members' department-specific knowledge. Though there are thousands of educational institutions in India, only a small number of them offer the most essential credit system, which gives students a wide range of options and freedom. In these institutions, the curriculum is typically created

with the learner in mind and offers a wide range of specialist areas from which students can select courses. The institutions will make an effort to have individual course instructors be in charge of the credit system design as well as the modalities of instruction and evaluation. Students should be allowed to choose courses outside of their primary focus and not be restricted to it. Stronger partnerships between university departments and the outside world are required for this. CGPA/SGPA and grading will be done by CoE of the University.

22. CLASS / DIVISION

The division the candidate will be documented in the degree. The list of successful candidates after the six semesters of examinations for the Bachelor of Science programme shall be arranged as follows into divisions based on the total marks earned in all semester examinations calculated together.

- **First Division** to students obtaining 60% or more of the aggregate marks.
- **Second Division** to students obtaining 50% or more but less than 60% of the aggregate marks.
- Those who qualify all semester examinations in first attempt obtaining 75% or more marks in the aggregate shall be declared to have qualified with **DISTINCTION**.
- Upon passing the semester exam, each successful candidate will be given a copy of their complete score report.

23. TRANSFER OF CREDIT /ACADEMIC CREDIT BANK

23.1 The Academic Council, acting on the advice of the newly formed Credit Transfer Committee, may, within the general parameters of these regulations, allow students to transfer a portion of the credit they have earned at other recognised universities in India or overseas.

23.2 On a case-by-case basis, the Academic Council may additionally authorise the admission of students who have successfully completed a portion of their coursework at another accredited institution of repute via the multiple entry & exit system.

23.3 Students who have completed at least one year of coursework at a university other than the one to which transfer is desired may apply for admission transfer to this institution. Only through a procedure that adheres to the same rules for new admissions may a student be admitted. To achieve credit transfer, all universities must adhere to a standard credit system.

23.4 Only once the student has been admitted to the relevant programme and the following requirements have been satisfied may a credit transfer request be made:

- The coursework was finished in a full-time, formal learning mode at a university that has received UGC approval and accreditation.
- The accreditation grade or rating of the university is not inferior to that of the institution from which the transfer is requested.
- Under the UGC CBCS system, the courses must adhere to the common minimum syllabus.
- The courses were completed with a letter grade of "B" or above.
- The total number of credits that can be transferred does not go over the established cap.
- The programme in question must have a comparable credit system, specifically one that is modular or semester-based, the same system of letter and number grades, and a shared definition of "credit" in numerical terms.

When accepting credits, it is important to take the aspect of a course's shelf life into account because it is important to determine whether a particular field's expertise has become outdated or no longer relevant. It is important to take into account how much time has passed between successfully completing specific programme courses and being admitted to the programme to which transfer is desired. It is necessary to specify the maximum amount of credit points that may be taken into account during a credit transfer. While drafting the credit transfer policy, contextual factors such the teaching-learning methodology used, the learning facilities provided, and the use of evaluation modalities may also be taken into account.

24. CHANGE OF DISCIPLINE

The student can change the discipline within 15 days of commencement of the classes that too if the eligibility matches and availability of vacant seats.

25. USE OF TECHNOLOGICAL INTERVENTION

The ubiquity of various access devices, particularly mobile access devices, presents an opportunity for technology to enhance established teaching strategies and transform evaluation and learning processes. In reality, technology has the potential to be a key enabler of lifelong learning. The use of technology in a variety of ways, including synchronous learning, semi-synchronous learning, blended learning, collaborative learning, the flipped classroom, etc., helps students learn and stay engaged.

MOOCs are a window of opportunity for lifelong learning and are delivered through technology-based platforms, particularly through SWAYAM. Institutions may employ learning management systems (LMS) to integrate the complete teaching, learning, and evaluation process. Institutions may use the learning management system to present academic material in a blended format and to evaluate student learning through theses, assignments, etc. You can submit content in the form of videos, audios, e-learning modules, live class sessions, and other formats using open-source learning management systems like Moodle and Edmodo. To verify the originality of content, it will be strongly advised to use plagiarism detection software.

Universities face many obstacles when conducting exams, including the need for trained staff, the need for error-free question paper distribution, the delay in answer script evaluation, the lack of infrastructure needed to conduct exams on a large scale, the unavailability of faculty members for evaluation, security concerns during paper setting and paper distribution, certificate and answer script tampering, and more.

For a typical examination department of a university, from student registration to convocation through an integrated system, it will be an autonomous entity. In actuality, actions must be taken to put in place a comprehensive examination management system that takes into account the entire life cycle of the examination process. Utilizing technology will eliminate errors and lessen reliance on human intervention. The subsequent processes will be automated:

- Student registration and creation of distinctive PRN.
- Filling up of examination form.
- Generation of seat numbers and admit cards/hall tickets.
- Making a list of paper setters..
- Generating question papers and creating question sets using a question bank system.

- Online release of exam-day question papers using an encryption mechanism.
- Barcode system for answer books (this will eliminate issues related to errors, avoid malpractices etc.)
- Digitalization of the answer papers and on-screen scoring of the answers.
- Monitoring student's performance.
- Submission of marks through online tools.
- Online system for viewing results.
- Online mechanism of verification and revaluation.
- Digitalization of diplomas and transcripts (to avoid tampering and easy retrieval)..
- Certificate authentication system.
- Submission of various other applications through online system.

The aforementioned will result in the efficient and transparent operation of the examination system as well as the prompt dissemination of information to pupils.

26. STUDENT DISCIPLINE

A student is expected to behave appropriately in accordance with the ethical and socio cultural standards established by the University for day to day living. Additionally, students must adhere to the norms and regulations established by the University for Various Activities.

27. STUDENT WELFARE

Any case of student disobedience that is brought to the attention of the Dean (Students Welfare) and the Head of the Department must be sent to a Discipline Committee formed especially for that purpose. The Committee will investigate the claims if they are accurate and choose an appropriate punishment. The committee will also give the Dean of Students Welfare approval to request that the Vice-Chancellor implement the decision. The Vice-Chancellor, to whom the offending student may appeal, shall render the final decision.

28. RAGGING

In our nation, ragging in any form is illegal and is not subject to bail. The state and federal laws in effect today offer severe penalties, including imprisonment for anyone involved in such act. Once a student's involvement in ragging, offending other students or staff, harassing other students or staff in any way, etc., is proven, the student may be expelled from the university in accordance with the specified UGC/Government/Institute procedures. Every senior student at the university has to sign and submit an undertaking in this regard, at the time of registration.

29. POWER OF MODIFY

Despite what has been said above, the academic council has the authority to change any or all of the mentioned regulations as necessary, subject to Board of Studies approval and Vice Chancellor approval in the final instance.

30. EXIT POINT

Student may exit after getting the certificate, diploma or on the completion of 48 and 96 credits.

31. NC/NON-CREDIT COURSE

USR University Social Responsibility and Sports

Evaluation Schemes

School of Life Sciences & Technology
B.Sc. MICROBIOLOGY
Year: III / Semester: I

S.No.	Course Code	Subject	Course Type	Study Scheme			Evaluation Scheme			Credit
				L	T	P	Internal	External	Total	
1	BMBC-NP-111	General Microbiology	Core1	4	0	0	25	75	100	4
2	BMBC-NP-112	Bacteriology and Biosystematics	Core2	4	0	0	25	75	100	4
3	BMBDSE-NP-113a	Basic Computer and Bioinformatics	DSE1	4	0	0	25	75	100	4
	BMBDSE-NP-113b	Biosafety and Intellectual property Rights								
4	NHU-N-111/NHU-NPR-112	English communication/Environment & Ecology	AECC1/2	4	0	0	25	75	100	4
5	GENCC-101	NCC	Gen E	2	0	0				2
6	NECC-112	University Social Responsibility	USEC	0	0	0	25	0	25	0
PRACTICALS										
8	BMBC-NP-111P	General Microbiology Lab	Core	0	0	2	20	30	50	2
9	BMBC-NP-121P	Bacteriology and Biosystematics Lab	Core	0	0	2	20	30	50	2
10	BMBDSE-NP-113aP	Basic Computer and Bioinformatics Lab	DSE1	0	0	2	20	30	50	2
	BMBDSE-NP-113bP	Biosafety and Intellectual property Rights Lab								
11	NHU-NPR-112P	Environment & Ecology lab	AECC1/2	0	0	1	20	30	50	1
		TOTAL					180	420	600	
12	SPT-111	Sports	USEC				50	0	NC	
23 (25 including NCC)										

Page | 293

Page | 294

23 (25 including NCC)

Page | 296

24 (26 including NCC)

Evaluation Schemes

2024

(I and II Semester)

Department of Microbiology, IIMT University, Meerut
Study & Evaluation Schemes as per NEP-2020
B. Sc. Microbiology I Year/ Certificate Course
I Semester w. e. f. 2024-2025

S. No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core1	BMB-NPR-111	General Microbiology	4	0	0	4	25	75	100
2	Core2	BMB-NPR-112	Prokaryotic cell Structures	4	0	0	4	25	75	100
3	DSE1	BMBD-NPR-113a	Eukaryotic cell Structures	4	0	0	4	25	75	100
		BMBD-NPR-113bP	Food Fermentation Technology							
4.	AECC 1/2	NHU-NPR-112	Environment & Ecology	4	0	0	4	25	75	100
		NHU-N-111	English communication	3	0	0	3	15	35	50
5.	Gen E	GENCC-101	NCC	2	0	0	2			NC
7.	VAC	VAC-1	(Indian Ethos and Modern Management)	2	0	0	2	20	30	50
8	USEC	NECC-112	University Social Responsibility	0	0	0	0	25	0	NC
PRACTICALS										
1.	Core 1	BMB-NPR-111P	General Microbiology Lab	0	0	2	2	20	30	50
2.	Core2	BMB-NPR-112P	Prokaryotic cell Structures Lab	0	0	2	2	20	30	50
3.	DSE1	BMBD-NPR-113aP	Eukaryotic cell Structures	0	0	2	2	20	30	50
		BMBD-NPR-113bP	Food Fermentation Technology							
4	AECC	NHU-NPR-112P	Environment & Ecology Lab	0	0	1	1	15	35	50
5	USEC	SPT-111	Sports	0	0	0	0	0	50	NC
TOTAL								195	455	650

25 (27 including NCC)

Department of Microbiology, IIMT University, Meerut
Study & Evaluation Schemes as per NEP-2020
B. Sc. Microbiology I Year/ Certificate Course
II Semester w. e. f. 2024-2025

S. No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core3	BMB-NPR-121	Microbial Physiology and Metabolism	4	0	0	4	25	75	100
2	Core 4	BMB-NPR-122	Basic & Applied Biochemistry	4	0	0	4	25	75	100
3	DSE2	BMBD-NPR-123a	Control of microorganisms in the environment	4	0	0	4	25	75	100
		BMBDSE-NP-123b	Microbial Biotechnology							
4.	AECC 1/2	NHU-NPR-112	Environment & Ecology	4	0	0	4	25	75	100
		NHU-N-111	English communication	3	0	0	3	15	35	50
5.	GE1	BMBGE-NP-124a	Interaction with Entrepreneur in Microbial Technology & Startup	4	0	0	4	25	75	100
		BMBGE-NP-124b	Microbial World and Microbial Diversity							
6	GenE	GENCC-201	NCC	2	0	0	2			
7.	USEC	NECC-122	University Social Responsibility	0	0	0	0	25	0	NC
8	SEC 1	NECC-124	MOOCs	2	0	0	2	50	0	50
PRACTICALS										
1.	Core3	BMB-NPR-121P	Microbial Physiology and Metabolism Lab	0	0	2	2	20	30	50
2.	Core4	BMB-NPR-122P	Basic and Applied Biochemistry Lab	0	0	2	2	20	30	50
3.	DSE2	BMBD-NPR-123aP	Control of microorganisms in the environment	0	0	2	2	20	30	50
		BMBDSE-NP-123bP	Microbial Biotechnology Lab							
4	USEC	SPT-111	Sports	0	0	0	0	0	50	NC
			TOTAL					225	425	650

27 (29 including NCC)

Format-1

NEP-2020 IMPLEMENTATION 3 STEPS PLAN (FORMAT-1,2& 3)
CBCS: Statement of Credits distribution

Format -1

College/School:

Programme:

Duration: UG (6 Sem.), UG (Hons./Research) 8 Sem., PG (4 Sem.)

Credit range: Minimum 120 for UG

160 for UG (Hons.), 80 for PG

(Suggested by CBCS-NEP Committee)

COURSE	CREDIT	SEMESTER	CORE (Th 4+P 2) Major	DSE (Th 4+P 2) Minor	AECC (Th 3)	SEC **	GE (Th 4) Interdisciplinary	General Elective (2)	Value Added Course (VAC) (2)	Industrial Training/ Survey / Research Project (4)	Total Credits
Certificate Course in.....	52	1st	C1-General Microbiology C 2- Bacteriology and Biosystematics	DSE 1- Basic Computer & Bioinformatics/ Biosafety and Intellectual Property Rights	AECC 1 English Communication/Environment Science			NC C	VAC- 1:(Indian Ethos and Modern Management)		25 (Excluding NCC)
		2nd	C3-Microbial Physiology & Metabolism C4- Basic Biochemistry	Control of microorganisms in the environment / Microbial Biotechnology	AECC 1/2- English Communication /Environment & Ecology	SEC 1 - MOOCs	GE1- Interaction with Entrepreneur in Microbial Technology and Startup/ Microbial technology for human welfare	NC C			27 (Excluding NCC)

Entry and Exit point											
Diploma in	54	3 rd	C5- Microbial Pathogenicity and Diseases C6-Virology	Basic Computers, Biostatistics & Bioinformatics / Microbial Entrepreneurship	AECC 3- Human values		GE 2-Food Fermentation Technology/ Microbial quality control in food & pharmaceutical industries	NC C	VAC-2- (Ancient Sanskrit Language)		27 (Excluding NCC)
		4 th	C7-Molecular Biology C8- Environmental Microbiology	Microbiological Methods / Pharmaceutical Microbiology	AECC 4- Professional Skills	SEC 2- MOOCs		NC C		Summer Internship in between 4 th and 5 th Sem. During session break (6-8 weeks) (Credit-4)	23+4= 27
Entry and Exit point											
B.Sc.	52	5 th	C9-Microbial Genetics C10- Immunology	Epidemiology / Agricultural Microbiology			GE-3 Research writing	NC C	VAC-3- (Traditional System of Medicine)	Industrial Training/ Survey/Research Project (Credit-4, for 3 years programmes)	28

Note: For 04 years undergraduate programmes, research projects will be of 6 credits each in last 02 semesters.

**** One SEC must be E&I and IPR (Can be through NPTEL or IPR can be from TIFAC, DST)**

Page | 304

		9 th	C17-Industrial Microbiology C18- Molecular Diagnosis, Drug Designing and Vaccines	DSE 9- Recombinant DNA Technology/S oil & Agriculture Microbiology			GE-4 Food and Dairy Microbiology /Advances in Microbiology	NC C	VAC-3- (Traditional System of Medicine)	Seminar/Industrial Training/ Research (Credits-4)	28 (Excluding NCC)
		10 th				SEC 5-MOOCs		NC C		Research Project (Credits - 16)	20 (Excluding NCC)

Format-2

NEP-2020 IMPLEMENTATION 3 STEPS PLAN (FORMAT-1,2 & 3)

Format-2

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
CERTIFICATE COURSES –(48 Credits)	FIRST YEAR	SEMESTER -I	i) C1- General Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C1- General Microbiology	Unit=6/Period=60	N/A	N/A
			ii) C2-Bacteriology and Biosystematics (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C2-Bacteriology and Biosystematics	Unit=6/Period=60	N/A	N/A
			iii) AECC-1/2- English communication/Environment & Ecology (Th.3 Cr)	3	3	45	iii) AECC-1/2- English communication/Environment & Ecology	Unit=5/Period=45	N/A	N/A
			iv) DSE 1- Basic Computer & Bioinformatics/ Biosafety and Intellectual Property Rights(Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iv) DSE 1- Basic Computer & Bioinformatics/ Biosafety and Intellectual Property Rights	Unit=5/Period=60	N/A	N/A

SEMESTER - II	i) C3-Microbial Physiology and Metabolism (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C3-Microbial Physiology and Metabolism	Unit=6/Period=60	N/A	N/A
		4+2	8	60+60	ii) C4- Basic Biochemistry	Unit=6/Period=60	N/A	N/A
	ii) C4- Basic Biochemistry (Th.4 Cr.+ P 2Cr.)	3	3	45		Unit=5/Period=45	N/A	N/A
	iii) AECC-1/2- English Communication/ Environment & Ecology (Th.3 Cr)	2	2	30	iii) AECC-1/2- English Communication/Environment & Ecology	Unit=5/Period=30	N/A	N/A
	iv) SEC-1 MOOCs (Th.2 Cr)	4+2	8	60+60	iv) SEC-1 MOOCs	Unit=5/Period=60	N/A	N/A
	v) DSE 2- Plant Pathology & Disease Management/Microbial Biotechnology (Th.4 Cr.+ P 2Cr.)	4	4	60	v) DSE 2- Plant Pathology & Disease Management/ Microbial Biotechnology	Unit=5/Period=60	10+2 Bio	B.Sc. Biotech/A gri
	vi) GE1-Interaction with Entrepreneur in Microbial Technology & Startup/Microbial world and Microbial diversity (Th.4 Cr)				vi) GE1--Interaction with Entrepreneur in Microbial Technology & Startup/Microbial world and Microbial diversity			

Programme Outcome:

PO 1: Apply the knowledge acquired and comprehension of the principles of Microbiology as they relate to a variety of disciplines, including Medicine, Industry, the Environment, Genetics, Agriculture, Food, and others.

PO 2: Use skills learned during the programme with fluency that will allow

Programme Specific Outcome:

PSO1: Students will be able to pick up specific knowledge and abilities related to microbiology and apply them.

PSO2: Students will be able to recognize the range of microbes and microbial communities that live

students to pursue higher education, find employment in a variety of industries, and build their entrepreneurship capabilities.

PO 3: Exhibit essential practical abilities when dealing with microbes for research and application both in and out of the lab, including the application of sound microbiological principles.

PO 4: Clearly and concisely express scientific ideas, experimental findings, and analytical arguments related to the field of microbiology

PO 5: Correlate the subject to society and explain the benefit of Microbiology in development and welfare of the mankind

PO 6: Keep themselves skilled and advanced in the subject as the course includes more practical, which helps the students get hands on experience about the subjects taught

in a variety of habitats and comprehend both their pathogenic and beneficial roles in the environment and in human health.

PSO3: Students will learn and be able to demonstrate mastery in acceptable laboratory procedures in a microbiological laboratory, as well as the theoretical underpinnings and practical abilities of the equipment and technologies typically used to investigate this discipline.

PSO4: The fundamentals of agricultural and environmental microbiology and associated concepts will be taught to the students.

PSO5: Students who complete the certificate programme will be able to apply for technical jobs at public and private research facilities.

Program me	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
DIPLOMA COURSE (96 Credits) –	SECOND YEAR	SEMESTER -III	i) C5- Mycology and Phycology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C5- Mycology and Phycology	Unit=6/Period=60	N/A	N/A
			ii) C6-Virology (Th.4 Cr.+ P 2Cr.)	4+2 3	8 3	60+60 45	ii) C6-Virology	Unit=7/Period=60 Unit=5/Period=45	N/A N/A	N/A N/A
			iii) AECC-3- Human Values (Th.3 Cr)	4+2	8	60+60	iii) AECC-3- Human values	Unit=6/5Period=60	N/A	N/A
			iv) DSE-3- Biophysics and Biostatistics/Microbial products: Biofertilizers & Biopesticides (Th.4 Cr.+ P-2Cr.)	4	4	60	iv) DSE-3- Biophysics and Biostatistics/ Microbial products: Biofertilizers & Biopesticides	Unit=6/5Period=60	10+2 Bio	B.Sc. Biotech./HM/ Agri

Page | 310

PO 3: Exhibit essential practical abilities when dealing with microbes for research and application both in and out of the lab, including the application of sound microbiological principles.

PO4: Clearly and concisely express scientific ideas, experimental findings, and analytical arguments related to the field of microbiology

PO5: Correlate the subject to society and explain the benefit of Microbiology in development and welfare of the mankind

PO6: Keep themselves skilled and advanced in the subject as the course includes more practical, which helps the students get hands on experience about the subjects taught

PSO 3: Students will have the knowledge and skills necessary to use microbiology to identify problems involving microorganisms, discuss these with colleagues, and take corrective action.

PSO 4: Students will be able to explain the processes, through which microorganisms acquire energy, carry out their metabolism, reproduce, survive, and interact with their surroundings, hosts, and host populations.

PSO 5: The biological and medical sciences, environmental groups, public health, pharmaceutical, the food, dairy, and biotechnology industries are just a few of the career options available to students after completing this programme.

Program me	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
UNDER GRADUATE DEGREE (142 Credits)	THIRD YEAR	SEMESTER -V	i) C9—Clinical and Diagnostic Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C9-- Clinical and Diagnostic Microbiology	Unit=5/Period=60	N/A	N/A
			ii) C10-Immunology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C10-Immunology	Unit=6/Period=60	N/A	N/A
			iii) DSE-5- Food and dairy Microbiology/ Microbes in Sustainable agriculture (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iii) DSE-5- - Food and dairy Microbiology/ Microbes in Sustainable agriculture	Unit=6/5Period=60	N/A	N/A
			*Research project/ Industry Training/ Internship Survey	4	4	60				

SEMESTER - VI	i) C 11- Industrial Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C 11- Industrial Microbiology	Unit=5/Period=60	N/A	N/A
	ii) C 12-Medical Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C 12-Medical Microbiology	Unit=5/Period=30	N/A	N/A
	iii) SEC-3MOOCs (Th.2 Cr)	2	2	30	iii) SEC-3 MOOCs	Unit=5/5Period=60	N/A	N/A
	iv) DSE-6 Genetic Engineering & RDT/ Advanced Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iv) DSE-6 Genetic Engineering & RDT/ Advanced Microbiology		N/A	N/A
	*Research project/ Industry Training/ Internship Survey	4	4	60				

*Research Topic may be selected from any one of 02 core papers.

Programme Outcome:

PO1: Apply the knowledge acquired and comprehension of the principles of Microbiology as they relate to a variety of disciplines, including Medicine, Industry, the Environment, Genetics, Agriculture, Food, and others.

PO2: Use skills learned during the programme with fluency that will allow students to pursue higher education, find employment in a variety of industries, and build their entrepreneurship capabilities.

PO3: Exhibit essential practical abilities when dealing with microbes for research and application both in and out of the lab, including the application of sound microbiological principles.

PO4: Clearly and concisely express scientific ideas, experimental findings, and analytical arguments related to the field of microbiology

PO5: Correlate the subject to society and explain the benefit of Microbiology in development and welfare of the mankind

PO6: Keep themselves skilled and advanced in the subject as the course includes more practical, which helps the students get hands on experience about the subjects taught

Note: Correlation between CO/PO/PSO3 are to be established by bloom taxonomy:

Programme Specific Outcome:

PSO1: Students enrolled in the B.Sc. Microbiology Program will develop their ability to reason scientifically as they research a wide range of modern topics, including Virology Bacteriology, Biochemistry, Immunology, Microbial Physiology, Cell Biology, Molecular Biology, Genetics and Microbial Genetics, as well as the significance of environmental microbiology.

PSO2: Students will gain knowledge of the numerous biotechnological uses of microorganisms as well as the compounds produced by microbes that are significant to industry. They will discover the unique function bacteria have in genetic modification techniques.

PSO3: Students will gain knowledge of proper lab procedures in a microbiological lab and be able to describe the theoretical underpinnings and practical applications of the equipment and technologies frequently employed in this field. Students can become proficient in the quantitative abilities required to study biological issues.

PSO4: Students will gain knowledge of experimental techniques, the development and testing of hypotheses, and the planning and carrying out of experiments. Students can improve both their capacity for critical thought and for reading and

interpreting scientific texts. Students can develop strong oral and writing communication skills by presenting experimental results persuasively and by participating in workshops.

PSO5: The degree programmes will prepare students for advanced study in microbiology and related fields that lead to postgraduate and doctoral degrees.

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
POST GRADUATE DEGREE (R)	FOURTH YEAR	SEMESTER -VII	i) C13-Fundamental of Microbiology and Bacteriology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C13- Fundamental of Microbiology and Bacteriology	Unit=5/Period=60	N/A	N/A
			ii) C14-Biochemistry and Instrumentation (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C14- Biochemistry and Instrumentation	Unit=5/Period=60	N/A	N/A
			iii) DSE7-Immunology/Biosafety & IPR (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iii) DSE7- Immunology/Biosafety & IPR	Unit=5/Period=60	N/A	N/A
			iv)AECC 5- English Communication/Environment and Ecology (Th.3 Cr)	3	3	45	iv)AECC 5- English Communication/ Environment and Ecology	Unit=5/Period=45	N/A	N/A

SEMESTER - VIII	i) C15- Mycology and Phycology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C15- Mycology and Phycology	Unit=5/Period=60	N/A	N/A
	ii) C16-Virology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C16-Virology	Unit=5/Period=60	N/A	N/A
	iii) DSE8-Molecular Biology/ Environmantal Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iii) DSE8- Molecular Biology/ Environmantal Microbiology	Unit=5/Period=60	N/A	N/A
	iv) GE 3- Biostatistics and Bioinformatics/ Pharmaceutical Microbiology (Th.4)	4	4	60	iv) GE 3- Biostatistics and Bioinformatics/ Pharmaceutical Microbiology	Unit=5/Period=60	10+2 Bio	B.Sc. Biotech. /Agri.
	v) SEC 4- MOOCs (Th.2)	2	2	30	v) SEC 4- MOOCs	Unit=5/Period=30	N/A	N/A

***Dissertation report will be evaluated by external & internal examiners & Research topic may be selected from the main core paper**

Programme Outcome:

PO1: Be capable of providing high-quality clinical investigations by having knowledge and technical expertise related to Microbiology laboratories.
 PO2: Handle common laboratory instruments, Perform sophisticated molecular microbiological techniques, maintain/operate laboratory equipment and Conduct standard clinical laboratory techniques while adhering to appropriate quality control standards.
 PO3: Acquire problem-solving skills for identifying and addressing pre-, post-, and analytical variables. Thereby compiling and presenting research studies that progress all fields of advanced research using the basics of the research process.
 PO4: Work in a wide range of professional and industrial research fields as a team leader or team member to gain real-world experience.
 PO5: Foster a questioning mindset toward the growth of inventiveness and the improvement of entrepreneurship abilities.

Programme Specific Outcome:

PSO 1: Learners will be able to pick up specific knowledge and skills related to microbiology and apply them.
PSO 2: Students will be able to understand the pathogenic as well as beneficial significance of microorganisms and microbial communities to man and nature, and appreciate the diversity of microorganisms and microbial communities inhabiting a multitude of settings.
PSO 3: states that students will learn and be able to use good laboratory procedures in a Microbiological lab, and be able to describe the theoretical underpinnings and practical abilities of the tools/technologies typically employed to investigate this topic.
PSO 4: Students will learn the basic theories and concepts underlying the diverse branches of agricultural and environmental microbiology.
PSO 5: Students will gain acquaintance with and understanding of the ideas in microbiology as they relate to diverse fields, including biochemistry, microbial physiology, molecular biology, and genetics.
PSO 6: states that students must demonstrate sufficient proficiency in the use of instruments, technological advancements, and microbiology-related procedures, as well as the use of logic and theory testing in the organisation and administration of exams.

PSO 7: Students will have the knowledge and skills necessary to use microbiology to identify problems involving microorganisms, discuss these with colleagues, and take corrective action.

PSO 8: Students will be able to explain the processes through which microorganisms acquire energy, carry out their metabolism, reproduce, survive, and interact with their surroundings, hosts, and host populations.

PSO 9: Students will have a wide range of career options, including positions in higher education institutions teaching biological and medical science, environmental groups, public health, and the food, dairy, pharmaceutical, and biotechnology industries.

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
POST GRADUATE DEGREE (235 Credits)	FIFTH YEAR	SEMESTER -IX	i) C17-Industrial Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C17- Industrial Microbiology	Unit=6/Period=60	N/A	N/A
			ii) C18-Medical Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C18-Medical Microbiology	Unit=6/Period=60	N/A	N/A
			iii) DSE9-Recombinant DNA Technology/ Soil & Agriculture Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iii) DSE 9-Recombinant DNA Technology/ Soil & Agriculture Microbiology	Unit=5 Period=60	N/A	N/A
			iv) GE 4- Food and Dairy Microbiology/Advances in Microbiology (Th.4)	4	4	60	iv) GE 4- Food and Dairy Microbiology/Advances in Microbiology	Unit=6/5Period=60	N/A	N/A
			*Research project/ Industry Training/ Internship Survey	4	4	60			B.Sc. Bio	M.Sc. Biotech

		SEMESTER - X	SEC 5 - MOOCs (Th.2)	2	2	30	SEC 5 MOOCs	Unit=5/Period=30		
			*Research project/ Industry Training/ Internship Survey	20						
*Research topic is to be selected from main core paper.										

Programme Outcome:

PO1: Be capable of providing high-quality clinical investigations by having knowledge and technical expertise related to Microbiology laboratories.

PO2: Handle common laboratory instruments, Perform sophisticated molecular microbiological techniques, maintain/operate laboratory equipment and Conduct standard clinical laboratory techniques while adhering to appropriate quality control standards.

PO3: Acquire problem-solving skills for identifying and addressing pre-, post-, and analytical variables. Thereby compiling and presenting research studies that progress all fields of advanced research using the basics of the research process.

PO4: Work in a wide range of professional and industrial research fields as a team leader or team member to gain real-world experience.

PO5: Foster a questioning mindset toward the growth of inventiveness and the improvement of entrepreneurship abilities.

Programme Specific Outcome:

PSO10: Students in the M.Sc. Microbiology Program will develop their ability to reason scientifically as they explore a wide range of modern topics, including virology, microbial physiology, biochemistry, immunology, cell biology, genetics, molecular biology and microbial genetics, as well as the significance of environmental microbiology.

PSO 11: Students will gain knowledge of the different biotechnological uses of microorganisms as well as the materials produced by microbes that are pertinent to industry. They will gain knowledge of the unique function bacteria play in genetic modification techniques.

PSO 12: Students will gain knowledge of proper lab procedures in a microbiological lab and be able to explain the theoretical underpinnings and practical applications of the equipment and technologies frequently employed in this field. Students can become proficient in the quantitative abilities required to study biological issues.

PSO 13: Students will gain knowledge of experimental techniques, the development and testing of hypotheses, and the planning and carrying out of experiments. Students can improve both their capacity for critical thought and for reading and interpreting scientific texts. Students can develop strong oral and writing communication skills through the effective presentation of experimental results and workshops.

PO 14: Use skill sets to comprehend the justifications for the numerous regulatory/legal organisations that control industry R&D.

PSO 15: The courses will prepare students to pursue Ph.D.-level study in microbiology and related fields.

Format-3

CORE-1
BMBC-NP-111 GENERAL MICROBIOLOGY

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: I Semester: I
Credits: 6 Theory: 4 Practical: 2		Subject: MICROBIOLOGY
Course Code: BMBC-NP-111		Title: GENERAL MICROBIOLOGY
Course Objectives: CO1: The main objective of this course is to provide knowledge to students on microbial world. CO2: To study the history and scope of Microbiology CO3: To provide knowledge on various systems of classification. CO4: The emergence of microbiology as a distinct field of study will be discussed in this course. CO5: To study the microbial diversity and various techniques used in microbiology. CO6: The student will comprehend how bacteria affect our daily lives and the sustainability of life on the earth in terms of their diversity, structure, evolution, and effect.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction, History and Scope of Microbiology: History of microbiology, golden age of microbiology, discoveries and development in various branches of microbiology. Contributions of eminent scientists in the field of microbiology such as, Antonie von Leeuwenhoek, Robert Koch, Louis Pasteur, Joseph Lister, Edward Jenner etc.	12
II	Systems of Classification: Binomial nomenclature, comparison of the three domain of microorganisms- bacteria, archaea, eukarya, classification: five kingdom and three kingdom classification. Bergey’s manual and introduction to classification of bacteria. Overview of prokaryotic and eukaryotic microorganisms with special reference to their cell structure. Acellular and cellular microorganisms.	08
III	Microbial Diversity: Ultrastructure and general characteristics of bacterial cell, comparison of Archaeobacterial and Eubacterial cell. General features of fungi, algae, protozoa, cyanobacteria, action mycetes, rickettsia, and Chlamydia with reference to their occurrence, cell wall structure, reproduction and economic importance.	14

IV	Techniques in Microbiology: Principles, concept of magnification and resolution, Types of microscope: Bright field Microscope, Darkfield Microscope, Phase Contrast Microscope, Fluorescence Microscope, Electron Microscope- TEM and SEM. Principles and application of centrifuge, Laminar flow, bacteriological Incubator & Incubator Shaker Colourimeter as well as Spectrophotometer (UV- Vis).	10
V	Sterilization Techniques and Control of Microorganisms: Sterilization: Physical methods (moist heat- heat under pressure, autoclave, boiling, pasteurization, tyndallization as well as dry heat- hot air oven, incineration; Filtration- depth filter, membrane filter, HEPA filter; Radiation- Ionizing and non- ionizing) Chemical methods- Alcohols, phenols, aldehydes, halogens and ethylene oxide.	10
VI	An overview on scope and inter-disciplinary aspects of microbiology: Importance of micro-organisms in human health, Food and dairy industry, agriculture and environment. Space microbiology: emerging aspect	06

Reference / Text Books:

1. Alexopoulos C.J. and Mims C.W., Introductory Mycology, New Age International, New Delhi.
2. Aneja K.R., Experiments in Microbiology, plant pathology, Tissue culture and Mushroom cultivation, New Age International, New Delhi.
3. Atlas R.M., Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
4. Benson Harold J., Microbiological Applications, WCB McGraw-Hill, New York.
5. Bold H.C. and Wynne M.J., Introduction to Algae, Prentice Hall of India Private Limited, New Delhi.
6. Baveja C.P., Textbook of microbiology APC 6th edition.
7. Dubey R.C. and Maheshwari D.K., Textbook of microbiology, S Chand Publications.
8. Pelczar M.J., Chan E.C.S and Kreig N.R., Microbiology, McGraw-Hill Book Company, New York.
9. Prescott Lansing M., Harley John P. and Klein Donald A., Microbiology, WCB McGraw-Hill, New York.
10. Stanier R.Y., Ingraham J.L., General Microbiology, Prentice Hall of India Private Limited, New Delhi.
11. Sharma P.D., Microbiology, Rastogi Publications. Tortora G.J., Funke B.R. and Case C.L., Microbiology: An introduction, 9th edition, Pearson Education

If the course is available as Generic Elective, then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology	
Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

CLO1: Will be able to recall the history and development of microbiology as a scientific discipline.

CLO2: Will be able to demonstrate about systems of classification, acellular and cellular microorganisms.

CLO3: Will be able to determine the diversity, distribution, cell structure, general characteristics and economic importance of bacteria, algae fungi and protozoa.

CLO4: Will be able to analyze detailed information on the microscopy and other basic techniques.

CLO5: Will be able to appraise various methods of control of microorganisms and safety measures to be followed while working with microbes.

CLO6: Will be able to formulate wide outlook of the scope of microbiology.

PRACTICALS

BMBC-NP-111P : GENERAL MICROBIOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

1. To study various microbiological laboratory practices such as sterilization of glassware and equipment, wrapping of glassware and preparation of cotton plug. Biosafety principles.
2. To study the principle and applications of autoclave, BOD incubator, biological safety cabinets, autoclave, oven and compound microscope.
3. Demonstration of microflora of air by exposing NAM plates.
4. To prepare temporary mount of fungi (Rhizopus, Saccharomyces, Aspergillus etc.) and study reproductive structures and thallus.
5. To prepare temporary mounts of algae (Chlamydomonas, Volvox and Spirogyra, any two).
6. Study of protozoa using permanent mounts or photographs such as amoeba, paramecium, giardia etc.

CORE-2
BMBC-NP-112 BACTERIOLOGY AND BIOSYSTEMATICS

Programme: Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: I Semester: I
Credits: 6 Theory: 4 Practical: 2		Subject: MICROBIOLOGY
Course Code: BMBC-NP-112		Title: BACTERIOLOGY AND BIOSYSTEMATICS
Course Objectives: CO1: The main objective of this course is to give students a thorough understanding of bacterial cell CO2: To study the structure, cultivation, development, and reproduction in a bacterial cell. CO3: To enlighten the students about bacterial diversity and its importance. CO4: To provide the knowledge of bacterial growth and environmental factors affecting the bacterial growth. CO5: To study general characteristics of various Gram’s positive and Gram’s negative bacteria along with Archaeobacteria CO6: This course will also provide the practical knowledge in fundamental and crucial bacteriological procedures, giving the student a solid foundation in microbiology.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Cell structure and organization: Shape, size and arrangement of cell, Cell envelope: capsule and slime layer, flagella, fimbriae and pili. Cell-wall: Structure and Composition, Gram-positive, Gram-negative cell walls and archaebacterial cell wall. Cell Membrane: Structure, chemical composition and function of bacterial and archaeal cell membranes. Cell Cytoplasm: nucleoid, plasmids, Ribosomes, mesosomes and inclusion bodies such as PHB, sulphur globules, cyanophycin, gas vacuoles magnetosomes and polyphosphate granules,. Structure, formation and germination of endospore, sporulation stages.	10
II	Bacterial Growth and Nutrition: Categorization of bacteria on the basis of nutritional requirements. Culture media: components and types (natural and synthetic media, chemically defined media,	10

	complex media, selective, differential, indicator, enriched and enrichment media, transport media etc.). Bacterial growth curve: logarithmic representation of bacterial populations, growth rate and time, phases of growth curve in batch culture.	
III	Bacterial systematics: Bacterial systematics, taxonomy, taxa, species, strains, phonetic classification, phylogenetic classification, genotypic classification, polyphasic taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing and signature sequences. Conventional (classical characteristics, numerical taxonomy), molecular (nucleic acid hybridization, nucleic acid sequencing).	10
IV	Bacteriological techniques: Isolation and Pure culture methods: Streak plate, pour plate, stab culture, slant culture and spread plate methods. Methods of cultivation and maintenance pure cultures. Culture preservation technique, Culture collection Anaerobic bacteria cultivation and non-culturable bacteria.	10
V	Gram negative and Gram positive bacteria: Morphology and general characteristics of typical eubacteria such as <i>Bacillus</i> , <i>Staphylococcus</i> , <i>Corynebacterium</i> , <i>Escherichia</i> , <i>Salmonella</i> , <i>Shigella</i> , <i>Helicobacter</i> , <i>Meningococcus</i> , <i>Streptococcus</i> , <i>Spirochaetes</i> , <i>Rickettsia</i> , <i>Mycoplasma</i> , <i>Clostridium</i> , <i>Mycobacterium</i> , <i>Vibrio</i> etc.	10
VI	Archaeobacteria Overview of Nanoarchaeota (Nanoarchaeum), Crenarchaeota (Sulfolobus, Thermoproteus) and Euryarchaeota [Methanogens (Methanobacterium, Methanocaldococcus), thermophiles (Thermococcus, Pyrococcus, Thermoplasma), and Halophiles (Halobacterium, Halococcus)].	10
Reference / Text Books: 1. Atlas, R.M. (1997). Principles of Microbiology. 2 nd edition. Brown Publishers, USA. 2. Black, J.G. and Black, L.J. (2017). Microbiology: Principles and Explorations. 10th edition. 3. Cappuccino, J. and Welsh, C.T. (2016). Microbiology: A Laboratory Manual. 11th edition. Pearson Education, USA. 4. Madigan, M.T. and Martinko, J.M. (2017). Brock Biology of Microorganisms. 15th edition. Prentice Hall International Inc., USA. 5. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. (1993). Microbiology. 5th edition. McGraw Hill, USA. 6. Srivastava, S. and P.S. Srivastava, P.S. (2003). Understanding Bacteria. Springer, Netherlands. 7. Stanier, R.Y., Ingrahm, J.I., Wheelis, M.L. and Painter, P.R. (1987). General Microbiology. 5 th edition. McMillan Press, UK. 8. Tortora, G.J., Funke, B.R., Case, D., Weber, D. and Bair, W. (2019). Microbiology: An Introduction. 13 th edition. Pearson Education, USA. 9. Willey, J. M., Sandman, K. and Wood, D. (2019). Prescott's Microbiology. 11th edition. McGraw Hill Higher Education, US 10. Prescott, M.J., Harley, J.P., and Klein D.A. Microbiology. 5th edition WCB Mc Graw Hill, New York, 2002.		
If the course is available as Generic Elective then the students of following departments may opt it. NO		
Evaluation/Assessment Methodology		
Max. Marks:100		

1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3)Assignments	04
4)Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes:	
CLO1: will be able to recall the shape, structure, and organisation of many cell components and be able to tell the difference between the cell walls of archaea and eubacteria, as well as between Gram-positive and Gram-negative bacteria. Will be able to describe the Gramme and acid-fast staining processes as well as how antibiotics and enzymes affect the construction of cell walls. CLO2: will be able to demonstrate and specify generation time and growth rate, as well as the nutritional requirements of various types of bacteria and the media composition for bacterial growth. CLO3: will be able to determine and distinguish between distinct classes. will learn about the methods employed in the taxonomy of polyphasic bacteria. CLO4: Will be able to categorize many methods for bacterial culture isolation, cultivation, and preservation. CLO5: Will be able to appraise the morphology and distinguishing characteristics of many Gram-positive and Gram-negative bacteria. CLO6: Will be able to formulate the differences between archaea and eubacteria and be able to list their key general traits, as well as their ecological and economic relevance.	
PRACTICALS	
BMBC-NP-112P : BACTERIOLOGY AND BIOSYSTEMATICS LAB	
Marks: 50	Duration: 60 hours (2 credits)
- To study aseptic techniques and bacterial control methods including physical by heat and radiation, filtration and chemical methods using alcohol. - To prepare different types of media: Nutrient Agar medium, Mac Conkey Agar medium, Eosine Methylene Blue Agar medium, Blood Agar and Chocolate agar, - To isolate pure cultures of bacteria by streaking, pour plate and spread plate method. Preparation of stab culture and slant culture. - To perform enumeration of bacteria by CFU count method by means of spread plate method/pour plate method. - To perform simple and negative staining on bacterial sample and observe size, shape and arrangement of bacteria. - Identification of bacteria using differential staining methods including Gram staining, Capsule staining, Spore staining, Acid fast staining. - To Demonstrate motility by hanging drop method.	

DSE-1a

BMBDSE-NP-113a BASIC COMPUTERS AND BIOINFORMATICS

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: I Semester: I
Credits: 6 Theory: 4 Practical: 2		Subject: MICROBIOLOGY
Course Code: BMBDSE-NP-113a		Title: BASIC COMPUTERS AND BIOINFORMTICS
Course Objectives: CO1: The major objective of this paper is to create a clear knowledge and practical understanding of numerous concepts in computers and bioinformatics in order for students to pursue interdisciplinary studies in the future. CO2: To provide the knowledge of basic computers and bioinformatics in order to apply these techniques in multidisciplinary study and research like-molecular biology, genetics, genomics, transcriptomics, proteomics, and interactomics CO3: To enlighten the students with the knowledge of Rational database management system. CO4: To provide the knowledge of global and local sequence alignment. CO5: To study the diversity of prokaryotic and eukaryotic cell’s genome CO6: To update the students with the knowledge of the structure of various proteins.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Computer fundamentals: Introduction and classification of computer, computer generation, software and hardware, number system, flow chart and operating systems (windows, Unix). Basic concept of MS office, internet, e-mail, web pages and search engines like google etc.	12
II	RDBMS - Relational database introduction; Data transfer mode (FTP, SFTP, SCP), encrypted data transfer and its advantage. Biological databases and types: genome, nucleic acid, protein sequenc and gene expression databases, Metabolic pathways database, Different mode of data storage (File formats: Gene bank, FASTA, and Uniprot, Submission & retrieval of data from NCBI, DDBJ, Uniprot, EMBL and PD.	12
III	Local and global sequence alignment: sequence analysis, sequence alignment pairwise and multiple sequence. Scoring an alignment and matrices, series of	12

	matrices-PAM & BLOSUM. Types of phylogenetic trees, Different approaches of phylogenetic tree construction-, Neighbour joining, Maximum Parsimony, Maximum likelihood and UPGMA	
IV	Diversity of Genomes: Prokaryotic, eukaryotic and viral genomes diversity; Major characteristics of whole genomes of <i>E.coli</i> , <i>S. cerevisiae</i> , and Arabidopsis. Genome. introduction to transcriptome and proteome; Techniques for genome analysis: 2-D gel electrophoresis, MALDI TOF spectroscopy;	12
V	Protein structure: Structures of protein, modeling of structural classes into Folds, Motifs and Domains. Prediction of Protein structure in presence and absence of structure template. Ramachandran plot: Energy minimizations and evaluation. Rational drug design.	12

Reference / Text Books:

1. Mount D., Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press, New York. (2004).
2. Baxevanis, A.D. and Francis Ouellette, B.F., Bioinformatics- A Practical Guide to the Analysis of Genes and Proteins. Wiley India Pvt Ltd. (2009)
3. Teresa K. Attwood, David J. Parry-Smith, Introduction to Bioinformatics. Pearson Education. (1999).
4. Jean-michel Claverie Cedric Notredame. Bioinformatics for Dummies. Publisher: Dummies (2007).
5. Arthur M. Lesk. Introduction to bioinformatics. Oxford University Press.(2004)
6. Dan E. Krane and Michael L. Raymer Fundamental Concepts of Bioinformatics (2002)
7. KRANE Fundamental Concepts of Bioinformatics (2003)
8. Teresa Attwood. Introduction to Bioinformatics (2007)

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

		Max. Marks:100
1) Class tasks/ Sessional Examination		16
2) Presentations /Seminar		-
3) Assignments		04
4) Research Project Report		-
Seminar On Research Project Report		-
5) ESE/Attendance		05
INTERNAL MARKS		25
EXTERNAL MARKS		75
TOTAL		100

Prerequisites for the course:

Course Learning Outcomes:

CLO1: will be able to recall computer skills necessary for the study of biological data.

CLO2: will be able to demonstrate skills using key biological databases, retrieval tools, and tools for comparing data about biological macromolecules. will have a basic understanding of how bioinformatics relates to molecular biology, genetics, and genomics.

CLO3: will be able to determine the idea and importance of sequence alignment, the usage of score matrices and gaps penalty, a comparison of global and local sequence alignment, methods and software for pairwise and multiple sequence comparisons, and applications for each, will all have been covered.

CLO4: Will be able to categorize various viral, prokaryotic, and eukaryotic genomes and their organisation, sequencing techniques, as well as current concepts in gene organisation, difficulties in gene prediction, and primer designing. They will also have knowledge of current genomic and interact omics techniques.

CLO5: Will be able to appraise and comprehend the specifics of proteins' primary, secondary, and tertiary structures, as well as their domains, motifs, and folds.

CLO6: Will be able to formulate protein structures, protein modelling techniques, and rational drug design and discovery.

PRACTICALS

BMBDSE-NP-113aP : BASIC COMPUTERS AND BIOINFORMATICS LAB

Marks: 50

Duration: 60 hours (2 credits)

1. Outline of various operating systems -such as UNIX, LINUX and Windows.
2. Outline to databases of bioinformatics: NCBI/PDB/DDBJ, Uniprot, PDB (any three).
3. To study Sequence retrieval tool by means of BLAST.
4. To study phylogenetic analysis with methods like phylip and clustal.
5. Picking out a given gene from genomes using software such for identification of promoter region, repeat in genome, prediction of ORF such as Glimmer, GENSCAN etc., Primer designing, Genscan /Genetool.
6. Prediction of protein structure: primary and secondary structure prediction by psi-pred, homology modeling using Swiss model. Molecular visualization by jmol, Protein structure model evaluation (PROCHECK).

DSE-1b

BMBDSE-NP-113b BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: I Semester: I
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code: BMBDSE-NP-113b	Title: BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS	
Course Objectives: CO1: Students will learn about the fundamentals of intellectual property rights in this course. CO2: An objective of this course is to prepare them to make significant contributions to the nation's economy through research and innovations. CO3: All facets of the IPR Acts are covered in the course. CO4: The course contains case studies in law and scientific research to comprehend the applicability of the legal ideas in science CO5: This course is meant to increase understanding regarding the protection of intellectual property. CO6: This course will also provide the knowledge of Biosafety guidelines and regulations.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Biosafety Introduction to biosafety, Biological Safety Cabinets and their types; Biohazards and primary contaminant, Biosafety Levels for Specific Microorganisms. Guidelines (AERB/RSD/RES) for using radioisotopes in laboratories and necessary precautions, methods for biohazard waste discard and disinfection methods. biosafety issues in biotechnology	12
II	Biosafety Guidelines and Regulations: GMOs/LMOs: Concerns and Challenges, National and International Regulations; IBSC, RCGM, GEAC, and other institutional biosafety committees' roles in applications of GMOs in food and agriculture; Environmental GMO release; analysis; risk management assessment; Overview of international agreements like the Cartagena Protocol and GRAS organisms.	12
III	Overview of Intellectual Property: Introduction to IPR, IPR in India, the importance of IPR, history and development,	12

	an overview of various IPR types, patents, types, copy right and related rights, industrial design and rights, trademarks, traditional knowledge, and geographical indications; legal protection of biotechnological inventions, World Intellectual Property Rights Organisation (WIPO).	
IV	Grant of Patent and Patenting Authorities: Patent applications and their various types, including Ordinary, PCT, Conventional, Divisional, and Patent of Addition; the patent drafting and filing process; Patent agreements and licencing; Patent infringement: definition, scope, case studies, the rights and responsibilities of the patent owner, and the difference between a granted patent and a patent publication.	12
V	Agreements, Acts and Treaties: The Budapest Treaty on International Recognition of the Deposit of Microorganisms, the GATT and TRIPS Agreements, the Hague and Madrid Agreements, the WIPO Treaties, and the Role of the Madrid Agreement; The Indian Patent Act of 1970 and recent changes; the UPOV and Brene conventions; and the Patent Co-operation Treaty (PCT).	12

Reference / Text Books:

1. Private Power, Public Law: The Globalization of Intellectual Property Rights by Susan K. Sell Cambridge University Press, 2000
2. Essentials of Intellectual Property: Law, Economics, and Strategy by Alexander I. Poltorak; Paul J. Lerner Wiley, 2011 (2nd edition)
3. M K Sateesh .Bioethics and Biosafety . Kindle Edition
4. Diane O. Fleming, Debra L. Hunt Biological Safety: Principles and Practices, 4th Edition. ASM 2006
5. Shomini Parashar, Deepa Goel IPR, Biosafety and Bioethics Pearson India 2013.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

CLO 1: will be able to recall how to work in a microbiological lab while adhering to all safety precautions, handling live bacteria, disposing of infectious waste, and taking care of equipment that needs to be safety audited.

CLO2: will be able to demonstrate the biosafety processes and laws that are followed on a national and worldwide level.

CLO3: will be able to determine the ideas of IPR and its protection.

CLO4: Will be able to categorize the IP protection provided by patents, copyright, and other related

rights.

CLO5: Will be able to appraise the fundamentals of IP protection through the use of trade names, geographical indications, industrial designs, new plant varieties, and particular biotechnological cases.

CLO6: will be able to assemble the Acts, Treaties, and Agreements related to IP protection.

PRACTICALS

BMBDSE-NP-113bP : BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS LAB

Marks: 50

Duration: 60 hours (2 credits)

1. To Study components and design of a BSL II and BSL-III laboratory.
2. To study the procedure for filing applications for approval from biosafety committee [IBSC].
3. To study method/procedure of filing primary applications for patents.
4. To study steps of a patenting process.
5. A case study

CORE-3

BMBC-NP 121: MICROBIAL PHYSIOLOGY AND METABOLISM

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: I Semester: II
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code: BMBC-NP-121	Title: MICROBIAL PHYSIOLOGY AND METABOLISM	
Course Objectives: CO1: Giving learners a thorough understanding of microbial physiology and metabolism is the course's primary goal. CO2: Students will learn about the growth patterns of bacteria and how the environment affects microbial development. CO3: These comprise numerous metabolic pathways present in microorganisms for energy production and carbon and nitrogen absorption. CO4: The course also include mechanisms involved in microbial physiology such as nutrient uptake, bacterial growth, and variables controlling it. CO5: This course will demonstrate various bacterial fermentation methods. CO6: This course will also focus on Chemo lithotrophic and phototrophic metabolism		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Microbial Nutrition and Transport: Microorganism classification based on food supply and energy. Passive and assisted diffusion, primary and secondary active transport, the idea of uniport, symport, and antiport, group translocation, and iron uptake are all examples of nutrient uptake and transport.	10
II	Microbial growth and influence of environmental factors on microbial growth: Definition of growth Bacterial growth curves include diauxic, synchronous, batch, and continuous cultures as well as generation time and particular growth rates. Growth is impacted by temperature, pH, oxygen levels, solute concentration, and water activity.	10

III	Carbon metabolism and energy generation: Concepts of aerobic, anaerobic, and fermentation respiration. EMP route/glycolysis, ED pathway, Pentose phosphate pathway (PPP), Krebs cycle/tricarboxylic acid cycle, and glyoxylate cycle are all involved in the breakdown or catabolism of glucose. A comparison of the mitochondrial and bacterial electron transport chains, electron transport phosphorylation, uncouplers, and inhibitors are all included in the electron transport chain. Dissimilatory nitrate reduction (denitrification, nitrate/nitrite, and nitrate/ammonia respiration) is an anaerobic respiration process that uses nitrate as the final electron acceptor.	10
IV	Bacterial fermentations: Lactate fermentation (homofermentative and heterofermentative routes), Pasteur effect, and alcohol fermentation. idea of branching and linear fermentation routes.	10
V	Chemo lithotrophic and phototrophic metabolism: Definition, physiological categories of chemolithotrophs, descriptions of H ₂ oxidizers in aerobic chemolithotrophy, and methanogens in anaerobic chemolithotrophy. phototrophic bacterium families. Methanogenesis, reductive TCA, anoxygenic and oxygenic photosynthesis, photosynthetic pigments, and cyclic and noncyclic photophosphorylation are among the processes that fix CO ₂ in the Calvin cycle.	10
VI	Assimilation of inorganic nitrogen: Diversity, nitrogen fixation mechanism, nitrogenase activity and its physiological regulation, alternate nitrogenases, ammonia absorption, and assimilatory nitrate reduction are all aspects of biological nitrogen fixation.	10

Reference / Text Books:

1. Cohen, G.N. (2014). Microbial Biochemistry. 2nd edition. Springer, Germany.
2. Gottschalk, G. (1986). Bacterial Metabolism. 2nd edition. Springer, Germany.
3. Madigan, M.T. and Martinko, J.M. (2017). Brock Biology of Microorganisms. 15th edition. Prentice Hall International Inc., USA.
4. Moat, A.G., Foster, J.W. and Spector, M.P. (2002). Microbial Physiology. 3rd edition. John Wiley & Sons, USA.
5. Nelson, D.L. and Cox, M.M. (2017). Lehninger Principles of Biochemistry. 7th edition. W.H. Freeman and Company, UK.
7. Reddy, S.R. and Reddy, S.M. (2005). Microbial Physiology. Scientific Publishers, India.
8. Stanier, R.Y., Ingrahm, J.I., Wheelis, M.L. and Painter, P.R. (1987). General Microbiology. 5th edition. McMillan Press, UK.
9. White, D., Drummond, J. and Fuqua, C. (2011). The Physiology and Biochemistry of Prokaryotes. 4th edition. Oxford University Press, UK.
10. Willey, J. M., Sandman, K. and Wood, D. (2019). Prescott's Microbiology. 11th edition. McGraw Hill Higher Education, USA.

If the course is available as Generic Elective then the students of following departments may opt it. NO

Evaluation/Assessment Methodology	
Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-

5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcome: CLO1: will be able to recall the many bacterial/archaeal physiological groupings and microbial transport systems. CLO2: will be able to demonstrate bacterial development patterns, the bacterial growth curve, how to calculate generation times and specific growth rates, and how the environment affects growth. CLO3: will be able to determine the range of bacterial energy production mechanisms and energy conservation during growth in both aerobic and anaerobic environments. CLO4: Will be able to categorize two significant microbial fermentation routes. CLO5: Will be able to appraise more about the many chemolithotrophic and phototrophic groups and families, depending on their capacity to absorb carbon from CO ₂ and extract energy from inorganic molecules. CLO6: Will be able to formulate the physiological processes through which bacteria fix nitrogen and take up inorganic nitrogen.	
PRACTICALS	
BMBC-NP-121P: MICROBIAL PHYSIOLOGY AND METABOLISM LAB	
Marks: 50	Duration: 60 hours (2 credits)
1. Use the turbidometric method to analyze and plot the growth curve of E. coli. 2. Calculations of the bacteria's production time and specific growth rate from the graph created using the supplied data. 3. How temperature and pH affect the development of E. coli or Aspergillus. 4. Demonstrate that alcohol is fermenting. 5. How carbon and nitrogen affect microbial development. 6. How salt affects the development of E. coli.	

CORE-4
BMBC-NP-122 BASIC BIOCHEMISTRY

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: I Semester: II
Credits: 6 Theory: 4 Practical: 2		Subject: MICROBIOLOGY
Course Code: BMBC-NP-122		Title: BASIC BIOCHEMISTRY
Course Objectives: CO1: The main goal of this essay is to give students a thorough understanding of the fundamental characteristics of various biomolecules, such as carbohydrates, lipids, proteins, and nucleic acids. CO2: The learners will learn the principles of thermodynamics and bioenergetics and CO3: The learners will learn how to apply bioenergetics to biological systems. CO4: The learners will learn the basic composition of various biomolecules. CO5: The learners will learn the structure and biological function of various biomolecules CO6: The learners will learn the classification and function of enzymes.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Concept of Bioenergetics Thermodynamics' first and second laws. Entropy, Gibb's Free Energy, and their mathematical relationships standard equilibrium constant and free energy change Coupled reactions, the additive nature of free energy change, and rich in energy substances like ATP.	10
II	Carbohydrate Aldoses, ketoses, and other monosaccharides Monosaccharides, epimers, mutarotation, and anomers of glucose all exhibit stereoisomerism. Haworth projection formulas for glucose, chair and boat forms of glucose, sugar derivatives, glucosamine, galactosamine, muramic acid, and furanose and pyranose forms of glucose and fructose Disaccharides: reducing and non-reducing sugars, maltose, lactose, and sucrose Haworth projections, Storage polysaccharides include starch and glycogen. structural polysaccharides, including chitin, cellulose, and peptidoglycan.	10
III	Protein Structures that are primary, secondary, tertiary, and quaternary. Amino acid	10

	titration curve and its significance, Amino acids are categorized as proteins' building blocks. Typical protein amino acid structure and notation in biochemistry Ninhydrin response. The definition of zwitterion and the generic amino acid formula. Hydrolysine, cystine, and hydroxyproline are naturally occurring modifications of the amino acids found in proteins. Gramicidin, beta-alanine, D-alanine, and D-glutamic acid are non-protein amino acids.	
IV	Enzymes Enzyme structure, Enzyme classification, metal cofactors, the prosthetic group TPP, the coenzyme NAD, and the apoenzyme and cofactors Active site, transition state complex, and activation energy make up the enzymes' mechanism of action. Both the lock and key and the induced fit hypotheses. significance of the allosteric mechanism notion of V _{max} and K _m , enzyme unit, specific activity, and turnover number, and hyperbolic, double reciprocal graphs of enzyme activity. temperature and pH effects on enzyme activity. Competitive and non-competitive enzyme inhibition.	10
V	Lipids Lipids used in storage and structure. Triacylglycerols, Essential Fatty Acids, Storage Lipids, and Structure and Function of Fatty Acids. Saponification. lipids used in structure Phosphoglycerides: Components, Basic Structure, Uses, and Characteristics. Phosphatidylethanolamine and phosphatidylcholine molecule structures Sphingolipids are the ceramide and sphingosine's structural building blocks. Sphingomyelins, cerebroside, and gangliosides deserve special consideration. Lipid micelles, monolayers, and bilayers are introduced. Cell signals, cofactors, and prostaglandins all have lipid roles.	10
VI	Nucleic acids and vitamins Nucleoside and nucleotide structures, as well as purines and pyrimidines. The production of nucleotides. The basic structure of genomes rich in A+T and G+C. Structure of DNA and RNA types and purposes. Concept, varieties, and function of vitamins in metabolism.	10
Reference / Text Books: 1. Berg, J.M., Tymoczko, J.L., Gatto, G.J., and Stryer, L. (2019). Biochemistry. 9th edition. W.H.Freeman and Company, UK. 2. Campbell, M.K., Farrell, S.O. and McDougal, O.M. (2017). Biochemistry. 9th edition. Cengage Learning, USA. 3. Nelson, D.L. and Cox, M.M. (2017). Lehninger Principles of Biochemistry. 7th edition. W.H. Freeman and Company, UK. 4. Voet, D. and Voet, J.G. (2016). Biochemistry. 5th edition. John Wiley and Sons, UK. 5. Tortora, G.J., Funke, B.R. and Case, C.L. Microbiology: An Introduction. Pearson Education, Singapore, (2004). 6. M.M. Cox, D. L. Nelson. Lehninger's principles of biochemistry. W H Freeman.		
If the course is available as Generic Elective then the students of following departments may opt it. NO		
Evaluation/Assessment Methodology		
Max. Marks:100		

1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes: CLO1. will be able to recall the principles of thermodynamics applied to biological systems and will be able to calculate free energy changes accompanying metabolic reactions. CLO2. will be able to demonstrate the structures of carbohydrates and their key properties and their importance as functional components such as energy generation and as storage food molecules for bacterial cells. CLO3. will be able to determine about the structure and multifarious function of protein and amino acids are formation of polypeptides. CLO4. Will be able to categorize the basic concepts of enzyme biochemistry including enzyme kinetics, and will become aware of different variants of enzymes found in living cells and will be able to calculate enzyme activity and other quantitative and qualitative parameters of enzyme kinetics. CLO5. Will be able to appraise the properties of storage and membrane lipids and also will be acquainted with different types of lipid aggregates and their applications. CLO6. Will be able to formulate the structures and types of nucleic acid and also acquainted with different types of vitamins and their role in metabolic activities	
PRACTICALS BMBC-NP-122P: BASIC BIOCHEMISTRY LAB	
Marks: 50	Duration: 60 hours (2 credits)
1. Water characteristics, the idea of pH and buffers, creating buffers, and numerical problems to clarify concepts. 2. The use of pipettes and micropipettes and accuracy checks. 3. To create the desired Normality and Molarity in the solutions. 4. Numerical issues with equilibrium constant and standard free energy change calculations. 5. Coupled reactions with a standard free energy change. 6. Tests for carbs, reducing sugars, and non-reducing sugars that are qualitative or quantitative. 7. Lipids and protein qualitative and quantitative assays. 8. Model-based study of protein secondary and tertiary structures. 9. Calculation of the V _{max} and K _m values in the study of enzyme kinetics. 10. Research how heavy metals, pH, and temperature affect enzyme activity.	

DSE-2a

BMBDSE-NP-123a: PLANT PATHOLOGY AND DISEASE MANAGEMENT

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: I Semester: II
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code: BMBDSE-NP-123a	Title: PLANT PATHOLOGY AND DISEASE MANAGEMENT	
Course Objectives: CO1: The primary goal of this course is to give students a thorough understanding of plant diseases. CO2: This will also include their causes, symptoms, biochemical and genetic components that affect host-pathogen interactions. CO3: The learner will gain knowledge of the many strategies used by plants to defend themselves and control or avoid plant diseases. CO4: This will give the student the opportunity to start researching new, environmentally friendly ways to prevent disease and boost crop quality and yield. CO5: Students will be able to learn how to treat various illnesses. CO6: Students will also gain knowledge about the management of various plant diseases.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Concept and history of plant disease: information on disease classifications, illness cycles, and pathogenicity, symptoms of microbial plant diseases, different kinds of plant pathogens, financial losses, and the social and economic effects of plant diseases. significant developments in the field of plant pathology contributions from molecular Koch's postulates, Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor, and Van Der Plank.contributions from renowned plant pathologists from India.	12
II	Disease cycle, epidemiology and pathogenicity: Pathogen dispersion, invasion, colonisation, and perennation. Disease triangle, disease pyramid, forecasting of plant diseases, and its applicability in the Indian setting are all concepts covered. the pathogenicity of microbes Enzymes, poisons (both particular and non-specific to the host), growth regulators, and viral virulence factors (replicase, coat protein, silence suppressors) all play a role in the progression of disease.	12

	Pathogen impacts on physiological functions of the host, including photosynthesis, respiration, cell membrane permeability, water and nutrient transport, and plant growth and reproduction.	
III	Genetics of Plant Disease: Types of plant resistance include actual resistance—horizontal and vertical—and apparent resistance. The concepts of resistance (R) gene and avirulence (avr) gene are gene for gene. Concepts of constitutive defence mechanisms in plants, induced structural defences (histological-cork layer, abscission layer, tyloses, gums), and induced biochemical defences [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis-related (PR) proteins, plant bodies, phenolics, quinones, and oxidative bursts] are all covered in the section on defence mechanisms in plants.	12
IV	Principles and practices involved in the management of plant diseases by different methods: Regulations include crop certification, pathogen avoidance, and the use of propagation materials free of pathogens. Cultural: Mulches, crop rotation, use of polyethylene traps, and elimination of hosts. Chemical-resistant diseases, systemic fungicides, antibiotics, and protective agents. biological: suppressive soils, adversarial bacteria and fungus, trap plants; genetic engineering of disease-resistant plants using genes from both plants and pathogens.	12
V	Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control: crucifers' white rust (Albugo candida); potato late blight caused by Phytophthora infestans Wheat's Puccinia graminis tritici black stem rust Wheat flour in loose form, Ustilago nuda; Tobacco wilt caused by Fusarium oxysporum. sugarcane red rot caused by Colletotrichum falcatum; cotton's angular leaf spot, crown galls, and citrus canker; Rice-tungro, coconut cadag-cadang, papaya ring spot, banana bunchy top, aster yellow, papaya ring spot, tomato leaf curl.	12

Reference / Text Books:

1. Agrios, G.N. (2005). Plant Pathology. 5th edition. Elsevier Academic Press, USA.
2. Lucas, J.A. (1998). Plant Pathology and Plant Pathogens. 3rd edition. Blackwell Science, UK.
3. Mehrotra, R.S. and Aggarwal, A. (2017). Plant Pathology. 3rd edition. Tata McGraw-Hill Education, India.
4. Rangaswami, G. and A. Mahadevan, A. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hall, India.
5. Singh, R.S. (2018). Introduction to Principles of Plant Pathology. 5th edition. MedTech, India.
6. Singh, R.S. (2018). Plant Diseases. 10th edition. MedTech, India.

If the course is available as a Generic Elective then the students of the following departments may opt for it. NO

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05

INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes: CLO1: will be able to recall a fundamental understanding of how various pathogens cause plant diseases, as well as knowledge of the contributions made by different plant pathologists. CLO2: will be able to demonstrate disease types based on host and pathogen life cycles and will obtain an in-depth understanding of disease development stages, CLO3: will be able to determine bacteria use growth regulators, enzymes, and toxins to assault plants. They will also become familiar with the genetics of plant diseases and their defensive mechanisms. CLO4: Will be able to categorize the different cultural, regulatory, physical, chemical, and biological strategies that can be used to prevent and/or treat these disorders. CLO5: Will be able to appraise the epidemiology, causes, symptoms, and treatment of several plant diseases. CLO6: Will be able to formulate different methods and principles and practices involved in the management of plant diseases.	
PRACTICALS	
BMBDSE-NP-123aP: PLANT PATHOLOGY AND DISEASE MANAGEMENT LAB	
Marks: 50	Duration: 60 hours (2 credits)
1. Proof of Koch's postulates in bacterial, viral, and fungal plant pathogens. 2. To examining pieces of diseased plant material allows researchers to study significant fungal infections that affect crop plants. 3. To examine Phytophthora infestans using potato leaves that have been infected. 4. To research Puccinia graminis tritici using wheat leaves that have been infected. 5. Studying Colletotrichum falcatum using infected sugarcane is (c) the goal. 6. Examining bacterial infections using images or slides.	

DSE-2 b

BMBDSE-NP-123b: MICROBIAL BIOTECHNOLOGY

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: I Semester: II
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code:BMBDSE-NP-123b	Title: MICROBIAL BIOTECHNOLOGY	
Course Objectives: CO1: This course aims to explain the function of microorganisms in the development of biotechnology, both traditional and modern. CO2: The learners will learn the use of microbe-based processes and technologies, such as biosensors, biopesticides, bioplastics, bioleaching, and genetically modified organisms, CO3: The learners will learn about the advantages and potential drawbacks of microbe-based processes and technologies. CO4: The learners will learn about unconventional vaccines. CO5: The students will gain knowledge about the microbial based transformation CO6: Students will gain knowledge about the purification of Microbial products.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Scope of Microbial Technology: Scope and its uses in food technology, agriculture, the environment, and human medicine. Evaluation of genetically modified organisms (GMOs) critically. Trends in biotechnology in India, with a focus on the top biotechnology businesses and institutions in the nation.	12
II	Industrial Products: Streptokinase and recombinant vaccinations (such as the Hepatitis B vaccine) are examples of recombinant microbial products produced by the pharmaceutical industry. polyester and microbial polysaccharides, Production of bio-pesticides and bioplastics by microorganisms bacteria-based biosensors.	12
III	Microbial-based transformation: Steroids and sterols transformation by microorganisms. Biocatalytic techniques and their industrial uses, manufacturing cocoa butter substitute and high-fructose corn syrup.	12
IV	Microbial product purification: Filtration, ion exchange, and affinity chromatography techniques for the purification of microbial products. Methods	12

	of immobilization and their use. Immobilization of the entire cell. Applications of RNAi in host-pathogen interactions, medication resistance, treatments, and gene silencing.	
V	Microbes for bioenergy and environment: Commercial production of bio-ethanol and bio-diesel from lignocellulosic waste and algal biomass, Biogas production: Using microbial culture, this process produces methane and hydrogen. Microorganisms used in bioremediation include those that break down xenobiotics, recover minerals, and remove heavy metals from aqueous effluents.	12

Reference / Text Books:

1. Crueger, W., Crueger, A. and Aneja, K.R. (2017). Biotechnology: A Textbook of Industrial Microbiology. 3rd edition. Medtech Publisher, India.
2. Demain, A.L., Davies, J.E. and Atlas, R.M. (1999). Manual of Industrial Microbiology and Biotechnology. 2nd edition. ASM Press, USA.
3. Dubey, R.C. (2014). A Textbook of Biotechnology. 5th edition. S. Chand and Co, India.
4. Glazer, A.N. and Nikaido, H. (2007). Microbial Biotechnology: Fundamentals of Applied Microbiology. 2nd edition. Cambridge University Press, UK.
5. Glick, B.R., Pasternak, J.J. and Patten, C.L. (2009). Molecular Biotechnology. 4th edition. ASM Press, USA.
6. P.K. Gupta, P.K. (2009). Elements of Biotechnology. 2nd edition. Rastogi Publications, India.
7. Ratledge, C. and Kristiansen, B. (2006). Basic Biotechnology. 3rd edition. Cambridge University Press, UK.
8. Stanbury, P.F., Whitaker, A. and Hall, S.J. (2016). Principles of Fermentation Technology. 3rd edition. Elsevier Science, Netherlands.
9. Willey, J. M., Sandman, K. and Wood, D. (2019). Prescott's Microbiology. 11th edition. McGraw Hill Higher Education, USA.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

CLO1: Will be able to recall the potential applications of microorganisms in various technologies and disciplines for the direct or indirect benefit of people and the environment.
CLO2: Will be able to demonstrate how producer bacteria and/or processes might generate goods with therapeutic or medical value, extending human longevity.
CLO3: Will be able to determine how microbiology relates to technological advancements in the food and fermentation industries.
CLO4: Will be able to categorize how advances in recombinant DNA technology are compared to advances in microbially-based technology for the environment, industry, and agriculture.

CLO5: Will be able to appraise the significance of microbes in preserving environmental homeostasis, preventing pollution, getting rid of xenobiotics, and producing cheap energy from waste natural lignocellulosic will be further examined.

CLO6: Will be able to formulate commercial production of bio-ethanol and bio-diesel from lignocellulosic waste and algal biomass.

PRACTICALS

BMBDSE-NP-123bP: MICROBIAL BIOTECHNOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

1. Research calcium alginate gels' ability to immobilise yeast cells.
2. Research the sodium alginate method of immobilising enzymes.
3. Fungi that produce pigment Trichoderma Penicillium Aspergillus.
4. Isolation of bacteria that produce xylanase or lipase.
5. Screening of antibiotic producing actinomycetes.
6. Purification of enzymes by filtration methods

GE-1a

BMBGE-NP-124a: INTERACTION WITH ENTREPRENEUR IN MICROBIAL TECHNOLOGY & STARTUP

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: I Semester: II
Credits: 4 Theory: 4 Practical: 0	Subject: MICROBIOLOGY	
Course Code: BMBGE-NP-124a	Title: INTERACTION WITH ENTREPRENEUR IN MICROBIAL TECHNOLOGY & STARTUP	
Course Objectives: CO1: To help students improve their knowledge of the sources of innovation opportunities as well as the abilities to recognize and evaluate these chances for bioentrepreneurship and innovation. CO2: To create a personal skill set for entrepreneurship, innovation, and creativity as well as specific ideas. CO3: The learners will learn methods for integrating and controlling creativity in an organization. CO4: Students will gain knowledge about scope, reach and benefits of medium and small scale industries. CO5: Learners will be aware with the business incubation centers, knowledge centres and RnD. CO6: Learners will gain knowledge about IPR and patents.		
Nature of Paper: Core/DSE/SEC/GE/AECC [GE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 P: 0 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	INTRODUCTION TO BIOENTREPRENEURSHIP – Bioentrepreneurship's potential and its significance. Entrepreneur definition, function, entrepreneur kinds, and benefits of being an entrepreneur. Different forms of innovation, out of box thinking, and potential for bioentrepreneurship. Public and corporate organizations (MSME, DBT, BIRAC, Startup, and Make in India) that promote entrepreneurship. IP protection, marketing methods, and the patent landscape.	10
II	MICROBIOLOGY ENTREPRENEURSHIP: Entrepreneurship in Microbiology: Concepts importance of entrepreneurship in microbiology, Important characteristics for entrepreneurs in microbiology and biotechnology qualities of microbes versus general entrepreneurship. background of entrepreneurial microbiology, Entrepreneurship through industrial, environmental, food, agricultural, and health microbiology can help	14

	to fuel, feed, and cure the planet.	
III	KNOWLEDGE CENTRE AND R & D: Universities, innovation hubs, research institutions, and business incubators examples of knowledge centres. R&D: technology development and improvement, assessment of technological development, management of technology transfer, industry visits to successful bio-enterprises, regulations for the transfer of foreign technologies, quality control, technology transfer agencies, Regulatory compliance and procedural knowledge (CDSCO, NBA, GLP, GCP, and GMP)	12
IV	MEDIUM & SMALL-SCALE INDUSTRY Definition, characteristics, rationalisation, goals, reach, and benefits of small-scale industries. Pharma, agriculture, and industrial: Three types of bioindustries. Production of biofertilizers using cyanobacteria, azospirillum, and azolla. Production of bacterial, fungal, viral, and plant insecticides under the name biopesticides. Sericulture. Apiculture. Dairy farming. Applications and production of single cell proteins. Vermicomposting's uses and benefits. production of mushrooms and use of mushrooms. Ancillary and tiny industries	12
V	INTRODUCTION TO IPR AND PATENT: Traditional Knowledge, Commercial Exploitation & Protection, Protection of Microbiological/Biotechnological Inventions, History & Definition of IPR, Forms/ Types of IPR, Introduction and Patent Types, Requirements for Patenting Different types of patent applications in India, the patent application process, Patent Search	12

Reference / Text Books:

1. Management Fundamentals”, Robert Lusier – Concepts, Application, Skill Development” Thomson
2. Entrepreneurship Development” S S Khanka , S Chand & Co

If the course is available as Generic Elective then the students of following departments may opt it.
yes

1. B.Sc. Biotechnology
2. B.Sc. Biology

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	

Course Learning Outcomes:

CLO1: Will be able to recall the prerequisites for starting a business, both legally and financially.

CLO2: Will be able to demonstrate their own business plan and be able to discuss the significance of management and marketing in small business ventures.

CLO3: Will be able to determine the factors that make bio-entrepreneurship schemes and projects successful.

CLO4: Will be able to categorize the fundamental performance metrics of different entrepreneurial activities can be specified.

CLO5: Will be able to appraise the business prospects, and students will be able to examine the business environment.

CLO6: Will be able to formulate the production of mushrooms and use of mushrooms.

GE-1b

BMGBE-NP-124b: MICROBIAL WORLD AND MICROBIAL DIVERSITY

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: I Semester: II
Credits: 4 Theory: 4 Practical: 0	Subject: MICROBIOLOGY	
Course Code: BMBGE-NP-124b	Title: MICROBIAL WORLD AND MICROBIAL DIVERSITY	
Course Objectives: CO1: After reading this course students will be familiar to various microbes and their properties. CO2: This course emphasis on general characteristic of cellular microorganisms. CO3: Students will gain knowledge of general concept of Phytoplanktons and Zooplanktons. CO4: Learners will be able to understand the historical developments in the field of Mycology including significant contributions of eminent mycologists. CO5: Learners will attain enough knowledge of Actinomycetes and various protozoa. CO6: This course will also focused on the classification of various microorganisms.		
Nature of Paper: Core/DSE/SEC/GE/AECC [GE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 P: 0 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Microbial world: Acellular microorganisms' (Viruses') physiochemical and biological properties; Baltimore categorization; general structure; with particular reference to viroids and prions. Whittaker's five kingdom, Carl Woese's three kingdom, and Binomial Nomenclature categorization schemes utility. Prokaryotic and eukaryotic microbes differentiation.	12
II	General characteristics of Cellular microorganisms: With an emphasis on distribution and occurrence, morphology, mode of reproduction, and economic significance of archaeobacteria, eubacteria, wall-less forms, and MLO (mycoplasma and spheroplasts) discussion. Mycoplasma's composition, reproduction, and economic significance.	12
III	General concept of Phytoplanktons and Zooplanktons: Algal characteristics, occurrence, thallus structure, and categorization. The existence, thallus organization, cell ultra-structure, reproduction, and economic significance of cyanobacteria. Algal uses in food production, industry, the environment, and agriculture.	12

IV	Historical developments in the field of Mycology including significant contributions of eminent mycologists: Fungi general characteristics, such as habitat, distribution, nutritional needs, fungal cell ultrastructure, thallus organization and aggregation, mechanism of reproduction, and economic relevance with examples in agriculture, the environment, industry, medicine, and food.	12
V	Actinomycetes and Protozoa: General characteristics, structure, reproductive method, and economic significance of Actinomycetes with specific reference to its use in industry and medicine. Protozoa's general characteristics, occurrence, classification scheme, reproduction, and economic significance.	12

Reference / Text Books:

1. Singh, R.P. General Microbiology. Kalyani Publishers, New Delhi (2007).
2. Aneja, K.R. Experiments in Microbiology, Plant Pathology and Biotechnology, Fourth edition, New Age International publishers.
3. Dubey, R.C. and Maheshwari, D.K. Text book of Microbiology. S. Chand and company (1999).
4. Powar, C.B. and Dagainawal, H.F. General Microbiology. Vol-I and Vol- II, Himalaya Publishing House.
5. Chakraborty P. A Textbook Of Microbiology. New central book Agency (2005).
6. Prescott, M. J. Harley, J.P. and Klein, D.A. Microbiology. 5th Edition W C B M c Graw Hill, New York, (2002).
7. Tortora, G.J., Funke, B.R. and Case, C.L. Microbiology: An Introduction. Pearson Education, Singapore, (2004).
8. Alcamo, I.E. Fundamentals of Microbiology. VI Edition, Jones and Bartlett Publishers. Sudbury. Massachusetts, (2001).
9. Black J.G. Microbiology-Principles and Explorations. John Wiley & Sons Inc. New York, (2002).
10. Pelczar, M J Chan ECS and Krieg NR, Microbiology McGraw-Hill.
11. Willey, Sherwood, Woolverton. Prescott, Harley, and Klein's Microbiology McGraw-Hill publication
12. Tortora, Funke, Case. Microbiology. Pearson Benjamin Cumming

If the course is available as a Generic Elective, then the students of the following departments may opt it. YES

1. B.Sc. Biotechnology
2. B.Sc. Biology
3. BMLT

Evaluation/Assessment Methodology	
Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3)Assignments	04
4)Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

CLO1: will be able to recall the diversity of microbes and the fundamental traits of acellular microorganisms.

CLO2: will be able to demonstrate the fundamental traits, prevalence, and distribution of cellular microorganisms.

CLO3: will be able to determine the Basic Phytoplankton and Zooplankton Concepts

CLO4: Will be able to categorize historical mycological developments, including key contributions made by renowned mycologists.

CLO5: Will be able to appraise the features and economic significance of Actinomycetes and Protozoa in general.

CLO6: Will be able to formulate how microbiology has evolved historically.

BMBC-NP-231: MYCOLOGY AND PHYCOLOGYBOS Page | 348

	fermentation, baking, organic acids, enzymes, and mycoprotein secondary metabolites include pharmaceutical preparations; biofertilizers use in agriculture; mycotoxins as biological pesticides; and mycofungicides, mycoherbicides, and mycoinsecticides uses in agriculture. The cultivation of mushrooms.	
V	Introduction to Phycology Phycology includes information on the distribution of algae, classification of algae, pigments, the characteristics of chlorophylls, carotenoids, and phycobilins, as well as the reserve food, thallus organization in algae, and reproduction in algae. Algal commercial goods include biofuel. Algal role in soil fertility, biofertilizer, nitrogen fixation, and symbiosis.	12
VI	Life cycle of important genera of Algae Important genera of algae (Chlamydomonas, Volvox, Cladophora, Oedogonium, Vaucheria, Polysiphonia, Sargassum) and Economic importance of algae.	06
Reference / Text Books: - Alexopoulos, C.J., Mims, C.W. and Blackwell, M, Introductory Mycology. John Wiley, New York. - Mehrotra, R.S., and K.R.Aneja An Introduction to Mycology. New Age International Press, New Delhi. - Webster, J. Introduction to fungi. Cambridge University Press. Cambridge, U.K. (1985). - Bessey E.A. Morphology and Taxonomy of fungi. Vikas Publishing House Pvt. Ltd., New Delhi. - Jhon Webster and R W S Weber. Introduction to Fungi. Cambridge University Press 2007. A. V. S. S. Samba Murthy. A Textbook of Algae. I.K. International Publishing House Pvt. Limited, 2010 - H.D. Kumar and H.N. Singh. A Textbook on Algae (Macmillan international college edition).		
If the course is available as a Generic Elective then the students of the following departments may opt for it. NO		
Evaluation/Assessment Methodology		
		Max. Marks:100
1) Class tasks/ Sessional Examination		16
2) Presentations /Seminar		-
3) Assignments		04
4) Research Project Report		-
Seminar On Research Project Report		-
5) ESE/Attendance		05
INTERNAL MARKS		25
EXTERNAL MARKS		75
TOTAL		100
Prerequisites for the course:		

Course Learning Outcomes:

CLO 1: will be able to recall mycology's history and development, as well as the general traits, makeup, and reproduction of fungi, as well as the beneficial and hazardous actions of both fungi and algae.

CLO 2: will be able to recognize the Ascomycotina, Basidiomycotina, Deuteromycotina, etc. life cycle.

CLO 3: will be possible to apply the knowledge to understand the myxomycotin, mastigomycotin, zygomycotin, and other life cycles.

CLO 4: will be able to analyze the biotechnological uses of fungus.

CLO 5: will have the ability to predict the distribution, classification, general traits, structure, and reproduction of algae.

CLO 6: will be able to assemble the algal life cycles of significant genera.

PRACTICALS

BMBC-NP-231P: MYCOLOGY AND PHYCOLOGY

Marks: 50

Duration: 60 hours (2 credits)

1. Preparation of Potato Dextrose Medium.
2. To isolate fungi from soil.
3. By using the lactophenol cotton blue stain, identification of the fungus.
4. To count fungus spores with a hemocytometer.
5. Algal species identification (permanent slides).
6. Fungal spore identification using permanent slides.
7. Isolation and identification of algae from pond water.
8. Studies of permanent slides of different types of algae.
9. Study of fungus-infected plant symptoms.
10. Rhizopus: To investigate asexual stages from temporary mounts, students will culture Black bread mold in a lab. Mold's sexual stages should be examined on permanent slides.

CORE-6
BMBC-NP-232: VIROLOGY

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: II Semester: III
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code: BMBC-NP-232	Title: VIROLOGY	
Course Objectives: CO1: This course's main goal is to familiarise students with the structure, genomic organization, and replication techniques of viruses that infect plants, animals, and microbes. CO2: The learner will discover how they develop, spread, and cause illness. CO3: The learner will study how to prevent and control disease-causing viruses. CO4: The course also covers the management of emerging viruses in the context of threats to public health. CO5: Students will study the diversity, classification, and properties of bacteriophages. CO6: Students will also learn various types of oncogenic DNA and RNA viruses.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Nature and Properties of Viruses The nature and general characteristics of viruses, their discovery and development, the classification and name of several virus groupings, the fundamentals of virus taxonomy, and Principal traits of the viral families, genera, and groupings. Viroids, satellite viruses, satellite nucleic acids, and prions are sub-viral agents.	10
II	The structure of viruses Virion size, symmetry of the capsid, enveloped and non-enveloped viruses, and viruses' genomes Viral genome diversity includes circular and linear, single- and double-stranded DNA genomes. Positive and negative, linear and circular, single and double-stranded, and mono, bi, tri, and multipartite viral genomes are all types of RNA genomes.	08
III	Bacteriophages Diversity, classification, the idea of early and late proteins, lytic and	08

	lysogenic phages (lambda phage), and lambda phage transcription regulation.	
IV	Isolation, cultivation, and purification of viruses Animal viruses can be isolated and grown in primary and secondary cell cultures, embryonated eggs, experimental animals, and animal cells. Plant viruses – tissue cultures and experimental plants. Viral purification includes the removal of viruses from tissues, clarity, and chemical and physical concentration of the extracted viruses.	10
V	Replication of viruses Baltimore techniques of viral genome replication and expression are examples of viral replication and replication tactics. virus reproduction includes that caused by polio, MS2, T4, Lambda, Phi X-174, TMV, cauliflower mosaic virus, HIV, influenza, pox, and coronaviruses.	10
VI	Viruses and Cancer Oncogenes and proto-oncogenes are concepts that are used to describe many types of oncogenic DNA and RNA viruses.	06
VII	Prevention & control of viruses Aseptic procedures, washing and disinfection, protective attire, and isolation are all part of the infection control program. Sanitation, vector control, immunization, and vaccinations are all forms of prevention; Control: effectiveness of infection control, chemotherapy (antiviral medicines, interferon therapy).	08

Reference / Text Books:

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology,
4. Molecular biology, Pathogenesis, and Control. 2nd edition. ASM press Washington DC.
5. Levy JA, Conrad HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
6. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
7. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
8. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
9. Bos L. (1999) Plant viruses-A textbook of plant virology by. Backhuys Publishers.
10. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

If the course is available as a Generic Elective then the students of the following departments may opt it. NO

Evaluation/Assessment Methodology	
	Max. Marks:100
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:	
Course Learning Outcomes: CLO1: will have an understanding of the taxonomy of several virus groups and be able to describe the nature and general characteristics of viruses. CLO2: will be able understand the genomic and structural differences between various enveloped and non-enveloped viruses. CLO3: will be able to determine the composition, variation, classification, and reproduction of lytic and lysogenic bacteriophages. CLO4: will analyze how simple it is to isolate, grow, and purify significant bacterial, animal, and plant viruses. CLO5: will appraise key plant, animal, and bacterial viruses' replication mechanisms, maturation, and release. CLO6: will build a knowledge of newly developing viruses that have the potential to pose major hazards to public health and have become a global concern, as well as the concepts of oncogenesis and DNA and RNA cancer-causing viruses.	
PRACTICALS BMBC-NP-232P: VIROLOGY LAB	
Marks: 50	Duration: 60 hours (2 credits)
1. Use electron micrographs to study the structure of significant animal viruses, including corona, para myxo influenza, and rhabdo. 2. Use electron micrographs to study the structure of significant plant viruses, such as the caulimo, gemini, tobacco ring spot, cucumber mosaic, and alpha-alpha mosaic viruses. 3. Using an electron microscope, the structure of significant bacterial viruses (X 174, T4) was studied. 4. Using the double agar layer technique, bacteriophages (PFU) isolation and enumeration from a water/sewage sample. 5. Studying the isolation and spread of animal viruses using the chick embryo method. 6. Usage of pictures to study the cytopathic effects of viruses. 7. Use the local lesion method to test for plant viruses. 8. Study of the virus by photographic images.	

DSE-3 a
BMBDSE-NP-233a BIOPHYSICS AND BIOSTATISTICS

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: II Semester: III
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code: BMBDSE-NP-233a	Title: BIOPHYSICS AND BIOSTATISTICS	
Course Objectives: CO 1: The primary focus of this course is to prepare students to handle biological data. CO2: The learner will draw appropriate conclusions from its analysis. CO3: The main goal of this course is to provide knowledge of biophysics, a field that applies physics theories. CO4: The learner will understand how biological systems work. CO5: The learner will understand different biological system laws. CO6: The learner will understand the application of biostatistics.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Biophysics: Introduction, uses, and range of biophysics; biophysical techniques (centrifugation, microscopy, and spectrophotometer) Protein folding, DNA unzipping, and ion pumping are examples of membrane-based processes. Action Potentials and Ion Channels in Nerve Impulses; X-ray diffraction, light and neutron scattering, Nuclear Magnetic Resonance, Fluorescence, Tomography, Patch clamping; and general descriptions of the chemical composition of living cells in Physical Techniques and Related Biology.	10
II	Thermodynamics of biological systems: Laws of thermodynamics (first and second law), enthalpy, entropy, Kinetics of the simple enzymatic reaction, conformational properties of enzymes, mechanism of enzyme-substrate interaction.	10
III	Physico-chemical Foundations Water structure, molecular structure, and hydrophobic interactions are all	10

	covered in the biophysics of water. Small-Molecule Solutes: Hydrophiles, Hydrophobes, Large Hydrophobic Solutes and Surfaces, Aqueous Environment of the Cell, State of water in bio- structures & its significance, Protein Hydration-Nonspecific Effects, The Hydration Shell. Bases & Acids Acid-Base theories, mole theory, molecularity, molality, and normality, ampholyte, pH concept, pH measurements, Henderson-Hasselbatch equation, titration curve, pK values, buffers, and pH stability of their buffers are among the topics covered. Also included are numerical issues. Redox potential: Examples of redox potential in biological systems include oxidation and reduction.	
IV	Introduction of Bio-Statistics: Biostatistics' restrictions and application areas data classification and tabulation data shown graphically, mathematical mean the frequency distribution's median and mode, Variance; standard deviation; mean deviation.	10
V	Sampling Methods: simple stratified random sampling, applying a cluster sampling technique, Sampling Error, Regression Line Correlation, the least squares method, the Rank Correlation Coefficient, and Karlpearson's Coefficient of Correlation	10
VI	Test of significance: Variance, t-distribution chi-square test, one- and two-way classification, an ANOVA table, probability, Probability definition in terms of its addition and multiplication theorems.	10

Reference / Text Books:

1. Mechanics of the cell by David H. Boal, Cambridge University Press (2001)
2. Basic biophysics for biologists by Daniel, M: Agrobios (2007)
3. Biophysics: Searching for Principles by William Bialek, Princeton University Press (2012)
4. Introduction to Biophysics by P K Banerjee, S Chand & Company publishers (2010)
5. Biophysics - An Introduction by Rodney Cotterill, Wiley (2014)
6. Gupta S.P, Statistical Method, Sultan Chand & Sons Publications,(2005)
7. Khan I.A. Statistics, Ukaaz Publications, 2009
8. Taylor R.A. Biostatistics, Dorling Kindersley Pvt. Ltd.

If the course is available as a Generic Elective then the students of the following departments may opt for it. NO

Evaluation/Assessment Methodology	
Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes:	
CLO 1: will be able to recall to biophysics' introduction, applications, and methodology.	
CLO 2: will be able to understand how biological systems behave thermodynamically.	

CLO 3: will be able to determine the fundamental physical characteristics of cells or biological processes and the fundamental research techniques.
CLO 4: will be able to use biostatistics to analyze the introduction, scope, classification, and tabulation of data.
CLO 5: will have the ability to appraise several sampling techniques for data analysis.
CLO 6: will be possible to prepare several significance tests.

PRACTICALS

BMBDSE-NP-233aP: BIOPHYSICS AND BIOSTATISTICS LAB

Marks: 50

Duration: 60 hours (2 credits)

1. To confirm Lambert Beer's law.
2. Centrifugation demonstration and analysis of several microbe-related samples.
3. Titration of acids and bases using a pH meter and determination of pK values Strong acid vs Strong base, Weak acid vs Strong base, and a mixture of Strong and Weak acid vs Strong base.
4. pH measurement and buffer preparation.
5. To calculate the pKa values and determine the protein titration curve.
6. Using a dataset that has been grouped and ungrouped, calculate the Mean, Median, and Mode.
7. Coefficient of Variation and Standard Deviation.
8. Testing of Hypothesis: Chi-Square, t-Test, and Normal Distribution.

DSE-3b

BMBDSE-NP-233b: MICROBIAL PRODUCTS (BIOFERTILIZERS & BIOPESTICIDES)

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: II Semester: III
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code:BMBDSE-NP-233b	Title: MICROBIAL PRODUCTS (BIOFERTILIZERS & BIOPESTICIDES)	
Course Objectives: CO1: The major goal of this essay is to give students a solid understanding of the many kinds of bio-fertilizers. CO2: Learners will understand the bio-fertilizers benefits and drawbacks in comparison to chemical fertilizers. CO3: This course's main emphasis will be on the production of various types of bio-fertilizers for sale to final consumers. CO4: The purpose of this course is to teach students how to manage agricultural diseases and pests in an environmentally friendly way. CO5: Various microbial biopesticide properties will also be explored. CO6: The learners will learn the significance of mycorrhiza in the production of biofertilizers.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Biofertilizers: An overview of the benefits of using microorganisms instead of artificial fertilizers for various agricultural plants. Companion N2 fixers: Frankia - Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis; Rhizobium - Isolation, characteristics, types, inoculum generation and field application, legume/pulse plants.	12
II	Cyanobacteria as bio-fertilizers: characterization, mass multiplication, and isolation Farm application, crop response, and role in rice production. Nitrogen Fixers Without Symbiosis. Free-living Azospirillum, isolation without Azotobacter, characteristics, mass inoculums, production, and field uses.	12

III	Phosphate Solubilizers: Isolation, characterization, mass inoculum production, and field application of microorganisms that solubilize phosphate. Isolation, characterization, manufacture in large quantities, and application of PGPR.	12
IV	Mycorrhizal Bio-fertilizers: The significance of mycorrhizal inoculum, different mycorrhizae and their associated plants, mass production of VAM inoculum, and field application of Ectomycorrhizae and VAM.	12
V	Bioinsecticides: The significance of mycorrhizal inoculum, different mycorrhizae and their associated plants, mass production of VAM inoculum, and field application of Ectomycorrhizae and VAM.	12

Reference / Text Books:

1. Eldor A. Paul. Soil Microbiology. Ecology and Biochemistry. VI Edition: Academic Press, (2007).
2. Eugene L. Madsen. Environmental Microbiology: From Genomes to Biogeochemistry. I Edition, Wiley-Blackwell Publishing. (2008).
3. Agrios, G. N. Plant pathology. Harcourt Asia Pvt. Ltd. (2000).
4. Buchanan. B. B., Gruissem, W. and Jones, R. L. Biochemistry and Molecular Biology of Plants. I. K. International Pvt. Ltd. (2000).
5. Mehrotra R S and Ashok Agrawal. Plant Pathology. Tata Mc Graw Hill, 6th reprint (2006).
6. K. S. Bilgrami, H. C. Dube. A textbook of modern pathology. 6th Edition, Vani Educational Books, a division of Vikas, (1984).
7. Shalini Suri. Biofertilizer and Biopesticide Aph Publishing Corporation (2011).

If the course is available as a Generic Elective then the students of the following departments may opt for it. NO

Evaluation/Assessment Methodology	
Max. Marks: 100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

- CLO1: Will recall the broad description of using soil bacteria as fertilizers.
- CLO2: will be able to summarize the typical bacterial and cyanobacterial biofertilizers used for various crops.
- CLO3: will determine phosphate-solubilizing microorganisms' isolation, bulk cultivation, and field applications.
- CLO4: will categorize the information about the isolation, traits, and industrial production of mycorrhizal biofertilizers.
- CLO5: will be able to evaluate the basics of bacteria used as bioinsecticides and why they are

superior to synthetic pesticides.

CLO6: Students will be able to contrast the effects of chemical and biological fertilizers on crop productivity.

PRACTICALS

**BMBDSE-NP-233bP: MICROBIAL PRODUCTS (BIOFERTILIZERS & BIOPESTICIDES)
LAB**

Marks: 50

Duration: 60 hours (2 credits)

1. To isolate the Rhizobium, a symbiotic nitrogen fixer, from soil samples.
2. To isolate Azotobacter and Azospirillum, two asymbiotic nitrogen fixers, from soil samples.
3. Isolation of blue-green algae and phosphate-solubilizing microbes.
4. To prepare composting from kitchen waste.
5. Composting process demonstration.

GE-2a

BMBGE-NP-234a: FOOD FERMENTATION TECHNOLOGY

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: II Semester: III
Credits: 4 Theory: 4 Practical: 0	Subject: MICROBIOLOGY	
Course Code: BMBGE-NP-234a	Title: FOOD FERMENTATION TECHNOLOGY	
Course CO1: The main goal of this essay is to provide students with knowledge of food fermentation technology. CO2: The learners will learn the use of microorganisms in industrial production. CO3: The learners will learn the advantageous and disadvantageous behaviors of microorganisms in relation to food and their uses in the food industry. CO4: The learners will learn various design parameters of fermentation. CO5: The learners will learn the production method of dairy-fermented products. CO6: The learners will learn the principles and methods of food preservation.		Objectives:
Nature of Paper: Core/DSE/SEC/GE/AECC [GE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 P: 0 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Food fermentation The evolution and application of food fermentation technologies; food and nutrition concepts; food's physiochemical characteristics; the significance and kinds of microorganisms (bacteria, mold, and yeast) that can be found in food; Food as a substrate for microorganisms: Natural flora, sources of food contamination, and intrinsic and extrinsic variables that affect the development and survival of germs in food.	10
II	Design of fermenters Various fermenters, Fermenters' construction and operation fundamental ideas for choosing a reactor, Fluidized bed reactor, trickle bed reactor, bubble column reactor, packed bed reactor expansion of the bioreactor.	10
III	Food as a substrate for microbial growth and food-borne diseases Characteristics that influence microbial growth in food, both intrinsic and extrinsic. Food spoiled by microbes includes milk, bread, and canned goods. Clostridium botulinum food poisoning. Salmonella contamination of food. Traveler's diarrhea.	10

IV	Dairy-fermented products and Probiotics Acidophilus milk and cheese, Dahi, yogurt, buttermilk, kefir: inoculum preparation, fermentation types, and process of production. Definition, benefits, and examples of probiotics.	10
V	Grain-based and other non-dairy fermented foods Bread, idli, dosa, soy sauce: inoculum preparation, varieties of microorganisms, and fermentation process: Pickles, sauerkraut, and other fermented dishes made from vegetables, meat, or fish.	10
VI	Principles and methods of food preservation: Physical techniques include irradiation, aseptic packing, and high and low temperatures. Salt, sugars, benzoates, citric acid, ethylene oxide, nitrate, and nitrite chemical processes. Management for ensuring food quality: HACCP. Quality assurance tests of the finished product: Sterility testing, Pyrogen testing, Ames test, toxicity testing, and shelf life testing. Validation principles for the pharmaceutical business.	10

Reference / Text Books:

1. Adams, M.R. and Moss, M.O. (2000). Food Microbiology. 2nd edition. New Age International Publishers, India.
2. Banwart, G.J. (2004). Basic Food Microbiology. 2nd edition. CBS Publishers and Distributors, India.
3. Casida, L.E. (2019). Industrial Microbiology. 2nd edition. New Age International, India.
4. Crueger, W., Crueger, A. and Aneja, K.R. (2017). Biotechnology: A Textbook of Industrial Microbiology. 3rd edition. Medtech Publisher, India.
5. Frazier, W.C., Westhoff, D.C. and Vanitha, N.M. (2013). Food Microbiology. 5th edition. Tata McGraw-Hill Publishing Company Ltd, India.
6. Jay, J.M., Loessner, M.J. and Golden, D.A. (2006). Modern Food Microbiology. 7th edition. CBS Publishers and Distributors, India.
7. Patel, A.H. (1996). Industrial Microbiology. 1st edition. Macmillan India Limited.
8. Stanbury, P.F., Whitaker, A. and Hall, S.J. (2016). Principles of Fermentation Technology. 3rd edition. Elsevier Science, Netherlands.

If the course is available as a Generic Elective then the students of the following departments may opt for it.

YES

1. B.Sc. Biotechnology
2. B.Sc. Biology
3. B.Sc. Agriculture

Evaluation/Assessment Methodology

Max. Marks:100

1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcome:

CLO1: will be able to recall about the background, evolution, and application of food fermentation technology.

CLO2: will be able to demonstrate many types of fermenters and their components. Also, will be familiar with the many methods used for industrial strain isolation, screening, preservation, and upkeep.

CLO3: will be able to calculate key factors influencing microbial development in foods. The learner will learn about common food-borne illnesses as well as the microorganisms that can cause the spoilage of some common foods.

CLO4: will be able to analyze the use of microorganisms as food supplements and in the fermentation of dairy products.

CLO5: will be able to appraise the microorganism's utilization in the fermentation of non-dairy products and grain-based products.

CLO6: will be able to design many physical processes and chemicals used in food preservation. Additionally, the learner will be familiar with the idea of food quality management.

GE-2 b

BMBGE-NP-234b: MICROBIAL QUALITY CONTROL IN FOOD & PHARMACEUTICAL INDUSTRIES

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: II Semester: III
Credits: 4 Theory: 4 Practical: 0	Subject: MICROBIOLOGY	
Course Code: BMBGE-NP-234b	Title: MICROBIAL QUALITY CONTROL IN FOOD & PHARMACEUTICAL INDUSTRIES	
Course Objectives: CO1: Students will learn specialized skills in the area of quality control in this course. CO2: Students will learn the methods used in the food and pharmaceutical industries to maintain the quality, safety, potency, and reliability of their final products. CO3: Students become familiar with various procedures (qualitative and quantitative methods) for detecting different microorganisms and compliance with standards. CO4: Students will learn various methods to determine microbes in food samples. CO5: Students will learn methods for quickly determining the microbiological quality of milk CO6: Students will learn principles, flowcharts, and restrictions for the Hazard Analysis of Critical Control Points.		
Nature of Paper: Core/DSE/SEC/GE/AECC [GE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 P: 0 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Microbiological Laboratory and Safe Practices: Good laboratory practices, good microbiological practices, and biosafety cabinets with specifications for BSL-1, BSL-2, and BSL-3 are all important. Biohazardous waste disposal techniques include autoclaving, disinfecting, and incinerating.	12
II	Determining Microbes in Food / Pharmaceutical Samples: Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, and sterility testing for pharmaceutical items. Culture and microscopic methods: Standard plate count, Most Probable Numbers, Direct Microscopic Counts.	12
III	Methods to determine microbes in samples: Biosensors, PCR-based detection, and nucleic acid probes. cultural enrichment strategy, XLD agar for the detection of specific bacteria EMB agar, McConkey Agar, Manitol Salt Agar, Salmonella Shigella Agar, and Saboraud dextrose Agar.	12

Reference / Text Books:

1. Akers, M.J. (2016). Sterile Drug Products: Formulation, Packaging, Manufacturing and Quality. 1st edition. CRC Press, USA.
2. Baird, R.M., Hodges, N.A and Denyer, S.P. (2005). Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices. Taylor and Francis Inc., USA.
3. Cooper, M.S. (editor). Quality Control in the Pharmaceutical Industry Vol.2. Academic Press, The USA.
4. Garg, N., Garg, K.L and Mukerji, K.G. (2010). Laboratory Manual of Food Microbiology. I K International Publishing House, India.
5. Harrigan, W.F. (1998). Laboratory Methods in Food Microbiology. 3rd edition. Academic Press, USA.
6. Jay, J.M., Loessner, M.J. and Golden, D.A. (2006). Modern Food Microbiology. 7th edition. CBS Publishers and Distributors, India.
7. Law, J.W., Mutalib, N.A., Chan, K.G. and Lee, L.H. (2014). Rapid methods for the detection of foodborne bacterial pathogens: principles, applications, advantages and limitations in *Frontiers in Microbiology*. 5: 770, 2014.
8. Mathur, P. (2018). Food Safety and Quality Control. Orient Blackswan, India.

1. B.Sc. Biotechnology
2. B.Sc. Biology

Max. Marks:100

Prerequisites for the course:
Course Learning Outcomes: CLO1: will be able to define biosafety and good laboratory practices. CLO2: will be able to explain about how to identify bacteria in a sample. CLO3: will be able to calculate the numerous microbial load detection and CLO4: will be able to analyze the need for MBRT to assess the milk's microbiological quality. CLO5: will be able to appraise numerous certifications and standards for pharmaceutical and food items. CLO6: will be able to design assessment tests used in the food and pharmaceutical industries.

CORE-7

BMBC-NP-241: MOLECULAR BIOLOGY

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: II Semester: IV
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code:BMBC-NP-241	Title: MOLECULAR BIOLOGY	
Course Objectives: CO1: The main goal of this work is to create a comprehensive knowledge of how prokaryotic genome organization and expression relate to their ability to survive and reproduce. CO2: Students will master the fundamentals of molecular biology, which will serve as the foundation for later courses. CO3: The learners will learn the overview of genome organization. CO4: The learners will learn replication techniques. CO5: The learners will learn these processes' transcription, translation, and post mechanism. CO6: The learners will learn the mechanism to regulate gene expression.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Overview of the genome organization DNA types, genetic material types, and DNA structure: highlights of the double helix. RNA Organization. Cot curves, denaturation, and renaturation. DNA topology: topoisomerases, connecting numbers. DNA organization in viruses, eukaryotes, and prokaryotes.	10
II	DNA Replication in Prokaryotes and Eukaryotes: Semi-conservative and semi-discontinuous replication, bidirectional replication, and unidirectional replication. replication of DNA mechanism, Chromosome replication is completed. DNA replication techniques. Eukaryotic and prokaryotic replication are different.	10
III	Transcription in Prokaryotes and Eukaryotes: Concept of a transcription unit, promoter: its composition and function. Prokaryotes and eukaryotes both undergo general transcription; eukaryotes also undergo post-transcriptional modification. Prokaryotic and eukaryotic RNA Polymerases, RNA Interference, and tRNA and rRNA processing.	10

IV	Post-Transcriptional Processing: RNA splicing, the idea of introns and exons, the spliceosome system, the idea of alternative splicing, polyadenylation, and capping of gene splitting. rRNA processing. The importance of RNA interference. microRNAs: their importance and role.	10
V	Translation in prokaryotes and eukaryotes: tRNA structure, ribosome structure Prokaryotic and eukaryotic translational mechanisms, gene sequences, Wobble hypothesis, accuracy of the translation.	10
VI	Regulation of gene expression in prokaryotes and eukaryotes: Mechanisms for controlling transcription, regulating gene expression, DNA methylation-based gene regulation, and histone acetylation-based gene regulation Translation control systems, inducible operons, and repressible operons.	10

Reference / Text Books:

1. Watson, J. et. Al. 2004. Molecular Biology of the Gene, 5th Edition, CSHL Press, New York.
2. Conn, E., & Stumpf, P. 2009. Outlines of Biochemistry, 5Th Ed. Wiley India Pvt. Limited.
3. T A Brown. 2001. Essential Molecular Biology. Oxford University Press, USA
4. Brock, T.D. 1990. The Emergence of Bacterial Genetics, Cold Spring Harbor Lab Press.
5. Ptashne, M. 2002. Genes and Signals, Cold Spring Harbor Laboratory Press.
6. Miller, J.R. 1992. A Short Course in Bacterial Genetics: Lab Manual, Cold Spring Harbor
7. Hardin, J., Bertoni, G. and Kleinsmith, L. (2011). Becker's World of the Cell. 8th edition. Benjamin Cummings, USA.
8. Karp, G. (2013). Cell and Molecular Biology. 7th edition. Wiley and Sons, UK.
9. Krebs, J., Goldstein, E. and Kilpatrick, S. (2012). Lewin's Essential Genes. 3rd edition. Jones and Bartlett Publishers, USA. Laboratory Press.

If the course is available as a Generic Elective then the students of following departments may opt it. NO

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

CLO1: Will be able to recall the differences between prokaryotic and eukaryotic genome organisation, as well as the prokaryotic cellular structure and functional components of cells.
CLO2: Will be able to demonstrate the mechanisms through which chromosomal and extra chromosomal genes and sequences replicate, transmit, and act.
CLO3: Will be able to determine and classify multiple levels of genetic regulatory systems.
CLO4: Will be able to categorize split genes, introns, exons, spliceosomes and alternative splicing besides learning about other processing events like polyadenylation and capping. Will become familiar with RNA interference and its significance, siRNA and miRNA

CLO5: Will be able to appraise internal and external signals affecting microbial diversity, control gene expression, and influence microbial communities and their habitats.
CLO6: Will be able to formulate mechanisms that control how genes are expressed.

PRACTICALS BMBC-NP-241P: MOLECULAR BIOLOGY LAB	
Marks: 50	Duration: 60 hours (2 credits)
1. Study of various DNA and RNA types utilizing micrographs and models or schematics. 2. Study of DNA replication in a semi-conservative manner using micrographs or schematics. 3. Agarose gel electrophoresis study of genomic DNA isolated from E. coli. 4. Utilization of diphenylamine reagent to estimate DNA. 5. Protein separation utilizing polyacrylamide gel electrophoresis (SDS-PAGE) and Coomassie dye visualization. 6. Examine how bacterial cells are affected by physical (UV) and chemical (HNO₂) mutagens. 7. Examine the bacterial survival curve following exposure to ultraviolet (UV) radiation. 8. Bacterial transformation demonstration, and calculation of the efficiency of the transformation.	

CORE-8

BMBC-NP-242: ENVIRONMENTAL MICROBIOLOGY

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: II Semester: IV
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code:BMBC-NP-242	Title: ENVIRONMENTAL MICROBIOLOGY	
Course Objectives: CO1: This paper's major goal is to understand microbial diversity in various ecosystems. CO2: This course focuses on microbial diversity interactions with one another and with more advanced plants and animals. CO3: The students will gain knowledge of many environmental issues and be inspired to come up with original and sustainable solutions. CO4: The learners will learn the process and role of biogeochemical cycling in the environment. CO5: The learners will learn various types of waste and the process of waste management. CO6: The learners will learn the process of bioremediation.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Microorganisms in different habitats Terrestrial land: profile, texture, and microbiology of the soil. Aquatic environment: stratification and microorganisms in freshwater and marine settings. The spread of bacteria in the atmosphere and aeromicroflora. Microbes in/on the body of an animal (ruminants): the environment the animal inhabits. Salinity, limited nutrition, high hydrostatic and osmotic pressures, high and low temperatures, and pH for microorganisms (extremophiles): extreme environments. the idea of metagenomic non-cultivable microbes. microbial succession in the breakdown of plant organic materials.	12
II	Microbial Interactions Background, importance, and most recent developments in the field of microbial ecology. Ecosystem structure and function; contributions from Martin Alexander, Kluyver, Winogradsky, Van Niel, and Beijerinck. Selman A. Waksman. Mutualism, synergism, commensalism, competition,	12

	amensalism, parasitism, and predation are examples of microbe-microbe interactions. Both beneficial and detrimental interactions between microbes and plants.	
III	Biogeochemical cycling Breakdown of lignin, chitin, cellulose, and hemicellulose by microbes during the carbon cycle: Nitrogen cycle, nitrogen fixation, ammonification, nitrification, and denitrification are all examples of nitrate contamination. Cycle of phosphorous: Phosphate immobilization and solubilization; sulfate-cycle-related microorganisms.	12
IV	Waste management Solid waste source, type, disposal strategy (composting and sanitary landfill), and final disposal location Primary, secondary, tertiary, and oxidation pond (oxidation pond, trickling filter, activated sludge process, and septic tank) sewage treatment procedures in sewage waste management.	12
V	Microbial Bioremediation and Water Potability Bioremediation of contaminated soil and marine oil contamination. Mechanisms underlying the biosurfactant breakdown of common pesticides, such as hydrocarbon and oil spills, as well as the function of microorganisms in the management of e-waste. plastic breakdown caused by microbes. the safety and purification of drinking water; How to tell if a water sample is drinkable: Standard qualitative process for the MPN test/Presumptive test, verified test, and completed test for faecal coliforms test for the presence or absence of feces-borne coliforms using a membrane filter.	12
Reference / Text Books: 1. Atlas, R.M. and Bartha, R. (2000). Microbial Ecology: Fundamentals and Applications. 4 th edition. Benjamin Cummings, USA. 2. Bergey, D.H. (2019). Waste Water Microbiology. 2 nd edition. Medtech, India. 3. Madigan, M.T. and Martinko, J.M. (2017). Brock Biology of Microorganisms. 15 th edition. Prentice Hall International Inc., USA. 4. Okafor, N. (2011). Environmental Microbiology of Aquatic and Waste Systems. Springer, The USA. 5. Pepper, I.L., Gerba, C.P. and Gentry, T.J (editors). (2014). Environmental Microbiology. 3 rd edition. Academic Press, USA. 6. Singh, A., Kuhad, R.C. and Ward, O.P. (2009). Advances in Applied Bioremediation. Springer-Verlag, Germany. 7. Subba Rao, N.S. (2017). Soil Microbiology. 5 th edition. Medtech, India. 8. Willey, J. M., Sandman, K. and Wood, D. (2019). Prescott's Microbiology. 11 th edition. McGraw Hill Higher Education, USA.		
If the course is available as a Generic Elective, then the students of the following departments may opt for it. NO		
Evaluation/Assessment Methodology		
		Max. Marks:100
1) Class tasks/ Sessional Examination		16
2) Presentations /Seminar		-
3)Assignments		04
4)Research Project Report		-
Seminar On Research Project Report		-

5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes: CLO1: Will be able to recall many habitats and conditions that microbes can grow in, as well as the concepts of metagenomics and microbial succession. CLO2: With the aid of many instances, will be able to explain how bacteria interact with lower plants and animals as well as among themselves. CLO3: Will be able to determine the relevance of microorganisms in the biogeochemical cycle of vital components that occurs within an ecosystem. CLO4: Will be able to analyze the crucial function that microbes play in preserving a healthy environment through the breakdown of solid and liquid wastes; CLO5: Will be able to conclude pollution issues and applications of clean-up technologies (bioremediation) for the pollutants in the ecosystem, such as pesticides, oil, e-waste, and plastic, and will come to understand the significance of discovering novel, sustainable techniques for treating such pollutants. CLO6: Will be able to design sewage treatment facilities, the creation of activated sludge, and the operation of septic tanks utilize these bacteria and their activities.	
PRACTICALS	
BMBC-NP-242P ENVIRONMENTAL MICROBIOLOGY LAB	
Marks: 50	Duration: 60 hours (2 credits)
1. To evaluate the pH, moisture content, water-holding capacity, percolation, and capillary action of soil samples. 2. To separate and identify fungus from a soil sample at 280 and 450 degrees Celsius. 3. By counting the number of bacteria in soil from both rhizospheres and non-rhizospheres, the rhizosphere effect determination. 4. To evaluate the water's microbiological purity using a tried-and-true qualitative method. 5. OD/BOD of wastewater sample to determination using the dissolved oxygen electrode method. 6. To investigate the presence of microbial activity by qualitatively identifying any two of the following enzymes in soil: dehydrogenase, amylase, and urease. 7. To isolate Rhizobium/ Azotobacter from root nodules	

DSE-4a

BMBDSE-NP-243a: ADVANCED INSTRUMENTATION: PRINCIPLES AND APPLICATIONS

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: II Semester: IV
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code:BMBDSE-NP-243a	Title: ADVANCED INSTRUMENTATION: PRINCIPLES AND APPLICATIONS	
Course Objectives: CO1: This topic focuses on using instrumental approaches for both qualitative and quantitative drug analysis. CO2: This course aims to teach advanced information on the spectroscopic and chromatographic hyphenated techniques' fundamentals and instrumentation. CO3: The theoretical and practical knowledge of current analytical tools used for drug testing is also stressed in this. CO4: The learners will learn the molecular method of analysis. CO5: The learners will learn the principles and numerous techniques of radioimmunoassays. CO6: The learners will learn hyphenated techniques.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Nuclear Magnetic Resonance spectroscopy: H-NMR and C-NMR fundamentals, chemical shift, influences on chemical shift, coupling constant, instrumentation, and spin applications. Principles, fragmentation, and ionization methods used in mass spectrometry, including electron impact, chemical ionization, MALDI, FAB, apparatus, and analyzer application.	12
II	Molecular Methods of Analysis: X-Ray diffraction techniques include single crystal diffraction, powder diffraction, rotating crystal technique, structural elucidation and applications, biosensors, the CRISPR Cas system, and DNA microarray. History of X-rays, fundamental characteristics of crystals, X-ray crystallography, and applications.	12

III	Calibration and validation-as per ICH and USFDA guidelines, Instrument calibration: electronic balance, UV spectrophotometer, IR spectrophotometer, Flame Photometer, fluorimeter, HPLC, and GC.	12
IV	Radioimmunoassay: Importance, distinct elements, the principle, numerous techniques, limitations, and application. Extraction methods: The general principles and steps involved in liquid and solid phase extraction.	12
V	Hyphenated techniques- GC-MS/MS, HPTLC-MS, LC-MS/MS.	12

Reference / Text Books:

1. Cooper, G.M. (2018). The Cell: A Molecular Approach. 8 th edition. Sinauer Associates, UK.
2. Freifelder, D. (1982). Physical Biochemistry- Application to Biochemistry and Molecular Biology. 2 nd edition. W.H. Freeman and Company, USA.
3. Hofmann, A. and Clokie, S. (editors). (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology. 8 th edition. Cambridge University Press, UK.
4. Klostermeier, D and Rudolph, M.G. (2017). Biophysical Chemistry. 1st edition CRC press, UK.
5. Nelson, D.L. and Cox, M.M. (2017). Lehninger Principles of Biochemistry. 7 th edition. W.H. Freeman and Company, UK.
6. Nigam, A. and Ayyagari, A. (2007). Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill, India.
7. Skoog, D.A., Holler, F.J. and Crouch, S.R. (2017). Principles of Instrumental Analysis by D.A. 7 th edition. Cengage Learning, USA.
8. Willey, J. M., Sandman, K. and Wood, D. (2019). Prescott's Microbiology. 11 th edition. McGraw Hill Higher Education, USA.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

- CLO1: will be able to define the utilization of the advanced instrument and how they are applied in drug analysis.
- CLO2: will be able to recognize drug separation and analysis using chromatography.
- CLO3: will be able to determine the calibration of different analytical instruments.
- CLO4: will be able to analyze drugs utilizing different analytical tools.
- CLO5: will be able to decide the methods that involve combining or connecting two separate analytical approaches.
- CLO6: will be able to prepare different immunoassays.

PRACTICALS BMBDSE-NP-243aP: ADVANCED INSTRUMENTATION: PRINCIPLES AND APPLICATIONS LAB	
Marks: 50	Duration: 60 hours (2 credits)
1. Use of micrographs to differentiate between various microscopy techniques. 2. Ray diagrams for electron and phase contrast microscopy. 3. Mixture separation using paper-based or thin-layer chromatography. 4. A column chromatography demonstration. 5. Protein mixtures separation using Polyacrylamide Gel Electrophoresis (PAGE). 6. Calculation of the extinction coefficient and the determination of λ_{max} for an unknown sample. 7. Utilising a centrifuge on a laboratory scale to separate the components of a particular combination. 8. Using images and virtual labs to better understand density gradient centrifugation.	

DSE-4b

BMBDSE –NP- 243b: PHARMACEUTICAL MICROBIOLOGY

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: II Semester: IV
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code: BMBDSE-NP-243b	Title: PHARMACEUTICAL MICROBIOLOGY	
Course Objectives: CO1: The study of chemotherapeutic drugs and their effects is the focus of this topic. CO2: This course aims to provide advanced knowledge on the origins and mechanisms of antibiotic resistance CO3: This course aims to study different sterilization methods used to prevent pharmaceutical products from spoiling and maintain their quality. CO4: The learners will learn different preservation methods used to prevent pharmaceutical products CO5: The learners will learn the classification and mode of action of disinfectants. CO6: The learners will learn methods of antibiotic resistance and the development of new therapeutics.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to chemotherapeutic agents: The evolution of chemotherapeutic agents, Chemotherapeutic drug types includes synthetic, semi-synthetic, and natural. antibiotics: many antibiotic types and how they work; Antibacterial, antifungal, antiviral, and antiprotozoal properties of antimicrobial substances.	12
II	Antibiotic resistance and development of new therapeutics: Antimicrobial Peptides: History, Properties, Sources, Mode of Action, and Applications. Development and Mechanism of Antibiotic Resistance. Plant-based therapeutic agents, phage treatment.	12
III	Sterilization and Microbial spoilage of pharma products: Sources of contamination, elements influencing survival and growth, breakdown of active components, and general formulations. Microbial contamination spoilage and hazard. Sterilization principles in regard to the	12

	pharmaceutical sector. Sterilization techniques include heating, radiation, gas exchange, and filtration.	
IV	Preservation of Pharma Products: Principles of preservation include things like objectives of preservation, the optimum preservative, and the logical construction of a system for product preservation. Antimicrobial preservatives and their characteristics, including preservative monographs, antimicrobial activity, and factors influencing it. efficacy and stability of preservatives. Techniques for testing and evaluating preservation.	12
V	Classification and mode of action of disinfectants. Factors affecting the evaluation of antiseptics and disinfectants. for bactericidal and bacteriostatic effects bactericidal and bacteriostatic agent evaluation. Product sterility testing in accordance with IP, BP, and USP for solids, liquids, ophthalmic, and other sterile items.	12

Reference / Text Books:

1. A Textbook of Pharmaceutical Microbiology Paperback (2018) by Pulak Mujumder, Sameer Rajan Sahoo Everest Publishing.
2. A Textbook of Pharmaceutical Microbiology (2015) Mehra Prahlad Singh IK International Publishing.
3. Pharmaceutical Microbiology (2015) by Sheth Z.PCBS Publisher.
4. A.V.S.S. Sambamurthy .A Textbook of Plant Pathology. IK International Publishing House 2009.
5. Nidhi Goel .Pharmaceutical Microbiology: A Textbook .Alpha Science Intl Ltd. 2012.
6. Prahlad Singh Mehra .A Textbook of Pharmaceutical Microbiology. IK International Publication.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3)Assignments	04
4)Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	

Course Learning Outcomes:

CLO1: Will be able to recall more about the different chemotherapy drugs.

CLO2: Will be able to explain the causes and mechanisms of antibiotic resistance.

CLO3: Will be able to determine how pharmaceutical items are sterilized and how microbiological deterioration occurs.

CLO4: Will be able to categorize the various preservation techniques

CLO5: Will be able to conclude the bactericidal and bacteriostatic effects of various disinfectants.

CLO6: Will be able to prepare techniques for testing and evaluating preservation.

PRACTICALS

BMBDSE –NP- 243bP: PHARMACEUTICAL MICROBIOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

1. Examining the microbiology of both sterile and non-sterile products.
2. Testing for Bacterial Endotoxins Using a Gel Clot.
3. Test to confirm the labelled LAL reagent's sensitivity.
4. Antibiotic Potency Testing.
5. Estimating the bioburden of medical devices.
6. Calculating the D and Z values for pharmaceutical heat sterilisation.
7. Penicillin, Streptomycin, and Griesofulvin determination using chemical and microbiological methods.
8. Macromolecule binding site prediction with MEDsuMo programme.

CORE-9

BMBC-NP-351: CLINICAL AND DIAGNOSTIC MICROBIOLOGY

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: III Semester: V
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code:BMBC-NP-351	Title: CLINICAL AND DIAGNOSTIC MICROBIOLOGY	
Course Objectives: CO1: To understand the types and sources of various human diseases. CO2: To explore techniques for the identification of human diseases. CO3: To identify various disease-causing microbes using microscopic and biochemical techniques. CO4: To understand the basics of clinical laboratory protocols. CO5: To analyse various types of diseases, their causative agent, pathogenesis and laboratory diagnosis. CO6: To apply knowledge of clinical microbiology to identify the causative agents		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hr.= 1 credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Human Diseases: Types of Human Diseases, Sources of diseases. Infectious disease epidemiology, diseases in the community, including pandemics, endemic diseases, sporadic diseases, and outbreaks, Ways of entry and exit of diseases, herd immunity, and the prevention of disease transmission. Methods of disease transmission and the function of biological vectors like: House flies, Mosquitoes and Sand flies.	12
II	Types of Infections: Overview of the causative agent, pathogenesis and laboratory diagnosis of bacteremia, blood stream infections, and respiratory tract infections (Pneumonia, Influenza), infections of the central nervous system (Meningitis, Encephalitis), Gastrointestinal and Urinary tract infections, sexually transmitted diseases caused by Neisseria and Treponema.	12
III	Identification of microorganisms - Microscopic examination of clinical sample for Bacterial pathogens by Simple Staining, Differential Staining, Acid fast Staining, Negative Staining, Giemsa, Leishman, Wright stains and motility testing by hanging drop method; Biochemical Examination by Catalase test, Coagulase Test, Sugar fermentation test, IMViC Test, Urease Test, TSI agar	12

	Test; Antibiotic Susceptibility testing by Kirby Bauer and dilution methods. Isolation and identification of viruses.	
IV	Clinical laboratory technology: includes techniques for collecting urine, blood, sputum, and other samples. The procedures used for sample preservation. Serum and blood plasma separation. Preparations of blood smears, ESR, PCV, Blood indicators: Bleeding time and clotting time (BT-CT) test, Platelet count. Urine analysis includes collecting samples and looking at them under a microscope for crystals, casts and sediments; Pregnancy tests. Stool Examination: Indications, Collection and Microscopic Examination,	12
V	Serological Tests – Antigen - antibody reactions – Agglutinations (blood grouping, WIDAL) Hemagglutination, Precipitation (VDRL), Complement fixation test, Immunodiffusion, Immunoelectrophoretic (rocket, counter current). ELISA, RIA. Quantitative study of Antigen - Antibody precipitin reactions, Western blot analysis for HIV.	12

Reference / Text Books:

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Virology, Sawant, K.C., 2005, First edition, Dominant Publishers and distributors, Delhi.
4. Subash O. Panija Textbook of Medical Parasitology, 1996. First edition. All India Publishers and Distributors Regd. 920 Poonamallee High Road, Chennai.
5. Rajesh Karyakarte and Ajith Damle (2005) Medical Parasitology, books and Allied (P)Ltd. Kolkata.
6. Jaya Ram Paniker, Textbook of Medical Parasitology, Published by 'Jaypee Brothers', 4th Edition.
7. Coloratlas, Textbook of Diagnostic Microbiology (5th Edition), edited by Eimer.W. Koneman, published by Lippinett.
8. Mosby, Diagnostic Microbiology by Bailey and Swotts, 10th Edition, published.
9. David Greenwood, Richard C.B.Slack, John.F.Peutherer, Medical Microbiology, 16th Edition.
10. SharmaJ.B., Medical Microbiology – A Clinical perspective, paras publishing.
11. Patrick R.Murray, Ken.S.Rosenthal, George.S.Kobayashi, Michael A. Ptaller, Medical Microbiology, 3rd Edition.
12. Jawetz, Melnick and Adelberg's, Medical Microbiology (2004) 23rd Edition, Mc Graw Hill.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology	
	Max. Marks:100
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3)Assignments	04
4)Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	

Course Learning Outcomes:

- CLO1: Students will gain thorough knowledge of disease cycles and outbreaks.
CLO2: Will gain theoretical understanding of the most prevalent disease-causing microorganisms.
CLO3: Will be aware to categorizing the disease transmission mechanisms and carriers.
CLO4: Will be able to understand the fundamentals of clinical laboratory procedures.
CLO5: A comprehensive awareness of disease pathophysiology and laboratory diagnosis.
CLO6: Will gain knowledge concerning clinical procedures and serological methods.

PRACTICALS

BMBC-NP-351P: CLINICAL AND DIAGNOSTIC MICROBIOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

1. To prepare different culture media used in diagnostic Microbiology: Blood Agar, Eosine Methylene Blue Agar, Chocolate Agar, Mannitol salt agar, MacConkey agar,
2. To collect throat swabs – culturing the specimen. and laboratory examination for *Streptococcus pyogenes*
3. To examine urine for pathogenic microorganisms –collection of urine, microscopic examination of urine, Identification of – *Escherichia coli*, *Klebsiella pneumonia*
4. Mycology – Direct microscopy – cultures using Sabouraud's Dextrose agar medium, Wet mount preparations using Lactophenol cotton blue/KOH mount
5. Blood grouping and Rh typing
6. Hemoglobin estimation
7. RBC and WBC count
8. Bleeding time and Clotting time
9. Medical Parasitology – *E. histolytica*, *G. lamblia*, Trypanosomas, Leishmania and Plasmodium (Permanent Slide Observation)
10. Laboratory diagnosis of common helminthes infections (permanent slide observations of Helminths' Round worm, Hook worm and Pin worm)

CORE-10
BMBC-NP-352: IMMUNOLOGY

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: III Semester: V
Credits: 6 Theory: 4 Practical: 2		Subject: MICROBIOLOGY
Course Code:BMBC-NP-352		Title: IMMUNOLOGY
Course Objectives: CO1: Gain in-depth knowledge of the cells, tissues, and organs comprising the immune system, and comprehend their roles in defending the host against microorganisms. CO2: Understand the mechanisms employed by the immune system to recognize and eliminate pathogens, and grasp the process of immune response and the development of immunity. CO3: Recognize the intricate relationship between the immune system, pathogens, and the acquisition of immunity. CO4: Acquire knowledge of various immunological techniques used in research and diagnostics, and understand their applications. CO5: Explore common immunological disorders, their underlying mechanisms, and their impact on human health. CO6: Stay updated with recent advancements and breakthroughs in the field of Immunology, enabling students to critically evaluate and interpret scientific literature related to immunological research. CO7: By successfully completing the course, students will have developed a strong foundation in Immunology, enabling them to comprehend the intricacies of the host immune system, its interactions with pathogens, and the advancements in immunological techniques and disorders.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hr.= 1 credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	History and Basic Concepts of Immunology: Basic concepts of immunology, History and development in immunology, Contributions of Various Scientists in the field on Immunology, Non-Specific (Innate Immunity) and Specific Immunity (Adaptive Immunity), Phagocytosis and Inflammation, Introduction to Immunological Tolerance:	10
II	Immune cells and organs: Structure, Functions, and Properties of Immune Cells: Explore the characteristics, roles, and properties of immune cells, including stem cells, lymphoid lineage cells (T cells, B cells, NK cells), and	10

	myeloid lineage cells (macrophages, neutrophils, eosinophils, basophils, mast cells, dendritic cells). Central and Peripheral Immune Organs: Understand the structure and functions of central immune organs (such as the bone marrow and thymus) and peripheral immune organs (such as lymph nodes, spleen, and mucosa-associated lymphoid tissue).	
III	Antigens and antibodies: Antigenicity and Immunogenicity: Differentiate between antigenicity and immunogenicity and understand the factors that influence an antigen's ability to induce an immune response. Properties of an Antigen: Study the characteristics and properties of antigens, including haptens, epitopes (T and B cell epitopes), and adjuvants. Antibodies: Explore the structure, types, functions, and properties of antibodies. Learn about antigenic determinants on antibodies (isotypic, allotypic, idiotypic) and concepts such as monoclonal and chimeric antibodies. Understand antibody diversity and its significance.	10
IV	Major Histocompatibility Complex: Organization of MHC Locus: Examine the organization of the Major Histocompatibility Complex (MHC) locus in mice and humans. Structure and Functions of MHC I and MHC II Molecules: Understand the structure and functions of MHC I and MHC II molecules and their roles in antigen presentation. Antigen Processing and Presentation: Learn about the cytosolic and endocytic pathways of antigen processing and the mechanisms of antigen presentation to T cells and B cells.	10
V	Complement System: Components of Complement System: Study the components involved in the complement system, a series of proteins that contribute to immune defense. Classical, Alternative, and Lectin Pathways of Complement Activation: Explore the three pathways (classical, alternative, and lectin) that lead to complement activation. Biological Consequences of Complement Activation: Understand the biological consequences of complement activation and its role in immune responses. Learn about the complement fixation test.	10
VI	Immunological Techniques and Disorders: Immunological Techniques: Introduce various immunological techniques such as precipitation, agglutination, immunodiffusion, immune electrophoresis, ELISA, western blotting, immunofluorescence, and flow cytometry, explaining their principles and applications. Immunological Disorders: Explore different types of immunological disorders, including autoimmune diseases (types and mechanisms), hypersensitivity reactions, and immunodeficiency disorders.	10

Reference / Text Books:

1. Abbas, A.K., Lichtman, A.H. and Pillai, S. (2017). Cellular and Molecular Immunology. 9th edition. Elsevier, USA.
2. Coico, R. and Sunshine, G. (2015). Immunobiology: A short course. 7th edition. WileyBlackwell Scientific Publication, UK.
3. Delves, P., Martin, S., Burton, D. and Roitt, I.M. (2017). Roitt's Essential Immunology. 13th edition. Wiley- Blackwell Scientific Publication, UK.
4. Murphy, K., Travers, P. and Walport, M. (2007). Janeway's Immunobiology. 7th edition. Garland Science Publishers, USA.
5. Peakman, M. and Vergani, D. (2009). Basic and Clinical Immunology. 2nd edition. Churchill Livingstone, UK.
6. Punt, J., Stranford, S., Jones, P. and Owen, J. (2018). Kuby Immunology. 8 th edition. W.H.

Freeman and Company, USA.
7. Richard, C. and Geoffrey, S. (2009). Immunology. 6th edition. Wiley- Blackwell Scientific Publication, UK.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3)Assignments	04
4)Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

Upon successful completion of the course, the student:

CLO1: will be able to gain familiarity with the historical development of immunology and comprehend the immune system's role in protecting against infections through various defense mechanisms.

CLO2: will be able to acquire knowledge of the characteristics and functions of immune cells, as well as the organization of immune organs, enhancing understanding of the immune system's structure and functionality.

CLO3 will be able to determine the factors that determine antigenicity and become familiar with the types, properties, and functions of antibodies generated against antigens. Gain insights into the production and application of monoclonal antibodies.

CLO4: Will be able to categorize the cell surface proteins involved in generating acquired immune responses and their significance in discriminating self from non-self molecules. Gain an understanding of antigen processing and presentation pathways.

CLO5: Will be able to appraise the recruitment and enhancing effects of the complement system, including how it complements the abilities of antibodies and phagocytic cells.

CLO6: Will be able to formulate the knowledge of the generation and mechanisms of action in humoral and cell-mediated immunity. Acquire proficiency in various immunological techniques. Gain insight into immunodeficiency disorders, including autoimmunity and hypersensitivity reactions.

PRACTICALS

BMBC-NP-352P: IMMUNOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

1. Identify human blood groups through agglutination techniques.
2. Conduct Total Leukocyte Count (TLC) analysis on a provided blood sample.
3. Perform Differential Leukocyte Count (DLC) analysis on a given blood sample.
4. Demonstrate the separation of serum from a blood sample.
5. Conduct immunodiffusion using the double diffusion method (Ouchterlony method).
6. Perform DOT ELISA (Enzyme-Linked Immunosorbent Assay).
7. Conduct Immunoelectrophoresis analysis.

DSE-5a

BMBDSE-NP-353a: FOOD AND DAIRY MICROBIOLOGY

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: III Semester: V
Credits: 6 Theory: 4 Practical: 2		Subject: MICROBIOLOGY
Course Code: BMBDSE-NP-353a		Title: FOOD AND DAIRY MICROBIOLOGY
Course Objectives: CO1: Understand the role of microorganisms in relation to food, including their beneficial and harmful activities. CO2: Explore the applications of microorganisms in the food and dairy industry and their impact on food quality and safety. CO3: Gain knowledge of foodborne pathogens and their modes of transmission, prevention, and control measures. CO4: Examine the principles and methods used in the microbiological analysis of food, including sampling, isolation, and identification techniques. CO5: Understand the factors influencing microbial growth and survival in food, such as temperature, pH, moisture, and preservatives. CO6: Learn about food safety regulations and standards, including Good Manufacturing Practices (GMP) Hazard Analysis, and Critical Control Points (HACCP).		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hr.= 1 credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Microorganisms in Food: Understanding the natural flora and sources of contamination in foods. Exploring the intrinsic and extrinsic factors that impact the growth and survival of microbes in foods.	10
II	Microbial Spoilage of Foods: Principles of microbial spoilage. Spoilage of various food items such as vegetables, fruits, meat, eggs, milk, butter, bread, and canned foods.	10
III	Principles and methods of food preservation: Principles and Methods of Food Preservation: Introduction to the principles of food preservation.	10

	Physical methods of food preservation: Low-temperature methods: refrigeration and freezing. High-temperature methods: boiling, blanching, and pasteurization. Canning techniques (home and commercial), drying, irradiation, hydrostatic pressure, high voltage pulse, microwave processing, and aseptic packaging. Chemical methods of food preservation: Use of salt, sugar, organic acids, SO ₂ , nitrites and nitrates, ethylene oxide, antibiotics, and bacteriocins.	
IV	Fermented foods: Dairy starter cultures and their role in fermented dairy products such as yogurt, acidophilus milk, kumiss, kefir, dahi, and cheese. Other fermented foods like bread, idli, dosa, kanji, pickles, sauerkraut, soy sauce, and tempeh. Fermented meat and fish products. Introduction to prebiotics, probiotics, and synbiotics: Health benefits and limitations. Types of microorganisms used. Availability of probiotic foods in the market.	10
V	Food borne diseases and detection of food borne pathogens: Understanding the causative agents, associated foods, symptoms, and preventive measures of foodborne diseases. Exploring specific foodborne intoxications caused by Staphylococcus aureus, Clostridium botulinum, and mycotoxins. Studying food infections such as Salmonellosis, Shigellosis, Bacillus cereus infections, Vibrio parahaemolyticus infections, Escherichia coli infections, Yersinia enterocolitica infections, Listeria monocytogenes infections, and Campylobacter jejuni infections. Cultural and rapid methods for detecting foodborne pathogens in foods.	10
VI	Food quality and control: Introduction to Total Quality Management (TQM) concepts and approaches in the food industry. Hazard Analysis of Critical Control Point (HACCP) for food safety: Principles and limitations. Understanding the indices of food quality, including the standards set by FSSAI (Food Safety and Standards Authority of India) and ISO certification.	10
Reference / Text Books: 1. Adams, M.R. and Moss, M.O. (2000). Food Microbiology. 2nd edition. New Age International Publishers, India. 2. Banwart, G.J. (2004). Basic Food Microbiology. 2nd edition. CBS Publishers and Distributors, India. 3. Davidson, P.M., Sofors, J.N. and Branen, A.L. (2005). Antimicrobials in Foods. 3rd edition. CRC Press, UK. 4. Dillon, V.M. and Board, R.G. (1994). Natural Antimicrobial Systems and Food Preservation. CAB International, UK. 5. Frazier, W.C., Westhoff, D.C. and Vanitha, N.M. (2013). Food Microbiology. 5th edition. Tata McGraw-Hill Publishing Company Ltd, India. 6. Gould, G.W. (1995). New Methods of Food Preservation. Blackie Academic and Professional, UK.		

7. Jay, J.M., Loessner, M.J. and Golden, D.A. (2006). Modern Food Microbiology. 7th edition. CBS Publishers and Distributors, India. 8. Lund, B.M., Baird- Parker, A.C and Gould, G.W. (editors). (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2. Springer, USA. 9. Tortora, G.J., Funke, B.R., and Case, C.L. (2016). Microbiology: An Introduction. 12th edition. Pearson Education, USA.	
If the course is available as Generic Elective then the students of following departments may opt it. NO	
Evaluation/Assessment Methodology	
Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes: On successful completion of the course, the student: CLO1: will be able to recall the factors influencing microbial growth in foods and recognize the potential sources of food contamination. CLO2: will be able to demonstrate the microbial spoilage patterns observed in various food types. CLO3: will be able to determine different methods used for food preservation, including both physical and chemical techniques. CLO4: Will be able to categorize the processes involved in the production of fermented dairy and non-dairy food products, and recognize the health benefits associated with prebiotics, probiotics, and synbiotics. CLO5: Will be able to appraise common foodborne diseases, including their causes and symptoms, and demonstrate knowledge of the methods used for detecting foodborne pathogens. CLO6: Will be able to formulate the principles and practices of food quality control, including the implementation of Total Quality Management (TQM) concepts and the application of Hazard Analysis of Critical Control Point (HACCP) principles.	
PRACTICALS	
BMBDSE-NP-353aP: FOOD AND DAIRY MICROBIOLOGY LAB	
Marks: 50	Duration: 60 hours (2 credits)
- To perform the Microbial Bioburden Reduction Test (MBRT) on milk samples and determine their standard plate count. - To conduct the alkaline phosphatase test to assess the effectiveness of milk pasteurization. - To isolate spoilage fungi from deteriorated vegetables and fruits. - To isolate spoilage fungi from bread exhibiting signs of spoilage. - To prepare yogurt or dahi using appropriate fermentation techniques. - To isolate Lactobacillus bacteria from various dairy products. - To isolate bacteria from spoiled food items to identify potential contaminants.	

DSE-5b

BMBDSE-NP-353b: MICROBES IN SUSTAINABLE AGRICULTURE

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology	Year: III Semester: V	
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code:BMBDSE-NP-353b	Title: MICROBES IN SUSTAINABLE AGRICULTURE	
Course Objectives: CO1: Familiarize students with the diverse microbial communities found in soil and their significance in agriculture and environmental development. CO2: Provide knowledge about soil microbiology, including the composition, function, and interactions of microorganisms in soil ecosystems. CO3: Explore the various applications of microorganisms as biocontrol agents for managing plant diseases and pests in agriculture. CO4: Introduce students to the concept of biofertilizers and their role in enhancing soil fertility and promoting sustainable agriculture practices. CO5: Discuss the utilization of microorganisms in the production of biofuels and their potential as renewable energy sources. CO6: Examine the application of microorganisms in the production of bio manure for organic farming and waste management. Provide an understanding of genetically modified crops and animals, including their development, benefits, and potential concerns. CO7: By the end of the course, students will have a comprehensive understanding of soil microbiology, the role of microorganisms in agriculture and development, and the applications of microorganisms in various fields, including biocontrol, biofertilizers, biofuel, and genetically modified organisms.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hr.= 1 credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Soil Microbiology: Introduction to soil as a microbial habitat Soil profile and properties Soil formation processes	12

	Diversity and distribution of microorganisms in soil Microbial activity in soil and its impact on greenhouse gas production and control (carbon dioxide, methane, nitrous oxide, nitric oxide)	
II	Mineralization of Organic and Inorganic Matter in Soil: Processes and factors influencing mineralization of organic matter (cellulose, hemicelluloses, lignocelluloses, lignin, humus) Mineralization of inorganic matter (phosphate, nitrate, silica, potassium) in soil	12
III	Microbial Control of Soil Borne Plant Pathogens: Biocontrol mechanisms and strategies for managing microbial plant pathogens Microorganisms used as biocontrol agents against soil-borne plant pathogens Biocontrol of insects and weeds in soil	12
IV	Bio fertilizers and Bio insecticides: Introduction to plant growth-promoting bacteria Symbiotic bio fertilizers (Bradyrhizobium, Rhizobium, Frankia) and their applications Non-symbiotic biofertilizers (Azospirillum, Azotobacter, Mycorrhizae, phosphate solubilizers, algae) and their role in nutrient cycling Novel combinations of microbes as biofertilizers Plant growth-promoting rhizobacteria (PGPRs) and their benefits	12
V	Secondary Agriculture Biotechnology and GM crops: Overview of biotech feed, silage, bio manure, biogas, and biofuels, Advantages and processing parameters of secondary agriculture products, Social and environmental aspects of secondary agriculture practices, Introduction to genetically modified (GM) crops and their applications, Examples of GM crops, such as Bt crops and golden rice, Considerations and implications of transgenic animals,	12

Reference / Text Books:

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press.
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4 th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Altman A (1998). Agriculture Biotechnology, 1st edition, Marcel decker Inc.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.
12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes: CLO1: The student will be able to recall about soil formation, soil profile, and soil properties. They will also gain an understanding of the diverse microbial populations present in the soil. Additionally, they will become familiar with greenhouse gases and the role of microbial activity in soil. CLO2: The student will be able to demonstrate an understanding of the process of mineralization, which involves the conversion of organic and inorganic matter into mineral forms in the soil. CLO3: The student will be able to determine the biocontrol mechanisms and applications of bacterial, fungal, and viral biopesticides in managing pest populations and controlling microbial plant pathogens. They will learn about how these biopesticides can be utilized as alternatives to chemical pesticides. CLO4: The student will be able to categorize commonly used bacterial, fungal, and cyanobacterial biofertilizers for different crops. They will be able to compare and contrast the symbiotic and non-symbiotic associations of these microbes and explore novel combinations of microbes as biofertilizers. CLO5: The student will be able to appraise biotech feed, biofuels, and bio manure. They will also develop an understanding of genetically modified crops and animals, including their applications and implications. CO6: The student will be able to formulate a comprehensive understanding of soil science, including soil properties and microbial interactions, as well as the use of biopesticides, biofertilizers, and biotechnology in agriculture and environmental sustainability.	
PRACTICALS	
BMBDSE-NP-353bP: MICROBES IN SUSTAINABLE AGRICULTURE LAB	
Marks: 50	Duration: 60 hours (2 credits)
1. Soil profile study: Examining different layers of soil to understand its formation, composition, and properties. 2. Microflora analysis: Studying microbial populations in soils to assess soil health and ecosystem functioning. 3. Rhizobium as soil inoculants: Nitrogen-fixing bacteria forming symbiotic association with leguminous plants for improved nitrogen availability. 4. Azotobacter as soil inoculants: Free-living nitrogen-fixing bacteria enhancing plant growth and reducing synthetic nitrogen fertilizer dependency. 5. Biogas plant design and functioning: Utilizing organic materials through anaerobic digestion to produce methane-rich biogas for energy. 6. Isolation of cellulose-degrading organisms: Identifying microorganisms capable of breaking down cellulose for various applications.	

CORE-11

BMBC-NP-361: INDUSTRIAL MICROBIOLOGY

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: III Semester: V
Credits: 6 Theory: 4 Practical: 2		Subject: MICROBIOLOGY
Course Code:BMBC-NP-361		Title: INDUSTRIAL MICROBIOLOGY
Course Objectives: CO1.The students will be familiar with the scope and importance of industrial microbiology. CO2. The students will be able to describe the fermenter, its design and operation. CO3. The students will be able to differentiate between different types of fermentation processes. CO4. The students will become conversant with the industrial production of various biomolecules and metabolites of industrial significance. CO5. The students will gain knowledge about enzyme immobilization and its applications. CO6: The students will learn the upstream and downstream processing.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction and Scope of industrial microbiology History and developments of industrial microbiology. Different types of fermentation processes including batch (solid state and liquid state) and continuous.	12
II	Fermentation processes and bio-reactors Bioreactor and its components. Different types of bioreactors, Definition of fermenters and their type’s air-lift tank and constantly stirred fermenters, fermentation parameters - temperature, pH, dissolved oxygen, aeration and foaming, their control and management.	12
III	Upstream and downstream processing Downstream processing and its uses, regulation and limiting factors. Industrially important microbes and methods for their isolation, selective media, fermentation conditions, maintenance and preservation. Media; corn-steep liquor, whey, yeast extract, protein hydrolysates. sulphite waste liquor and molasses.	12

IV	Microbial production of industrial products Production of industrially important products (citric acid, glutamic acid, vitamin B12, ethanol, penicillin), enzymes (amylase, protease, lipase) and other products like wine, beer etc. Techniques involved in microbial production such as cell disruption, centrifugation, filtration, solvent extraction, lyophilization, precipitation and spray drying.	12
V	Enzyme immobilization Immobilization methods, advantages and applications. Immobilized enzymes (glucose isomerase and penicillin acylase) and their large-scale application. Aseptic packaging, food sanitation and control protocol– HACCP.	12
Reference / Text Books: - Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited. - Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA. - Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell. - Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company. - Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited. - Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi. - Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.		
If the course is available as Generic Elective then the students of following departments may opt it. NO		
Evaluation/Assessment Methodology		
Max. Marks:100		
1) Class tasks/ Sessional Examination		16
2) Presentations /Seminar		-
3) Assignments		04
4) Research Project Report		-
Seminar On Research Project Report		-
5) ESE/Attendance		05
INTERNAL MARKS		25
EXTERNAL MARKS		75
TOTAL		100
Prerequisites for the course:		
Course Learning Outcomes By the conclusion of this course, the students- CLO1: The students will be able to recall the fermentation process. CLO2: The students will be able to demonstrate various fermentation processes used in the production of organic acids, alcohols, enzymes, antibiotics and various foods in the industry. CLO3: The students will be able to determine mechanism of upstream and downstream processing during fermentation process. CLO4: The students will be able to classify physical parameters required for the production of industrially important products by the microbes. CLO5: The students will be able to justify the laboratory skills involved in the immobilization process. CLO6: Students will be able to design different types of fermenters.		

PRACTICALS	
BMBC-NP-361P: INDUSTRIAL MICROBIOLOGY LAB	
Marks: 50	Duration: 60 hours (2 credits)
1. To study fermenter and its different parts. 2. Qualitative and quantitative estimation of enzymes, A. Amino acids, B. Organic acid C. Alcohol. 3. Amylase production Test 4. To demonstrate antibiotic assay methods. 5. To demonstrate vitamin B₁₂ assay. 6. Industrial visit demonstrating fermenter and downstream processing.	

CORE-12

BMBC-NP-362: MEDICAL MICROBIOLOGY

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: III Semester: V
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code: BMBC-NP-362	Title: MEDICAL MICROBIOLOGY	
Course Objectives: CO1: The students will familiarize themselves with the scope and importance of medical microbiology. CO2: The students will gain knowledge about different microbial pathogens and their mechanism of virulence. CO3: The students will learn about diagnostic methods and antimicrobial chemotherapy. CO4: The students will know about the recent development of new molecular diagnostic methods as infectious diseases are re-emerging and spreading globally. CO5: The students will learn the normal microflora of the human body. CO6: The students will learn the mechanism of host-pathogen interaction.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Normal microflora of the human body and host-pathogen interaction Importance and distribution of microflora on the human body with special reference to skin, gastrointestinal tract, throat and urogenital tract. Interaction of pathogen and host. Infection: Opportunistic and Nosocomial. Transmission Terminology - Infection, Pathogen, Invasion, Pathogenicity, Toxigenicity and Virulence. Infection Carriers and their types.	12
II	Bacterial diseases Diseases associated with organ systems and their causative agents. Symptoms of disease, laboratory diagnosis and their mode of transmission. Prophylaxis and control of the diseases caused by various disease causing pathogens (<i>Clostridium tetani</i> , <i>Corynebacterium diphtheriae</i> , <i>Streptococcus pyogenes</i> , <i>Pneumococcus</i> , <i>Staphylococcus aureus</i> , <i>Haemophilus influenza</i> , <i>Mycobacterium tuberculosis</i> , <i>Escherichia coli</i> , <i>Salmonella typhi</i> etc.)	12

Reference / Text Books:

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International.

Evaluation/Assessment Methodology	
	Max. Marks:100

Prerequisites for the course:
Course Learning Outcomes By the conclusion of this course, the students will – CLO1: The students will be able to describe the normal microflora of human body. CLO2: The students will be able to differentiate bacterial disease-causing microbes, fungal disease-causing microbes and viral disease-causing microbes. CLO3: The students will be able to determine the disease caused by viruses and their laboratory

diagnosis, prevention & control.

CLO4: The students will be able to classify various protozoal and fungal diseases.

CLO5: The students will be able to justify the role of antimicrobial agents and the mechanism of their action.

CLO6: The students will be able to formulate the laboratory diagnosis, prevention and control of various diseases.

PRACTICALS

BMBC-NP-362P: MEDICAL MICROBIOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

1. Morphological and biochemical identification commonly occurring bacteria on skin including (*Bacillus*, *Staphylococcus*, *Pseudomonas*, *Staphylococcus*, *Salmonella* and *E.coli*).
2. To study skin microflora using swab method.
3. To Study of differential media: their use and composition.
4. To determine antibacterial sensitivity by Kirby-Bauer method.
5. To determine MIC of an antibiotic.
6. To study symptoms of some diseases with the help of photographs such as AIDS, Polio, Chicken pox, Dermatomycoses, anthrax, herpes, HPV warts, candidiasis, dermatomycoses etc.

DSE-6 a

BMBDSE-NP-363a: GENETIC ENGINEERING & RDT

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: III Semester: V
Credits: 6 Theory: 4 Practical: 2		Subject: MICROBIOLOGY
Course Code: BMBDSE-NP-363a		Title: GENETIC ENGINEERING & RDT
Course Objectives: CO1: The students will be able to develop an understanding about the scope and importance of genetic engineering and biotechnology. CO2: The students will become familiar with recent development in tools and techniques having importance in genetic engineering. CO3: The student will gain knowledge about the manipulation of genes and recombinant proteins for therapeutic and agricultural use. CO4: The students will develop a broad spectrum in terms of system biology, biotechnology and bioengineering. CO5: The students will gain knowledge about the widespread application of RDT including gene therapy. CO6: The students will learn the various methods for the delivery and analysis of DNA.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to genetic engineering Milestones in biotechnology and genetic engineering. Contributions of eminent scientist such as Arber, Alwine, Alec Jeffrey, Burnett, Boyer and Cohen, Bolivar and Rodriguez, Craig Venter, Clark, Messing, Kary Mullis, Smith and Nathans, Paul Berg, Sanger, Southern.	12
II	Tools of molecular cloning - enzymes and vectors Restriction enzymes and their Types, Nomenclatures, Applications, mode of action and frequency of recognition sequences in a DNA molecule. Other endonucleases: DNase I, S1 nuclease. Cloning vectors and types including, baculovirus-based vectors, Cosmids, Plasmid vectors, Phagemids, BACs, and YACs. Phage vectors, Yeast vectors and mammalian SV40 based expression	12

	vectors.	
III	DNA delivery methods and methods of analysis of DNA, RNA and proteins. Methods of gene delivery: chemical method, electroporation methods, biolistics (gene gun), liposome and viral-mediated delivery, microinjections and Agrobacterium - mediated delivery. Analysis of DNA and RNA by agarose gel electrophoresis, Southern and Northern Blotting and microarray technique. Analysis of protein by SDS-PAGE and western blotting technique. Analysis of Electrophoretic mobility shift assay, DNA Foot printing and Phage display.	12
IV	DNA amplification and DNA sequencing: PCR: Introduction and types (RT-PCR and Real-Time PCR). Primer and its designing; Primer walking.). Method of DNA Sequencing: Sanger's sequencing, automated DNA sequencing, Hierarchical versus whole genome shotgun sequencing. Introduction to next generation sequencing methods.	12
V	Applications of recombinant DNA technology: Gene therapy: concept, strategies and types. Use of gene therapy to manufacture products of human therapeutic interest (Insulin, hGH) and agricultural significance (Flavr Savr Tomato, Bt cotton, stress resistant varieties of plants). Application of RFLP in DNA fingerprinting methods. Significance of mitochondrial DNA in forensics. Designing strategy for development of genetically modified crop.	12

Reference / Text Books:

1. Brown, T.A. (2016). *Gene Cloning and DNA Analysis: An introduction*. 7th edition. Wiley-Blackwell Publishing, U.K.
2. Clark, D.P and Pazdernik, N.J.(2015). *Biotechnology*. 2nd edition. Academic Press, USA.
3. Glick, B.R. and Patten, C.L. (2017). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. 5th edition. ASM Press, USA.
4. Glick, B.R., Pasternak, J.J. and Patten, C.L. (2009). *Molecular Biotechnology*. 4th edition. ASM Press, USA.
5. Green, M. and J. Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual*. 4th edition. Cold Spring Harbour Laboratory Press, USA.
6. Primrose, S.B. and Twyman, R.M. (2016). *Principles of Gene Manipulation and Genomics*. 8th edition. Blackwell Publishing, U.K.
7. Willey, J. M., Sandman, K. and Wood, D. (2019). *Prescott's Microbiology*. 11th edition. McGraw Hill Higher Education, USA.
8. Winnacker, E.L. (1986). From Genes to Clones. Reprinted by Panima Publishing Corporation, New Delhi.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05

INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes CLO1: The students will be able to define the contributions of various scientists in the field of genetic engineering. CLO2: The students will be able to differentiate between different kinds of enzymes used in Genetic engineering and cloning vectors. CLO3: The students will be able to determine DNA amplification and sequencing methods. CLO4: The students will be able to classify gene delivery methods and techniques used for the analysis of DNA, RNA and protein. CLO5: The students will be able to justify the application of RDT. CLO6: Students will be able to formulate recent developments in recombinant DNA technology.	
PRACTICALS BMBDSE-NP-363a: GENETIC ENGINEERING & RDT LAB	
Marks: 50	Duration: 60 hours (2 credits)
1. To perform Agarose gel electrophoresis. 2. Analysis of DNA after ligation of DNA fragments by agarose gel electrophoresis. 3. To study agarose gel electrophoresis profile: graphical determination of molecular weight of DNA fragments. 4. To demonstrate interpretation of sequencing gel electropherogram. 5. To demonstrate amplification of DNA by PCR and primer designing. 7. To demonstrate procedure of Southern Blotting.	

DSE-6 b

BMBDSE-NP-363b: ADVANCED MICROBIOLOGY

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: III Semester: VI
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code: BMBDSE-NP-363b	Title: ADVANCED MICROBIOLOGY	
Course Objectives: CO1: The students will gain knowledge about newer concepts in microbiology including metagenomics, CRISPR/Cas system and system biology. CO2: The students will be able to identify the significant challenges faced in the research. CO3: The students will be able to integrate the gained knowledge to generate scientific hypotheses. CO4: The students will gain the required skills in designing and executing experiments. CO5: The students will familiarize themselves with nanoscale biological and physical systems and their applications in the field of biotechnology. CO6: The students will learn the mechanism of regulation of genes.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Evolution of Microbial Genomes Important features of sequenced microbial genomes, Genome pool (core and flexible). Pangenome, Evolution of bacterial virulence – Characteristics of Genomic and Pathogenicity islands (PAI), Horizontal gene transfer.	12
II	Metagenomics Metagenomics: History and development, Metagenomics approach for understanding bacterial diversity, viral metagenome, Meta transcriptomics, meta-proteomics and metabolomics. Prospecting genes.	12
III	Molecular Basis of Host-Microbe Interaction Biofilms: types of microorganisms, molecular aspects and significance of biofilm in the environment, health care, virulence and antimicrobial resistance. Epiphytic fitness and its mode of action in plant pathogens. Type three secretion systems (TTSS) of plant and animal pathogens. Hypersensitive	12

	response (HR) to plant pathogens and its mechanism,	
IV	Systems and Synthetic Biology Biological systems networking, Quorum sensing, Bacterial virulence and its Co-ordinated regulation, Synthesis of poliovirus in the laboratory, Forthcoming inferences of synthetic biology with reference to bacteria and viruses.	12
V	Regulation of gene Expression Microbiomes and their significance, genetically modified organisms and their usages. Rapid identification of microbes using fluorescence-based techniques, PCR, mass spectrometry and CRISPR-Cas system.	12
Reference / Text Books: 1. Benjamin Lewin, Gene VII, Oxford University Press, (2000). 2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Molecular biology of the Cell, 4th Edition. Garland Publishing Inc, (2002). 3. Darnell, Lodish and Baltimore, Molecular Cell Biology, Scientific American Publishing Inc. (2000). 4. Watson. J.D, Baker. T.A, Bell. S.P, Gann.A. Levine.M. Losick. R, Molecular Biology of Gene, 5th Edition. The Benjamin/Cummings Pub. Co.Inc. (2003). 5. David Frifielder, Stanely R. Maloy, Molecular biology and Microbial genetics. 2nd Edition, Jones and Barlett Publishers. (1994). 6. Brown T.A., Gene Cloning and DNA analysis. 2nd Edition, ASM press. (2004). 7. Sandy Primrose. Principles of Gene Manipulation and Genomics. 7th Ed., Blackwell Publishers. (2006). 8. Glick BR and Pasternak J J, Molecular Biotechnology, 2nd Ed.ASM press. (2003). 9. Uldis N.Streips,Ronald E.Yasbin. Modern Microbial Genetics.2nd Edition Wiley-Liss, Inc. (2002). 10. Russel P J, Essential genetics, Blackwell Science Inc, 2 sub edition, (1987).		
If the course is available as Generic Elective then the students of following departments may opt it. NO		
Evaluation/Assessment Methodology		
		Max. Marks:100
1) Class tasks/ Sessional Examination		16
2) Presentations /Seminar		-
3) Assignments		04
4) Research Project Report		-
Seminar On Research Project Report		-
5) ESE/Attendance		05
INTERNAL MARKS		25
EXTERNAL MARKS		75
TOTAL		100
Prerequisites for the course:		
Course Learning Outcomes By the conclusion of this course, the students - CLO1. The students will be able to define the genomes of typical microorganisms. CLO2. The students will be able to differentiate between various techniques such as fluorescence-based techniques, PCR, mass spectrometry, CRISPR-Cas system etc. used to identify microbes. CLO3. The students will be able to determine the microorganisms involved in the formation of		

biofilm.

CLO4. The students will be able to categorize DNA from bacteria/soil and perform PCR for 16s Ribosomal genes using universal primers and interpret the results.

CLO5. The students will be able to justify the importance of metagenomics.

CLO6: Students will be able to formulate advanced techniques of Microbiology.

PRACTICALS

BMBDSE-NP-363b: ADVANCED MICROBIOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

1. To isolate DNA from soil sample for metagenomic studies.
2. To understand and identify the inhibitions/challenges in extracting metagenomics DNA from soil.
3. To perform amplification of metagenomics DNA by PCR using universal primers (16s ribosomal gene primers).
4. Case study: Synthesis of polio virus genome in the laboratory.
5. Case study: Networking of metabolic pathways in bacteria.

CORE-1
GENERAL MICROBIOLOGY (BMB-NPR-111)

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology	Year: I Semester: I	
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code: BMB-NPR-111	Title: GENERAL MICROBIOLOGY	
Course Objectives: CO1: To introduce students to the fundamental concepts, branches, and scope of microbiology and enable them to explore the historical development of microbiology, focusing on key discoveries and contributions by pioneering scientists. CO2: To provide a comprehensive overview of microbial classification systems and modern techniques in microbial phylogenetics as well as examine the diversity of microorganisms and their economic importance. CO3: To familiarize students with the principles, operation, and applications of essential microbiological instruments. CO5: To highlight the interdisciplinary applications of microbiology in various fields such as human health, agriculture, industry, and environmental science. CO6: To discuss the emerging trends, future prospects, and ethical considerations in microbiology.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Microbiology and its Historical Development: • Definition, branches and Scope of Microbiology • Early Discoveries (Contributions of Antonie van Leeuwenhoek) • The Golden Age of Microbiology: Key Discoveries • Contributions of • Robert Koch: Koch's Postulates • Louis Pasteur: Germ Theory of Disease • Joseph Lister: Antiseptic Surgery • Edward Jenner: Development of Vaccination Historical Developments in • Bacteriology	12

	• Virology • Mycology and Parasitology	
II	Microbial Classification • Systems of Classification: An Overview • Binomial Nomenclature: Rules and Examples • The Three Domains of Life: Bacteria, Archaea, Eukarya • Five Kingdom Classification: Overview and Details • Three Kingdom Classification: Historical Perspective • Bergey's Manual of Systematic Bacteriology • Acellular Microorganisms: Viruses, Viroids, and Prions • Differences between Prokaryotic and Eukaryotic Cells • Microbial Phylogenetics: Modern Techniques in Classification	12
III	Microbial Diversity: General Characteristic and economic importance of • Viruses, viroid and Prions • Bacteria (including archaebacteria, actinomycetes, rickettsia, chlamydia, mycoplasma) • Fungi • Algae and cyanobacteria • Protozoa	12
IV	Introduction to instrumentation in Microbiology: Principle, working (SOP) and application of various Instruments used in microbiology • Microscope • Autoclave and Biosafety cabinets • Incubator • Centrifuge • Spectrophotometer (UV/Visible) • pH meter • Laminar air flow and biosafety cabinets • □ Incubators and incubator shaker	12
V	Application of Microbiology and Interdisciplinary aspect: • Microorganisms in Human Health: Normal Flora and Pathogens • Antibiotics and Antimicrobial Resistance • Microbiology in Food and Dairy Industry • Microbiology in Agriculture: Soil Health and Plant Pathogens • Environmental Microbiology: Waste Degradation and Bioremediation • Industrial Microbiology: Fermentation and Biotechnology • Space Microbiology: Microorganisms in Space Research • Microbial Biotechnology: Genetic Engineering and Applications • Emerging and Re-emerging Infectious Diseases • Future Prospects and Ethical Issues in Microbiology	12

Reference / Text Books:

1. Alexopoulos C.J. and Mims C.W., Introductory Mycology, New Age International, New Delhi.
2. Aneja K.R., Experiments in Microbiology, plant pathology, Tissue culture and Mushroom cultivation, New Age International, New Delhi.
3. Atlas R.M., Microbiology- Fundamentals and applications, Macmillan Publishing Company, New

York.

4. Benson Harold J., Microbiological Applications, WCB Mcgraw-Hill, New York.
5. Bold H.C. and Wynne M.J., Introduction to Algae, Prentice Hall of India Private Limited, New Delhi.
6. Baveja C.P., Textbook of microbiology APC 6 th edition.
7. Dubey R.C.. and Maheshwari D.K., Textbook of microbiology, S Chand Publications.
8. Pelczar M.J., Chan E.C.S and Kreig N.R., Microbiology, Mcgraw-Hill Book Company, New York.
9. Prescott Lansing M., Harley John P. and Klein Donald A., Microbiology, WCB Mcgraw- Hill, New York.
10. Stanier R.Y., Ingraham J.L., General Microbiology, Prentice Hall of India Private Limited, New Delhi.
11. Sharma P.D., Microbiology, Rastogi Publications. Tortora G.J., Funke B.R. and Case C.L., Microbiology: An introduction, 9th edition, Pearson Education

If the course is available as Generic Elective, then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

Max. Marks:100

1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

By the end of this course, students will be able to:

CLO1: Describe various branches and scope of Microbiology as well as identify and explain the early discoveries and key contributions of pioneers such as Antonie van Leeuwenhoek, Robert Koch, Louis Pasteur, Joseph Lister, and Edward Jenner.

CLO2: Differentiate between various systems of microbial classification, including binomial nomenclature, the three domains of life, and the five and three kingdom classifications as well as utilize Bergey's Manual of Systematic Bacteriology for microbial classification and understand the differences between prokaryotic and eukaryotic cells.

CLO3: Describe the general characteristics and economic importance of viruses, viroids, prions, bacteria, fungi, algae, cyanobacteria, and protozoa.

CLO4: Operate and understand the principles of key microbiological instruments such as microscopes, autoclaves, incubators, centrifuges, spectrophotometers, and pH meters.

CLO5: Apply microbiological concepts to various industries, including food and dairy, agriculture, environmental science, and biotechnology.

CLO6: Evaluate the future prospects and ethical issues in the field of microbiology.

PRACTICALS

GENERAL MICROBIOLOGY LAB (BMB-NPR-111P)

Marks: 50

Duration: 60 hours (2 credits)

1. Prepare a portfolio of Louis Pasteur and Robert Koch.
2. To study various Good laboratory practices to be followed in Microbiology laboratory.

3. To perform washing of glassware and cleaning equipment, wrapping of glassware and preparation of cotton plug.
4. To calibrate common equipment and instruments (Micropipette/pH meter, weighing balance) for laboratory functions.
5. To study Standard operating protocols of all the instruments to be used (Group activity)
6. To prepare temporary mounts of fungi (e.g., Rhizopus/Saccharomyces/Aspergillus) and study their morphology.
7. To prepare temporary mounts of algae (Chlamydomonas, Volvox and Spirogyra).
8. Study of protozoa using permanent mounts or photographs such as amoeba, paramecium, giardia etc.
9. To prepare routine cultivation medium for bacteria and fungi (Nutrient agar medium and Potato dextrose agar medium respectively) and prepare their plates/slants/agar deep tubes.
10. To perform growth of algae in laboratory

CORE-2
PROKARYOTIC CELL STRUCTURES (BMB-NPR-112)

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: I Semester: I
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code: BMB-NPR-112	Title: PROKARYOTIC CELL STRUCTURES	
Course Objectives: CO1: The main objective of this course is to give students a thorough understanding of prokaryotic cell CO2: To provide comprehensive overview of the cell structure, it's organization and functions of various parts of the cell. CO3: To enlighten the students about culture media and culture methods used in bacteriology. CO4: To provide the knowledge of preservation methods for bacteria and various anaerobic culture methods. CO5: To familiarize students with various sterilization techniques to control the microorganisms. CO6: To highlight the cell structure, classification and types of Archaeobacteria.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Prokaryotic cell structure and organization: • Shape, size and arrangement of bacterial cell, • Bacterial capsule and slime layer • Bacterial cell wall (Gram's positive and Gram's negative) • Bacterial cell membrane • Bacterial flagella, fimbriae and pili • Bacterial endospore • Nucleoid and plasmids • Mesosome and Ribosomes • Inclusion bodies	10
II	Culture Media and Culture Methods • Culture media • Types of culture media	10

	Simple media Enriched media Enrichment media Selective media Differential media Indicator media Transport media Sugar media Anaerobic media - Isolation and Pure culture methods: Streak plate method Pour plate method Spread plate method Stab culture Slant culture - Methods of cultivation and maintenance pure cultures.	
III	Culture preservation techniques and Anaerobic culture methods - Culture preservation technique Agar Slant Cultures Refrigeration Paraffin method Saline suspension Cryopreservation Lyophilisation (Freeze-Drying) Preservation at Very Low Temperature Preservation by Drying in Vacuum - Cultivation of anaerobic bacteria Candle jar method McIntosh and Fildes' anaerobic jar Gas Pack jar method	10
IV	Sterilization Techniques - Sterilization and disinfection - Principle of sterilization - Physical Methods of sterilization (Sunlight, Heat, Filtration, Radiation) - Chemical methods of sterilization (Alcohols, Aldehydes, Phenols, Halogens, Oxidising agents, Salts, Surface active agents, Dyes and Gases)	10
V	Identification of Bacteria - Collection and transport of specimens - Processing of specimens - Identification of bacteria Colony appearance (size, shape and arrangement of bacteria) Microscopic characterization of the bacteria (Simple, Differential, Acid Fast, Capsular and Endospore staining) Biochemical tests	10
VI	Archaeobacteria Characteristics of Archaeobacteria	10

	- Cell wall and cell membrane - Major groups of Archaeobacteria Methanogens Thermophiles Halophiles	

Reference / Text Books:

1. Prescott, M.J., Harley, J.P., and Klein D.A. Microbiology. 7th edition WCB Mc Graw Hill, New York,
2. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. Microbiology. 5 th edition. McGraw Hill, USA.
3. Srivastava, S. and P.S. Srivastava, P.S. Understanding Bacteria. Springer, Netherlands.
4. Dubey RC and Maheshwari D K . A textbook of Microbiology, S Chand, 4th edition.
5. Black, J.G. and Black, L.J. Microbiology: Principles and Explorations. 10 th edition.
6. Aneja K.R., Experiments in Microbiology, plant pathology, Tissue culture and Mushroom cultivation, New Age International, New Delhi.
7. Baveja C.P., Textbook of microbiology APC 6th edition.
8. Stanier R.Y., Ingraham J.L., General Microbiology, Prentice Hall of India Private Limited, New Delhi.
9. Tortora, G.J., Funke, B.R., Case, D., Weber, D. and Bair, W. Microbiology: An Introduction. 13th edition. Pearson Education, USA

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

CLO1: will be able to recall the shape, structure, and organisation of many cell components and be able to tell the difference between the cell walls of archaea and eubacteria, as well as between Gram-positive and Gram-negative bacteria.

CLO2: Will be able to differentiate between various culture media and culture methods.

CLO3: will be able to determine and distinguish between different methods for the preservation of the culture and also will learn about the methods employed in the cultivation of anaerobic bacteria.

CLO4: Will be able to categorize many methods for the sterilization and disinfection.

CLO5: Will be able to appraise the morphology and distinguishing characteristics of many Gram-positive and Gram-negative bacteria.

CLO6: Will be able to evaluate the differences between archaea and eubacteria and be able to explain the characteristics of Archaeobacteria.

PRACTICALS	
PROKARYOTIC CELL STRUCTURES LAB (BMB-NPR-112P)	
Marks: 50	Duration: 60 hours (2 credits)
1. To prepare different types of media: Nutrient Agar medium, Mac Conkey Agar medium, Eosine Methylene Blue Agar medium, Blood Agar and Chocolate agar. 2. To perform Gram's staining to differentiate the Gram's positive and Gram's negative bacteria.\ 3. To prepare slants for the preservation of bacterial culture 4. To isolate the bacteria using streak plate method 5. To perform Catalase test 6. To perform Oxidase test. 7. Demonstration of Pour Plate Method using serial dilution technique 8. To check the motility of bacteria using Hanging drop method.	

DSE1a

EUKARYOTIC CELL STRUCTURES (BMBD-NPR-113a)

Programme: Microbiology Certificate/Diploma/Degree/ UG Class: B.Sc. Microbiology		Year: I Semester: I	
Credits: 6 Theory: 4 Practical: 2		Subject: MICROBIOLOGY	
Course Code:BMBD-NPR-113a		Title: EUKARYOTIC CELL STRUCTURES	
Course Objectives: CO 1 To understand the detailed structure and function of eukaryotic cell organelles. CO 2 To learn the various processes involved in cellular organization and function. CO 3 To study the regulatory mechanisms within eukaryotic cells. CO 4 To explore recent advances in cell biology and their applications. CO 5 To study the cell cycle and apoptosis regulation. CO 6 To learn the cell communication between the cells.			
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]			
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits			
L: 4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)			
Unit	Contents	No. of Lectures Allotted	
I	Introduction to Eukaryotic Cells: - History and evolution of eukaryotic cells - Comparison between prokaryotic and eukaryotic cells - Overview of cell theory - Cellular diversity and specialization	12	
II	Plasma Membrane and Cell Wall: - Structure and composition of the plasma membrane; - Fluid mosaic model - Cell wall structure and function in fungi Nucleus and Chromatin: - Nuclear envelope, nuclear pores, and nuclear lamina - Structure and function of the nucleolus	12	
III	Endomembrane System: - Endoplasmic reticulum: rough and smooth ER, functions - Golgi apparatus: structure, functions, and vesicular transport Mitochondria and Chloroplasts: - Structure and function of mitochondria - Structure and function of chloroplasts	12	

IV	Cytoskeleton and Cell Motility: - Components of the cytoskeleton; microfilaments, microtubules, and intermediate filaments - Functions of the cytoskeleton in cell shape, division and motility - Motor proteins: kinesin, dynein, and myosin - Cell movement: cilia and flagella	12
V	Cell Communication and Signal Transduction: - Types of cell signaling: autocrine, paracrine, endocrine, and juxtacrine - Second messengers: cAMP, Ca²⁺, and IP₃ Cell Cycle and Apoptosis: - Phases of the cell cycle: interphase, mitosis, and cytokinesis - Role of cell cycle and Mechanisms of apoptosis and necrosis	12
Reference / Text Books: "Molecular Biology of the Cell" by Alberts et al. "Cell and Molecular Biology: Concepts and Experiments" by Gerald Karp "The Cell: A Molecular Approach" by Geoffrey M. Cooper and Robert E. Hausman. "Essential Cell Biology" by Alberts et al. "Molecular Cell Biology" by Lodish et al. "Lehninger Principles of Biochemistry" by David L. Nelson and Michael M. Cox		
If the course is available as Generic Elective then the students of following departments may opt it. Yes		
Prerequisite: Intermediate/Basic knowledge of life science		
Evaluation/Assessment Methodology		
		Max. Marks
1) Class tasks/ Sessional Examination		16
2) Presentations /Seminar/Attendance		5
3) Assignments		4
4) Research Project Report Seminar On Research Project Report		
5) ESE		75
Total:		100
Prerequisites for the course: Knowledge of Basics of Microbiology (Intermediate level)		
Course Learning Outcomes: CLO1: Identify and describe the various components of eukaryotic cells. CLO2: Explain the functions of different cell organelles. CLO3: Understand the molecular mechanisms of cellular processes. CLO4: Apply knowledge of cell biology in research and practical applications. CLO5: Describe the structure and function of key cellular organelles, including the nucleus, mitochondria, endoplasmic reticulum, Golgi apparatus, lysosomes, and peroxisomes. CLO6: Explain the organization and dynamics of the cytoskeleton, including microtubules, microfilaments, and intermediate filaments		

PRACTICALS	
EUKARYOTIC CELL STRUCTURES LAB (BMBD-NPR-113aP)	
Marks: 50	Duration: 60 hours (2 credits)
EUKARYOTIC CELL STRUCTURES LAB (BMBD-NPR-113aP) 1. To understand the basic principles of light microscopy and observe the morphology of different eukaryotic cells. 2. To study the fluorescence microscopy to visualize specific organelles within eukaryotic cells. 3. To isolate mitochondria from eukaryotic cells using differential centrifugation. 4. To construct and study a model of the lipid bilayer. 5. To extract DNA from eukaryotic cells and visualize it. 6. To stain and observe chromatin in eukaryotic cells.	

DSE-1b

FOOD FERMENTATION TECHNOLOGY (BMBD-NPR-113b)

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: I Semester: I
Credits: 4 Theory: 4 Practical: 0	Subject: MICROBIOLOGY	
Course Code:BMBD-NPR-113b	Title: FOOD FERMENTATION TECHNOLOGY	
Course Objectives: CO1: The main goal of this essay is to provide students with knowledge of food fermentation technology. CO2: The learners will learn the use of microorganisms in industrial production. CO3: The learners will learn the advantageous and disadvantageous behaviors of microorganisms in relation to food and their uses in the food industry. CO4: The learners will learn various design parameters of fermentation. CO5: The learners will learn the production method of dairy-fermented products. CO6: The learners will learn the principles and methods of food preservation.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Food fermentation The evolution and application of food fermentation technologies; food and nutrition concepts; food's physiochemical characteristics; the significance and kinds of microorganisms (bacteria, mold, and yeast) that can be found in food; Food as a substrate for microorganisms: Natural flora, sources of food contamination, and intrinsic and extrinsic variables that affect the development and survival of germs in food.	10
II	Design of fermenters Various fermenters, Fermenters' construction and operation fundamental ideas for choosing a reactor, Fluidized bed reactor, trickle bed reactor, bubble column reactor, packed bed reactor expansion of the bioreactor.	10
III	Food as a substrate for microbial growth and food-borne diseases Characteristics that influence microbial growth in food, both intrinsic and extrinsic. Food spoiled by microbes includes milk, bread, and canned goods. Clostridium botulinum food poisoning. Salmonella contamination of food. Traveler's diarrhea.	10
IV	Dairy-fermented products and Probiotics	10

	Acidophilus milk and cheese, Dahi, yogurt, buttermilk, kefir: inoculum preparation, fermentation types, and process of production. Definition, benefits, and examples of probiotics.	
V	Grain-based and other non-dairy fermented foods Bread, idli, dosa, soy sauce: inoculum preparation, varieties of microorganisms, and fermentation process: Pickles, sauerkraut, and other fermented dishes made from vegetables, meat, or fish.	10
VI	Principles and methods of food preservation: Physical techniques include irradiation, aseptic packing, and high and low temperatures. Salt, sugars, benzoates, citric acid, ethylene oxide, nitrate, and nitrite chemical processes. Management for ensuring food quality: HACCP. Quality assurance tests of the finished product: Sterility testing, Pyrogen testing, Ames test, toxicity testing, and shelf life testing. Validation principles for the pharmaceutical business.	10

Reference / Text Books:

1. Adams, M.R. and Moss, M.O. (2000). Food Microbiology. 2nd edition. New Age International Publishers, India.
2. Banwart, G.J. (2004). Basic Food Microbiology. 2nd edition. CBS Publishers and Distributors, India.
3. Casida, L.E. (2019). Industrial Microbiology. 2nd edition. New Age International, India.
4. Crueger, W., Crueger, A. and Aneja, K.R. (2017). Biotechnology: A Textbook of Industrial Microbiology. 3rd edition. Medtech Publisher, India.
5. Frazier, W.C., Westhoff, D.C. and Vanitha, N.M. (2013). Food Microbiology. 5th edition. Tata McGraw-Hill Publishing Company Ltd, India.
6. Jay, J.M., Loessner, M.J. and Golden, D.A. (2006). Modern Food Microbiology. 7th edition. CBS Publishers and Distributors, India.
7. Patel, A.H. (1996). Industrial Microbiology. 1st edition. Macmillan India Limited.
8. Stanbury, P.F., Whitaker, A. and Hall, S.J. (2016). Principles of Fermentation Technology. 3rd edition. Elsevier Science, Netherlands.

If the course is available as a Generic Elective then the students of the following departments may opt for it.

YES

1. B.Sc. Biotechnology
2. B.Sc. Biology
3. B.Sc. Agriculture

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcome:	

CLO1: will be able to recall about the background, evolution, and application of food fermentation technology.

CLO2: will be able to demonstrate many types of fermenters and their components. Also, will be familiar with the many methods used for industrial strain isolation, screening, preservation, and upkeep.

CLO3: will be able to calculate key factors influencing microbial development in foods. The learner will learn about common food-borne illnesses as well as the microorganisms that can cause the spoilage of some common foods.

CLO4: will be able to analyze the use of microorganisms as food supplements and in the fermentation of dairy products.

CLO5: will be able to appraise the microorganism's utilization in the fermentation of non-dairy products and grain-based products.

CLO6: will be able to design many physical processes and chemicals used in food preservation. Additionally, the learner will be familiar with the idea of food quality management.

FOOD FERMENTATION TECHNOLOGY LAB (BMBD-NPR-113Bp)

PRACTICALS

Marks: 50

Duration: 60 hours (2 credits)

FOOD FERMENTATION TECHNOLOGY LAB (BMBD-NPR-113bP)

1. To study design of a stirred tank bioreactor.
2. Isolation of food spoilage microbe.
3. To study fermentation process by yeast (raising of dough in bread making)
4. Effect of salt, sugar and citric acid as preservative by performing antimicrobial effect of these chemicals on microbial growth.
5. Effect of irradiation on microbial growth.

AECC-2
ENVIRONMENT AND ECOLOGY NHU-NPR-112

Programme: BSc/ BA/BBA/BCA/BTech Certificate/Diploma/Degree/ All UG Programme		Year: I Semester: I
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code: NHU-NPR-112	Title: Environment and Ecology	
Course Objectives: Subject comprised of various fields of Environmental science and their applications for the mankind. It meets the local to global requirement. CO 1 To appreciate the historical context of human interactions with the environment and to gain insights into the international efforts to safeguard the Earth’s environment and resources. CO 2 To understand the concept of natural resources, identify types of natural resources, their distribution and use with special reference to India. CO 3 To develop a critical understanding of the environmental issues of concern CO 4 To describe the main types of ecosystems and their distribution in India and the world and to explain major conservation strategies taken in India. CO 5 To develop an understanding of pollution, its types and Control measures. CO 6 To gain a comprehensive knowledge of climate change, its science and response measures and to have an overview of national and global efforts to address climate change adaptation and mitigation. CO7 To Explain major conservation strategies taken in India. CO8 To Sensitize themselves to adverse health impacts of pollution.		
Nature of Paper: AECC		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T:0 P:1(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(2Hrs./Week=1Credits)		
Unit	Contents	No. of Lectures Allotted
I	Humans and the Environment: The man-environment interaction: Humans as hunter-gatherers; Mastery of fire; Origin of agriculture; Emergence of citystates; Great ancient civilizations and the environment, Indic Knowledge and Culture of sustainability; Middle Ages and Renaissance; Industrial revolution and its impact on the environment; Population growth and natural resource exploitation; Global environmental change. Environmental Ethics and emergence of environmentalism: Anthropocentric and eco-centric perspectives (Major thinkers); The Club of Rome- Limits to Growth; UN Conference on Human Environment 1972; World Commission on Environment and Development and the concept of sustainable	4

	development; Rio Summit and subsequent international efforts.	
II	Natural Resources and Sustainable Development: Overview of natural resources: Definition of resource; Classification of natural resources-biotic and abiotic, renewable and non-renewable. Biotic resources: Major type of biotic resources- forests, grasslands, wetlands, wildlife and aquatic (fresh water and marine); Microbes as a resource; Status and challenges. Water resources: Types of water resources- fresh water and marine resources; Availability and use of water resources; Environmental impact of overexploitation, issues and challenges; Water scarcity and stress; Conflicts over water. Soil and mineral resources: Important minerals; Mineral exploitation; Environmental problems due to extraction of minerals and use; Soil as a resource and its degradation. Energy resources: Sources of energy and their classification, renewable and non-renewable sources of energy; Conventional energy sources- coal, oil, natural gas, nuclear energy; Non-conventional energy sources- solar, wind, tidal, hydro, wave, ocean thermal, geothermal, biomass, hydrogen and fuel cells; Implications of energy use on the environment Introduction to sustainable development: Sustainable Development Goals (SDGs)- targets and indicators, challenges and strategies for SDGs.	8
III	Environmental Issues-Local, regional & Global: Environmental issues and scales: Concepts of micro-, meso-, synoptic and planetary scales; Temporal and spatial extents of local, regional, and global phenomena. Pollution: Impact of sectoral processes on Environment; Types of Pollution- air, noise, water, soil, thermal, radioactive ;municipal solid waste, hazardous waste; transboundary air pollution; acid rain; smog. Land use and Land cover change: land degradation, deforestation, desertification, urbanization. Biodiversity loss: past and current trends, impact. Global change: Ozone layer depletion; Climate change. Disasters-Natural and Man-made (Anthropogenic)	8
IV	Conservation of Biodiversity & Ecosystem: Biodiversity and its distribution: Biodiversity as a natural resource; Levels and types of biodiversity; Biodiversity in India and the world; Biodiversity hotspots; Species and ecosystem threat categories. Ecosystems and ecosystem services: Major ecosystem types in India and their basic characteristics• forests, wetlands, grasslands, agriculture, coastal and marine; Ecosystem services- classification and their significance. Threats to biodiversity and ecosystems: Land use and land cover change; Commercial exploitation of species; Invasive species; Fire, disasters and climate change. Major conservation policies: in-situ and ex-situ conservation approaches; Major protected areas; National and International Instruments for biodiversity conservation; the role of traditional knowledge, community-based conservation; Gender and conservation.	8
V	Environmental Pollution & Health: Understanding pollution:	8

	Production processes and generation of wastes; Assimilative capacity of the environment; Definition of pollution; Point sources and non-point sources of pollution. Air pollution: Sources of air pollution; Primary and secondary pollutants; Criteria pollutants- carbon monoxide, lead, nitrogen oxides, ground-level ozone, particulate matter and sulphur dioxide; Other important air pollutants- Volatile Organic compounds (VOCs), Peroxyacetyl Nitrate (PAN), Polycyclic aromatic hydrocarbons (PAHs) and Persistent organic pollutants (POPs); Indoor air pollution; Adverse health impacts of air pollutants; National Ambient Air Quality Standards. Water pollution: Sources of water pollution; River, lake and marine pollution, groundwater pollution; water quality Water quality parameters and standards; adverse health impacts of water pollution on human and aquatic life. Soil pollution and solid waste: Soil pollutants and their sources; Solid and hazardous waste; Impact on human health. Noise pollution: Definition of noise; Unit of measurement of noise pollution; Sources of noise pollution; Noise standards; adverse impacts of noise on human health. Thermal and Radioactive pollution: Sources and impact on human health and ecosystems.	
VI	Climate change: impacts, adaptation & mitigation: Understanding climate change: Natural variations in climate; Structure of atmosphere; Anthropogenic climate change from greenhouse gas emissions- past, present and future; Projections of global climate change with special reference to temperature, rainfall, climate variability and extreme events; Importance of 1.5 °C and 2.0 °C limits to global warming; Climate change projections for the Indian sub-continent. Impacts, vulnerability and adaptation to climate change: Observed impacts of climate change on ocean and land systems; Sea level rise, changes in marine and coastal ecosystems; Impacts on forests and natural ecosystems; Impacts on animal species, agriculture, health, urban infrastructure; the concept of vulnerability and its assessment; Adaptation vs. resilience; Climate resilient development; Indigenous knowledge for adaptation to climate change. Mitigation of climate change: Synergies between adaptation and mitigation measures; Green House Gas (GHG) reduction vs. sink enhancement; Concept of carbon intensity, energy intensity and carbon neutrality; National and international policy instruments for mitigation, decarbonizing pathways and net zero targets for the future; Energy efficiency measures; Renewable energy sources; Carbon capture and storage, National climate action plan and Intended Nationally Determined Contributions (INDCs); Climate justice.	8
VII	Environment management: Introduction to environmental laws and regulation: Constitutional provisions- Article 48A, Article 51A (g) and other derived environmental rights; Introduction to environmental legislations on the forest, wildlife and pollution	8

	control. Environmental management system: ISO 14001. Concept of Circular Economy, Life cycle analysis; Cost-benefit analysis. Environmental audit and impact assessment; Environmental risk assessment Pollution control and management; Waste Management- Concept of 3R (Reduce, Recycle and Reuse) and sustainability; Ecolabeling /Ecomark scheme	
VIII	Environmental Treaties and Legislation: An overview of instruments of international cooperation; bilateral and multilateral agreements; conventions and protocols; adoption, signature, ratification and entry into force; binding and non-binding measures; Conference of the Parties (COP) Major International Environmental Agreements: Convention on Biological Diversity (CBD); Cartagena Protocol on Biosafety; Nagoya Protocol on Access and Benefit-sharing; Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES); Ramsar Convention on Wetlands of International Importance; United Nations Convention to Combat Desertification (UNCCD); Vienna Convention for the Protection of the Ozone Layer; Montreal Protocol on Substances that Deplete the Ozone Layer and the Kigali Amendment; Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal; Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade; Stockholm Convention on Persistent Organic Pollutants; Minamata Convention on Mercury; United Nations Framework Convention on Climate Change (UNFCCC); Kyoto Protocol; Paris Agreement; India's status as a party to major conventions Major Indian Environmental Legislations: The Wild Life (Protection) Act, 1972; The Water (Prevention and Control of Pollution) Act, 1974; The Forest (Conservation) Act, 1980; The Air (Prevention and Control of Pollution) Act, 1981; The Environment (Protection) Act, 1986; The Biological Diversity Act, 2002; The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006; Noise Pollution (Regulation and Control) Rules, 2000; Industry-specific environmental standards; Waste management rules; Ramsar sites; Biosphere reserves; Protected Areas; Ecologically Sensitive Areas; Coastal Regulation Zone; Status phase-out of production and consumption of Ozone Depleting Substances by India; National Green Tribunal; Some landmark Supreme Court judgements Major International organisations and initiatives: United Nations Environment Programme (UNEP), International Union for Conservation of Nature (IUCN), World Commission on Environment and Development (WCED), United Nations Educational, Scientific and Cultural Organization (UNESCO), Intergovernmental Panel on Climate Change (IPCC), and Man and the Biosphere (MAB) programme.	8
Reference / Text Books: 1. A text book of Ecology and Environment, P.C. Joshi & Namita Joshi, Himalaya Publishing		

- House, Mumbai
- Ecology and Environment, P.D. Sharma, Rastogi Pub., New Delhi.
 - Ecology and Environment, H.R. Singh and Neeraj Kumar, Rastogi Publication.
 - Fundamentals of Ecology, E.P. Odum, W.B. Saunders Co., Philadelphia.
 - Essentials of Ecology & Environmental Science, S.V.S. Rana, Prentice Hall of India Pvt. Ltd., New Delhi.
 - Fisher, Michael H. (2018) An Environmental History of India- From Earliest Times to the Twenty-First Century, Cambridge University Press.
 - Wildlife Biology. Rajesh Gopal. Approved By MoEF, New Delhi.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Prerequisite: Intermediate/Basic knowledge of life science

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: Knowledge of Basics of Environment and Ecology (Intermediate level)

Course Learning Outcomes:

CLO1: Student will come up with the knowledge of field Environmental management as well as Sustainable development and benefit of mankind.

CLO2: Student will come up with the knowledge of Environment management.

CLO3: Student will come up with the knowledge of Environmental Science in cleaning the environment.

CLO4: Student will be Explain sustainable development, its goals, targets, challenges and global strategies for sustainable development.

CLO5: Student will be develop a critical understanding of the environmental issues

CLO6: The overall course outcome focused on the role of Environment management in human welfare.

CLO7: Student will be Explain major conservation strategies taken in India.

CLO8: Student will be able Sensitize themselves to adverse health impacts of pollution.

PRACTICALS

NHU-NPR-112P: Environment and Ecology Lab

Marks: 50 (35 + 15)

Duration: 30 hours (1 credits)

Case studies and fieldwork

The students are expected to be engaged in some of the following or similar identified activities:

- Discussion on one national and one international case study related to the environment and sustainable development.
- Field visits to identify local/regional environmental issues make observations including data collection and prepare a brief report.
- Participation in plantation drive and nature camps.
- Documentation of campus biodiversity.
- In-situ and Ex-situ Conservation Methods of Biodiversity

ASSESSMENT FOR PRACTICAL			
Internal Assessment	Marks	External Assessment	Marks
Lab Performance/ Filed Work	5	Major Experiment/ Case studies	8
Quiz/ Env. Diary	5	Minor Experiment/ Case studies	6
Charts/ Model	5	Spotting	10
-	-	Viva	6
-	-	Record	5
Total	15	Total	35

CORE-3

MICROBIAL PHYSIOLOGY AND METABOLISM (BMB-NPR- 121)

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: I Semester: II
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code:BMB-NPR-121	Title: MICROBIAL PHYSIOLOGY AND METABOLISM	
Course Objectives: CO1: Giving learners a thorough understanding of microbial physiology and metabolism is the primary goal of this course. CO2: Students will learn about the growth patterns of bacteria and how the environment affects microbial growth. CO3: These comprise numerous metabolic pathways present in microorganisms for energy production and carbon and nitrogen absorption. CO4: The course also include mechanisms involved in microbial physiology such as nutrient uptake, bacterial growth, and variables controlling it. CO5: This course will demonstrate various bacterial fermentation methods. CO6: This course will also focus on Chemo lithotrophic and phototrophic metabolism		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Microbial Nutrition and Transport: • Microbial Nutrition • Microorganism classification based on food supply and energy. • Nutritional types of microorganisms • Uptake of nutrients (Passive diffusion, Facilitated diffusion, Active transport, Primary active transport, Secondary active transport, Group translocation, Iron uptake)	10
II	Microbial growth and influence of environmental factors on microbial growth: • Definition of growth • Bacterial division • Generation time	10

	• Bacterial growth curve • Batch culture and continuous culture • Environmental factors affecting the microbial growth (Osmotic pressure, pH, Temperature, Oxygen concentration, Pressure, Radiation)	
III	Carbon metabolism and energy generation: • Concepts of aerobic, anaerobic, and fermentation respiration. • Sugar degradation pathways (EMP pathway, ED pathway, Pentose phosphate pathway, TCA cycle). • Electron transport chains: components of respiratory chain • Comparison of mitochondrial and bacterial ETC, • Electron transport phosphorylation, • Uncouplers and inhibitors	10
IV	Bacterial fermentations: • Fermentation: definition • Process of fermentation • Types of fermentation • Lactic acid fermentation • Alcohol fermentation • Acetic acid fermentation	10
V	Phototrophy and Autotrophy • Phototrophic metabolism: Introduction, • Groups of phototrophic microorganisms • Photosynthetic and accessory pigments, • Anoxygenic vs. oxygenic photosynthesis with reference to • photosynthesis in green bacteria and cyanobacteria. • Carbon fixation pathways	10
VI	Nitrogen metabolism • An overview of Nitrogen cycle • Biological nitrogen fixation • Nitrification • Nitrate reduction • Denitrification	10
Reference / Text Books: 1. Madigan, M.T. and Martinko, J.M. (2017). Brock Biology of Microorganisms. 15th edition. Prentice Hall International Inc., USA. 2. Gottschalk, G. (1986). Bacterial metabolism. Springer Verlag, New York, 2nd ed. 3. Stanier, R.Y., Ingrahm, J.I., Wheelis, M.L. and Painter, P.R. (1987). General microbiology. McMillan Press, London, 5th ed. 4. Moat, A.G., Foster, J.W. and Spector, M.P. (2002). Microbial Physiology. 3rd edition. John Wiley & Sons, USA. 5. Nelson, D.L. and Cox, M.M. (2017). Lehninger Principles of Biochemistry. 7th edition. W.H. Freeman and Company, UK. 6. Reddy, S.R. and Reddy, S.M. (2005). Microbial Physiology. Scientific Publishers, India. 7. White, D., Drummond, J. and Fuqua, C. (2011). The Physiology and Biochemistry of Prokaryotes. 4th edition. Oxford University Press, UK.		

8. Willey, J. M., Sandman, K. and Wood, D. (2019). Prescott's Microbiology. 11th edition. McGraw Hill Higher Education, USA.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology	
Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcome: CLO1: will be able to recall the many bacterial physiological groupings and microbial transport systems. CLO2: will be able to demonstrate bacterial growth patterns, the bacterial growth curve, how to calculate generation times and specific growth rates, and how the environment affects growth. CLO3: will be able to determine the range of bacterial energy production mechanisms and energy conservation during growth in both aerobic and anaerobic environments. CLO4: Will be able to categorize two significant microbial fermentation routes. CLO5: Will be able to appraise more about the many chemolithotrophic and phototrophic groups and families, depending on their capacity to absorb carbon from CO ₂ and extract energy from inorganic molecules. CLO6: Will be able to formulate the physiological processes through which bacteria fix nitrogen and take up inorganic nitrogen.	
PRACTICALS MICROBIAL PHYSIOLOGY AND METABOLISM LAB (BMB-NPR- 121P)	
Marks: 50	Duration: 60 hours (2 credits)
1. To plot the growth curve of bacteria by turbidimetric methods. 2. To calculate the generation time and specific growth rate of bacteria from the graph plotted with the given data. 3. To identify the bacteria using catalase test. 4. To identify the bacteria using Oxidase test. 5. To perform sugar fermentation test for the identification of bacteria 6. To check the effect of pH on bacterial growth. 7. To check the effect of temperature on bacterial growth	

CORE-4
BASIC AND APPLIED BIOCHEMISTRY (BMB-NPR-122)

Programme: Microbiology Certificate/Diploma/Degree/ UG Class: B.Sc. Microbiology		Year: I Semester: II	
Credits: 6 Theory: 4 Practical: 2		Subject: MICROBIOLOG	
Course Code:BMB-NPR-122		Title: Basic and Applied Biochemistry	
Course Objectives: CO1 To understand the fundamental concepts of biochemistry and their application in biological systems. CO2 To gain knowledge of the structure and function of biomolecules. CO3 To explore the metabolic pathways and their regulation. CO4 To understand the principles of enzyme kinetics and enzyme regulation. CO5 To apply biochemical techniques in the study of microbiological processes. CO6 To integrate biochemistry with microbiology for applications in clinical, industrial, and environmental fields.			
Nature of Paper: Core			
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits			
L: 4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)			
Unit	Contents	No. of Lectures Allotted	
I	Introduction to Biochemistry: • Definition and scope of biochemistry • Chemical foundations: pH, pKa, buffers • Concept of acids, bases, and buffer systems • Importance of pH in biological systems • Water: Properties and its role in biological systems • Hydrogen bonding, cohesion, and • Adhesion	12	
II	Biomolecules: • Carbohydrates: Classification, structure, and function • Monosaccharides, disaccharides, oligosaccharides, polysaccharides • Glycosidic bonds, starch, glycogen, cellulose, chitin • Lipids: Classification, structure, and function • Fatty acids, triglycerides, phospholipids, steroids • Micelles, lipid bilayers, and membrane structure • Proteins: Amino acids, peptide bonds, levels of protein structure	12	

	• Primary, secondary, tertiary, and quaternary structures • Protein folding and denaturation • Nucleic acids: Structure and function of DNA and RNA • Double helix structure, base pairing, RNA types and functions	
III	Enzymology: • Enzymes: Classification and nomenclature • Enzyme Commission (EC) numbers • Specificity and catalytic mechanisms • Enzyme kinetics: Michaelis-Menten equation, • Lineweaver-Burk plot • Km and Vmax determination • Turnover number (k_{cat}) • Factors affecting enzyme activity: Temperature, pH, inhibitors • Competitive, non-competitive, uncompetitive inhibition • Enzyme regulation: Allosteric regulation, covalent modification • Feedback inhibition, zymogens, isoenzymes	12
IV	Metabolism: • Carbohydrate metabolism: Glycolysis, gluconeogenesis, TCA cycle • Glycolysis: Steps, regulation, and energy yield • Gluconeogenesis: Pathway and regulation • TCA cycle: Steps, regulation, and energy yield • Lipid metabolism: Beta-oxidation, fatty acid synthesis • Beta-oxidation: Steps and energy yield • Fatty acid synthesis: Steps and regulation • Protein metabolism: Amino acid degradation and urea cycle • Transamination, deamination, urea cycle • Integration and regulation of metabolic pathways • Hormonal regulation of metabolism • Metabolic interrelationships	12
V	Applied Biochemistry: • Clinical biochemistry: Diagnostic enzymology, blood chemistry • Enzymes as biomarkers (e.g., ALT, AST, LDH) • Blood glucose, lipids, and proteins in health and disease • Industrial biochemistry: Enzyme applications in industry • Enzymes in food, textile, and pharmaceutical industries • Biocatalysts and enzyme engineering • Environmental biochemistry: Bioremediation, biodegradation • Microbial degradation of pollutants • Enzymes in waste treatment	12

Reference / Text Books:

1. Nelson D and Cox MM. (2010). Lehninger's Principles of Biochemistry. W.H. Freeman and Company, New York.
2. Voet D and Voet JG. (2013).
3. Principle's of Biochemistry. John Wiley and sons New York.
4. Moat AG and Foster J W (Latest Edition). Microbial Physiology. John Wiley and Sons, New York.
5. Stryer. L (2003). Biochemistry. W. H. Freeman and Co.

6. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hil
7. J.L. Jain (2015). Fundamentals of Biochemistry, S. Chand and Co.
8. U. Satyanarayan (2015). Biochemistry, Elsevier

If the course is available as Generic Elective then the students of following departments may opt it.
Yes

Prerequisite: Intermediate/Basic knowledge of life science

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: Knowledge of Basics of Microbiology (Intermediate level)

Course Learning Outcomes:

CLO1: Explain the structure and function of biomolecules such as proteins, carbohydrates, lipids, and nucleic acids.

CLO2: Perform basic laboratory techniques for the analysis of biomolecules, including spectrophotometry, chromatography, and electrophoresis.

CLO3: Illustrate the major metabolic pathways, including glycolysis, Krebs cycle, and oxidative phosphorylation, and their regulation.

CLO4; Critically evaluate scientific literature in biochemistry and apply knowledge to solve complex biochemical problems.

CLO5: Design and conduct experiments, and communicate findings effectively in both written and oral formats.

CLO6: Evaluate the use of biochemical tools in the production of pharmaceuticals and biofuels.

PRACTICALS

BASIC AND APPLIED BIOCHEMISTRY LAB (BMB-NPR-122P)

Marks: 50

Duration: 60 hours (2 credits)

1. Calculation of buffer solutions using Henderson-Hasselbalch equation
2. Detection of carbohydrates (Benedict's test, Iodine test)
3. Detection of proteins (Biuret test, Ninhydrin test)
4. Estimation of carbohydrates (Anthrone method, DNS method)
5. Estimation of proteins (Lowry method, Bradford assay)
6. Measurement of enzyme activity (e.g., amylase, catalase)
7. Determination of K_m and V_{max} using Lineweaver-Burk plot
8. Quantitative analysis of glucose (Glucose oxidase method)
9. Analysis of blood glucose (GOD-POD method)
10. Analysis of blood cholesterol (Enzymatic method)

DSE-2a

CONTROL OF MICROORGANISMS IN THE ENVIRONMENT (BMBD-NPR-123a)

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: I Semester: II
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code:BMBD-NPR-123a	Title: CONTROL OF MICROORGANISMS IN THE ENVIRONMENT	
Course Objectives: CO1: Provide a comprehensive understanding of the principles and methods used in microbial control as well as explore the historical perspectives and key discoveries that have shaped the field of microbial control. CO2: To elucidate the basic concepts and terminologies associated control methods and examine the factors affecting microbial control and the criteria for selecting appropriate control methods. CO3: To evaluate various physical, chemical, and biological methods of microbial control, including their applications, advantages, and disadvantages. CO4: To investigate the monitoring and control of microbes in various environments, including air, water, soil, and surfaces. CO5: To discuss advanced topics and emerging trends in microbial control, including antimicrobial resistance, innovative technologies, and policy and ethical considerations.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Microbial Control • Introduction to Microbial Control • Historical Perspectives and Key Discoveries • Basic Concepts: Sterilization, Disinfection, and Antisepsis • Factors Affecting Microbial Control • Assessing Microbial Load and Control Efficacy • Different methods of control • Physical • Chemical • Biological	10

	Criteria for selecting control methods.	
II	Physical and Chemical Methods of Microbial Control - Introduction to Physical Methods (Application, advantages and disadvantages) ❖ Heat Sterilization ❖ Radiation Sterilization ❖ Filtration Techniques ❖ Use of Low Temperatures and Desiccation ❖ High-Pressure Methods - Introduction to Chemical Agents (Application, advantages and disadvantages) ❖ Phenolics and Alcohols ❖ Halogens and Heavy Metals ❖ Aldehydes and Gaseous Sterilants ❖ Quaternary Ammonium Compounds and Biguanides ❖ Peroxygens and Other Oxidizing Agents - Evaluating Physical and Chemical Method Efficacy - Application of Physical and Chemical Method in Healthcare - Application of Physical and Chemical Method in Food and Water Treatment	10
III	Biological Methods of Microbial Control - Introduction to Biological Control ❖ Natural Antimicrobial Compounds ❖ Use of Bacteriophages ❖ Probiotics and Competitive Exclusion ❖ Antagonistic Microorganisms ❖ Bioengineering and Synthetic Biology Approaches - Bio-control Agents ❖ in Agriculture ❖ Aquatic Environments ❖ o Medical Applications	10
IV	Monitoring and Control of Microbes in different Environment - Air Quality Monitoring and Control ❖ Air Sampling Techniques: Impaction, Filtration, Settling Plates, and Volumetric Air Samplers ❖ Air Disinfection: Fumigation; UV Irradiation, Ionization, and Humidity Control - Water Quality Monitoring and Control ❖ Water Sampling Techniques: Grab and Composite Sampling - Microbial Testing in Water: Membrane Filtration, MPN, PCR ❖ Water Disinfection: Chlorination, Ozonation, UV Irradiation - Soil Quality Monitoring and Control ❖ Soil Sampling Techniques: Random and Grid Sampling ❖ Soil Microbial Analysis: Serial Dilution, DNA Extraction, Metagenomics Bioremediation and Soil Solarization - Surface Monitoring and Control: Swab Sampling, Contact Plates, Antimicrobial Coatings	12

V	Advanced Topics and Emerging Trends - Emerging Pathogens and Their Control (Corona and MDR Strains) - Antimicrobial Resistance and Control Strategies - Advances in Sterilization Technologies - Nanotechnology in Microbial Control - Integrated Pest Management - Genetic Approaches to Microbial Control - Policy and Ethical Considerations in Microbial Control (Regulatory agencies and their concerns) - Advances in Detection and Monitoring Technologies - Innovations in Disinfection and Sanitation - Public Health and Microbial Control awareness	12
Reference / Text Books: - Aneja K.R., Experiments in Microbiology, plant pathology, Tissue culture and Mushroom cultivation, New Age International, New Delhi. - Prescott Lansing M., Harley John P. and Klein Donald A., Microbiology, WCB Mcgraw- Hill, New York. - Stanier R.Y., Ingraham J.L., General Microbiology, Prentice Hall of India Private Limited, New Delhi. - Pommerville, J. C. Alcamo's Fundamentals of Microbiology 8th ed. Jones & Bartlett Publishers, - Gerard J. Tortora, Berdell R. Funke, Christine L. Case, Microbiology: An Introduction. Pearson 2013		
If the course is available as a Generic Elective then the students of the following departments may opt for it. NO		
Evaluation/Assessment Methodology		
		Max. Marks:100
1) Class tasks/ Sessional Examination		16
2) Presentations /Seminar		-
3) Assignments		04
4) Research Project Report		-
Seminar On Research Project Report		-
5) ESE/Attendance		05
INTERNAL MARKS		25
EXTERNAL MARKS		75
TOTAL		100
Prerequisites for the course:		
Course Learning Outcomes:		
By the end of this course, students will be able to:		
CLO1- Explain the historical context and key discoveries in the field of microbial control and differentiate between sterilization, disinfection, and antiseptics.		
CLO2- Identify and describe the factors influencing the effectiveness of microbial control methods, assess the microbial load and evaluate the efficacy of various microbial control techniques.		
CLO3- Compare and contrast the applications, advantages, and disadvantages of physical, chemical, and biological methods of microbial control.		
CLO4- Apply knowledge of microbial control methods to specific scenarios in healthcare, food and water treatment, and other environments.		
CLO5- Implement appropriate air, water, and soil quality monitoring techniques and microbial		

control strategies as well as critically analyze the challenges and strategies related to emerging pathogens and antimicrobial resistance.

CLO6- Discuss the role of policy, ethics, and public health awareness in the implementation and regulation of microbial control measures along with being informed about advances in detection, monitoring, disinfection, and sanitation technologies and their impact on microbial control practices.

PRACTICALS
CONTROL OF MICROORGANISMS IN THE ENVIRONMENT LAB
(BMBD-NPR-123aP)

Marks: 50

Duration: 60 hours (2 credits)

1. To study the effect of moist and dry heat on microbial growth
2. To demonstrate the use of UV to assess its impact on microbial viability.
3. To investigate the effectiveness of various chemical disinfectants in controlling microbial populations on surfaces.
4. To perform antibiotic susceptibility testing using methods such as the Kirby-Bauer disk diffusion test
5. Minimum inhibitory concentration (MIC) determination by tube dilution method.
6. To perform air sampling using impaction/filtration/settling plates, and to analyze the collected samples for microbial contamination.
7. To conduct water sampling using grab and composite methods, followed by microbial testing using membrane filtration/MPN.
8. To collect soil samples using random and grid sampling techniques, and to analyze microbial diversity and load through serial dilution.
9. To formulate a common sanitation solution and study its efficacy
10. Conduct a campaign related to Good hygiene and common practices for the control of microbial agents and prepare a portfolio for the same

DSE-2 b

BMBDSE-NP-123b: MICROBIAL BIOTECHNOLOGY

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: I Semester: II
Credits: 6 Theory: 4 Practical: 2		Subject: MICROBIOLOGY
Course Code: BMBDSE-NP-123b		Title: MICROBIAL BIOTECHNOLOGY
Course Objectives: CO1: This course aims to explain the function of microorganisms in the development of biotechnology, both traditional and modern. CO2: The learners will learn the use of microbe-based processes and technologies, such as biosensors, biopesticides, bioplastics, bioleaching, and genetically modified organisms, CO3: The learners will learn about the advantages and potential drawbacks of microbe-based processes and technologies. CO4: The learners will learn about unconventional vaccines. CO5: The students will gain knowledge about the microbial based transformation CO6: Students will gain knowledge about the purification of Microbial products.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Scope of Microbial Technology: Scope and its uses in food technology, agriculture, the environment, and human medicine. Evaluation of genetically modified organisms (GMOs) critically. Trends in biotechnology in India, with a focus on the top biotechnology businesses and institutions in the nation.	12
II	Industrial Products: Streptokinase and recombinant vaccinations (such as the Hepatitis B vaccine) are examples of recombinant microbial products produced by the pharmaceutical industry. polyester and microbial polysaccharides, Production of bio-pesticides and bioplastics by microorganisms bacteria-based biosensors.	12
III	Microbial-based transformation: Steroids and sterols transformation by microorganisms. Biocatalytic techniques and their industrial uses, manufacturing cocoa butter substitute and high-fructose corn syrup.	12
IV	Microbial product purification: Filtration, ion exchange, and affinity	12

	chromatography techniques for the purification of microbial products. Methods of immobilization and their use. Immobilization of the entire cell. Applications of RNAi in host-pathogen interactions, medication resistance, treatments, and gene silencing.	
V	Microbes for bioenergy and environment: Commercial production of bio-ethanol and bio-diesel from lignocellulosic waste and algal biomass, Biogas production: Using microbial culture, this process produces methane and hydrogen. Microorganisms used in bioremediation include those that break down xenobiotics, recover minerals, and remove heavy metals from aqueous effluents.	12

Reference / Text Books:

1. Crueger, W., Crueger, A. and Aneja, K.R. (2017). Biotechnology: A Textbook of Industrial Microbiology. 3rd edition. Medtech Publisher, India.
2. Demain, A.L., Davies, J.E. and Atlas, R.M. (1999). Manual of Industrial Microbiology and Biotechnology. 2nd edition. ASM Press, USA.
3. Dubey, R.C. (2014). A Textbook of Biotechnology. 5th edition. S. Chand and Co, India.
4. Glazer, A.N. and Nikaido, H. (2007). Microbial Biotechnology: Fundamentals of Applied Microbiology. 2nd edition. Cambridge University Press, UK.
5. Glick, B.R., Pasternak, J.J. and Patten, C.L. (2009). Molecular Biotechnology. 4th edition. ASM Press, USA.
6. P.K. Gupta, P.K. (2009). Elements of Biotechnology. 2nd edition. Rastogi Publications, India.
7. Ratledge, C. and Kristiansen, B. (2006). Basic Biotechnology. 3rd edition. Cambridge University Press, UK.
8. Stanbury, P.F., Whitaker, A. and Hall, S.J. (2016). Principles of Fermentation Technology. 3rd edition. Elsevier Science, Netherlands.
9. Willey, J. M., Sandman, K. and Wood, D. (2019). Prescott's Microbiology. 11th edition. McGraw Hill Higher Education, USA.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

	Max. Marks:100
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

CLO1: Will be able to recall the potential applications of microorganisms in various technologies and disciplines for the direct or indirect benefit of people and the environment.
CLO2: Will be able to demonstrate how producer bacteria and/or processes might generate goods with therapeutic or medical value, extending human longevity.
CLO3: Will be able to determine how microbiology relates to technological advancements in the food and fermentation industries.

CLO4: Will be able to categorize how advances in recombinant DNA technology are compared to advances in microbially-based technology for the environment, industry, and agriculture.

CLO5: Will be able to appraise the significance of microbes in preserving environmental homeostasis, preventing pollution, getting rid of xenobiotics, and producing cheap energy from waste natural lignocellulosic will be further examined.

CLO6: Will be able to formulate commercial production of bio-ethanol and bio-diesel from lignocellulosic waste and algal biomass.

PRACTICALS

BMBDSE-NP-123bP: MICROBIAL BIOTECHNOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

1. Research calcium alginate gels' ability to immobilise yeast cells.
2. Research the sodium alginate method of immobilising enzymes.
3. Fungi that produce pigment
Trichoderma
Penicillium Aspergillus
4. Isolation of bacteria that produce xylanase or lipase.
5. Screening of antibiotic producing actinomycetes.
6. Purification of enzymes by filtration methods

GE-1a

**BMBGE-NP-124a: INTERACTION WITH ENTREPRENEUR IN
MICROBIAL TECHNOLOGY & STARTUP**

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: I Semester: II
Credits: 4 Theory: 4 Practical: 0	Subject: MICROBIOLOGY	
Course Code:BMBGE-NP-124a	Title: INTERACTION WITH ENTREPRENEUR IN MICROBIAL TECHNOLOGY & STARTUP	
Course Objectives: CO1: To help students improve their knowledge of the sources of innovation opportunities as well as the abilities to recognize and evaluate these chances for bioentrepreneurship and innovation. CO2: To create a personal skill set for entrepreneurship, innovation, and creativity as well as specific ideas. CO3: The learners will learn methods for integrating and controlling creativity in an organization. CO4: Students will gain knowledge about scope, reach and benefits of medium and small scale industries. CO5: Learners will be aware with the business incubation centers, knowledge centres and RnD. CO6: Learners will gain knowledge about IPR and patents.		
Nature of Paper: Core/DSE/SEC/GE/AECC [GE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 P: 0 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	INTRODUCTION TO BIOENTREPRENEURSHIP – Bioentrepreneurship's potential and its significance. Entrepreneur definition, function, entrepreneur kinds, and benefits of being an entrepreneur. Different forms of innovation, out of box thinking, and potential for bioentrepreneurship. Public and corporate organizations (MSME, DBT, BIRAC, Startup, and Make in India) that promote entrepreneurship. IP protection, marketing methods, and the patent landscape.	10
II	MICROBIOLOGY ENTREPRENEURSHIP: Entrepreneurship in Microbiology: Concepts importance of entrepreneurship in microbiology, Important characteristics for entrepreneurs in microbiology and biotechnology qualities of microbes versus general entrepreneurship. background of entrepreneurial	14

	microbiology, Entrepreneurship through industrial, environmental, food, agricultural, and health microbiology can help to fuel, feed, and cure the planet.	
III	KNOWLEDGE CENTRE AND R & D: Universities, innovation hubs, research institutions, and business incubators examples of knowledge centres. R&D: technology development and improvement, assessment of technological development, management of technology transfer, industry visits to successful bio-enterprises, regulations for the transfer of foreign technologies, quality control, technology transfer agencies, Regulatory compliance and procedural knowledge (CDSCO, NBA, GLP, GCP, and GMP)	12
IV	MEDIUM & SMALL-SCALE INDUSTRY Definition, characteristics, rationalisation, goals, reach, and benefits of small-scale industries. Pharma, agriculture, and industrial: Three types of bioindustries. Production of biofertilizers using cyanobacteria, azospirillum, and azolla. Production of bacterial, fungal, viral, and plant insecticides under the name biopesticides. Sericulture. Apiculture. Dairy farming. Applications and production of single cell proteins. Vermicomposting's uses and benefits. production of mushrooms and use of mushrooms. Ancillary and tiny industries	12
V	INTRODUCTION TO IPR AND PATENT: Traditional Knowledge, Commercial Exploitation & Protection, Protection of Microbiological/Biotechnological Inventions, History & Definition of IPR, Forms/Types of IPR, Introduction and Patent Types, Requirements for Patenting Different types of patent applications in India, the patent application process, Patent Search	12

Reference / Text Books:

1. Management Fundamentals”, Robert Lusier – Concepts, Application, Skill Development” Thomson
2. Entrepreneurship Development” S S Khanka , S Chand & Co

If the course is available as Generic Elective then the students of following departments may opt it.
yes

1. B.Sc. Biotechnology
2. B.Sc. Biology

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

CLO1: Will be able to recall the prerequisites for starting a business, both legally and financially.

CLO2: Will be able to demonstrate their own business plan and be able to discuss the significance of management and marketing in small business ventures.

CLO3: Will be able to determine the factors that make bio-entrepreneurship schemes and projects successful.

CLO4: Will be able to categorize the fundamental performance metrics of different entrepreneurial activities can be specified.

CLO5: Will be able to appraise the business prospects, and students will be able to examine the business environment.

CLO6: Will be able to formulate the production of mushrooms and use of mushrooms.

GE-1b

BMBGE-NP-124b: MICROBIAL WORLD AND MICROBIAL DIVERSITY

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Certificate course in Microbial Techniques Diploma in Microbial Technology Degree in Bachelor of Science Class: B.Sc. Microbiology		Year: I Semester: II
Credits: 4 Theory: 4 Practical: 0	Subject: MICROBIOLOGY	
Course Code:BMBGE-NP-124b	Title: MICROBIAL WORLD AND MICROBIAL DIVERSITY	
Course Objectives: CO1: After reading this course students will be familiar to various microbes and their properties. CO2: This course emphasis on general characteristic of cellular microorganisms. CO3: Students will gain knowledge of general concept of Phytoplanktons and Zooplanktons. CO4: Learners will be able to understand the historical developments in the field of Mycology including significant contributions of eminent mycologists. CO5: Learners will attain enough knowledge of Actinomycetes and various protozoa. CO6: This course will also focused on the classification of various microorganisms.		
Nature of Paper: Core/DSE/SEC/GE/AECC [GE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 P: 0 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Microbial world: Acellular microorganisms' (Viruses') physiochemical and biological properties; Baltimore categorization; general structure; with particular reference to viroids and prions. Whittaker's five kingdom, Carl Woese's three kingdom, and Binomial Nomenclature categorization schemes utility. Prokaryotic and eukaryotic microbes differentiation	12
II	General characteristics of Cellular microorganisms: With an emphasis on distribution and occurrence, morphology, mode of reproduction, and economic significance of archaebacteria, eubacteria, wall-less forms, and MLO (mycoplasma and spheroplasts) discussion. Mycoplasma's composition, reproduction, and economic significance.	12
III	General concept of Phytoplanktons and Zooplanktons: Algal characteristics, occurrence, thallus structure, and categorization. The existence, thallus organization, cell ultra-structure, reproduction, and economic significance of cyanobacteria. Algal uses in food production, industry, the environment, and agriculture	12

IV	Historical developments in the field of Mycology including significant contributions of eminent mycologists: Fungi general characteristics, such as habitat, distribution, nutritional needs, fungal cell ultrastructure, thallus organization and aggregation, mechanism of reproduction, and economic relevance with examples in agriculture, the environment, industry, medicine, and food.	12
V	Actinomycetes and Protozoa: General characteristics, structure, reproductive method, and economic significance of Actinomycetes with specific reference to its use in industry and medicine. Protozoa's general characteristics, occurrence, classification scheme, reproduction, and economic significance.	12

Reference / Text Books:

1. Singh, R.P. General Microbiology. Kalyani Publishers, New Delhi (2007).
2. Aneja, K.R. Experiments in Microbiology, Plant Pathology and Biotechnology, Fourth edition, New Age International publishers.
3. Dubey, R.C. and Maheshwari, D.K. Text book of Microbiology. S. Chand and company (1999).
4. Powar, C.B. and Dagainawal, H.F. General Microbiology. Vol-I and Vol- II, Himalaya Publishing House.
5. Chakraborty P. A Textbook Of Microbiology. New central book Agency (2005).
6. Prescott, M. J. Harley, J.P. and Klein, D.A. Microbiology. 5th Edition W C B M c Graw Hill, New York, (2002).
7. Tortora, G.J., Funke, B.R. and Case, C.L. Microbiology: An Introduction. Pearson Education, Singapore, (2004).
8. Alcamo, I.E. Fundamentals of Microbiology. VI Edition, Jones and Bartlett Publishers. Sudbury. Massachusetts, (2001).
9. Black J.G. Microbiology-Principles and Explorations. John Wiley & Sons Inc. New York, (2002).
10. Pelczar, M J Chan ECS and Krieg NR, Microbiology McGraw-Hill.
11. Willey, Sherwood, Woolverton. Prescott, Harley, and Klein's Microbiology McGraw-Hill publication
12. Tortora, Funke, Case. Microbiology. Pearson Benjamin Cumming

If the course is available as a Generic Elective, then the students of the following departments may opt it. YES

1. B.Sc. Biotechnology
2. B.Sc. Biology
3. BMLT

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	

Course Learning Outcomes:

CLO1: will be able to recall the diversity of microbes and the fundamental traits of acellular microorganisms.

CLO2: will be able to demonstrate the fundamental traits, prevalence, and distribution of cellular microorganisms.

CLO3: will be able to determine the Basic Phytoplankton and Zooplankton Concepts

CLO4: Will be able to categorize historical mycological developments, including key contributions made by renowned mycologists.

CLO5: Will be able to appraise the features and economic significance of Actinomycetes and Protozoa in general.

CLO6: Will be able to formulate how microbiology has evolved historically.

School of Life Science & Technology

ACADEMIC HAND BOOK



DEPARTMENT OF BIOTECHNOLOGY
ORDINANCE M.Sc. BIOTECHNOLOGY
(As per New Education Policy 2020 & UGC Regulation)
(Academic Session 2024-25)

Indexing

1. Preamble
 - 1.1. Introduction to M.Sc. Biotechnology syllabus
2. Definitions and Nomenclatures
3. Vision and mission of the School
4. Program Educational objectives
5. Program outcome/ Program Specific outcome
6. Admission
7. Eligibility in all year as NEP (entry & exit) as per NEHQF and NSQF (if applicable)
8. Curriculum
9. Medium of Instruction
10. Choice base Credit system (CBCS)/LOCF/OBE
11. Registration for course in a semester
12. Attendance
 - 12.1 Condonation of medical cases
 - 12.2 Additional Condonation
13. Assessment procedure
 - 13.1 Internal Assessment (IA) (External Assessment (EA)
 - 13.2 Practical Assessment
14. Research Project/Semester Project Assessment Criteria
15. Internship – Research / Industrial Internship
16. For non – credit courses / audit courses
17. Credit weightage
18. Maximum duration of programme/promotion policy
19. Maximum gaps between semester/year
20. Credit system & grading CGPA/SGPA
21. Class / division
22. Transfer of credit /Academic Credit Bank
23. Change of discipline
24. Use of technological intervention
25. Student Discipline
26. Student Welfare
27. Ragging
28. Examination code of conduct
29. Power of modify
30. Exit point
31. NC/Credit course

1. **PREAMBLE:**

IIMT University is well known for its contributions to academics and research at the national and international levels in various disciplines. Department of Biotechnology runs under the School of Life Science and Technology. The main objective of the Biotechnology program is to study of life is at the core of it and the interdisciplinary networking potential of biotechnology has given it a separate status in fundamental research as well as in modern industrial enterprise. The focus of the century is to obtain knowledge and this shift attracts the Global and local on to technology development and development of various applications in life sciences. Biotechnology is an ideal platform to work, in the milieu of research and industrialization for economic development and social change.

The interdisciplinary aspects of biotechnology conforms living systems and their studies from basic to advance like from biostatistics to design of experiments, from cell and molecular biology to genomics, from biochemistry to biophysics, from protein engineering to proteomics, from genetic engineering to stem cell research, from bioinformatics to advanced genomics-proteomics, from environmental science to environment biotechnology, from microbiology to bioprocess engineering and reactor designing, from bioremediation to material transformation and so on.

1.1. **Introduction to M.Sc. Biotechnology syllabus**

M.Sc. Biotechnology syllabus provides students with an in-depth understanding of various subjects like Biochemistry and instrumentation, molecular biology, bioinformatics, Bio-separation and DSP, microbiology, IPR, agriculture biotechnology, genetics, analytical techniques, biostatistics, environment biotechnology, industrial biotechnology and other topics are included in the M.Sc. syllabus. This course's sole purpose is to provide students with advanced biological processes knowledge for industrial and other purposes.

2. **Definitions and nomenclature related with University:**

In these Regulations, unless the context otherwise requires:

1. "Program" means Degree Program like B.Sc. Biotechnology and M.Sc. Biotechnology,
2. "Course" means a theory or practical subject that is normally studied in a semester.
3. "Vice – Chancellor of IIMT-University" means the Head of the University.
4. "Registrar" is the Head of all academic and General Administration of the University.
5. "Dean" means the authority of the school who is responsible for all academic activities of various programs and implementation of relevant rules of these Regulations pertaining to the academic programs.
6. "Controller of Examinations" means the authority of the University who is responsible for all activities related to the University Examinations, publication of results, award of grade sheets and degrees.
7. "Dean – Student Welfare" is responsible for all student related activities including student discipline, extra and co – curricular activities, attendance and meetings with class representatives, Student Council, and parent – teacher meet.
8. "HoD" means the Head of the Department concerned.
9. "University" means IIMT-University, Meerut.
10. "TCH" means Total Contact Hours – refers to the teaching – learning periods.
11. "DEC" means Department Exam Committee.
12. "BoS" means Board of Studies.
13. "ACM" means Academic Council meeting the highest authoritative body for approval

for all academic Policies.

14. “Class Co-ordinator” is a faculty of the class who takes care of the attendance, academic performance, and the general conduct of the students of that class.
15. “IA” is Internal Assessment which is assessed for every student for every course during the semester.
16. “ESE” is End Semester Examination conducted by the University at the End of the Semester for all the courses of that semester.

3. Vision And Mission of The School

VISION: To become the finest institution and to create social, economic and intellectual wellbeing of the students through discovery, learning and innovations.

MISSION: To fulfill the educational needs of the students through imparting value based knowledge and innovative skills in an unbiased manner to meet greater challenges involving food, farming, fiber, feed, families, health, energy, water and environment.

Vision and Mission of the Department of Biotechnology:

Our vision is to produce proficient Biotechnologists having innovative concepts and capable to employ finest processes and applications which will intensely influence prevailing standards of environment, medical, industry, agriculture, and rebuilding of environment providing sustainable competitive approaches to present society.

Our mission is to provide Biotechnology educational Program with impetus to generate quality workforce.

- ❖ To generate awareness about potentials tools of Biotechnology for societal implications.
- ❖ To inculcate essence of innovation, entrepreneurship and creativity in young minds with sound research aptitude.
- ❖ To impart quality education in biotechnology program, both theoretical and practical, to students.
- ❖ To serve our students by schooling them leadership, problem solving, and teamwork skills, commitment to quality, ethical behavior, and respect for others and develop them as confident personages who are effective contributors towards growth of the nation.

4. Program Educational objectives:

Table1: Program Educational objectives

PEO 1	The first objective of the Biotechnology is to prepare students to apply knowledge of basic concepts related with the subjects like biochemistry, RDT, structural biology and Immunology so that students can develop the better understanding of metabolism, various analytical tools and different cells of immune system.
PEO 2	The laboratory aspects along with theoretical subjects are included to prepare students them for careers in academic, industries, medical, agriculture and environmental sectors.
PEO 3	Recent research in the areas of Genetics and molecular biology, Industrial Biotechnology, Bioreactor designing, Downstream processing, soil, Agriculture & Environmental Biotechnology, plant biotechnology are included to develop students in the field of

- research.
- PEO 4** The Master in Biotechnology Programme will address the globally growing requirement for trained technical and methodical manpower with a considerate mindset of understanding the research ethics involving animals and humans.
- PEO 5** To heighten career opportunities locally and globally in industrial sectors, pharmaceutical sectors, medical sector.
- PEO 6** To produce students who establish a promise to life-long learning and to generate and protect the intellectual property and contribute to their own and countries' development through entrepreneurship

5. Program Outcomes (POs) and PSO

Table 2: Program Outcomes (POs)/Program Specific Outcome

- PO1** To develop better understanding of the significant principles of biotechnological function at an advanced level for research emphasis and fulfillment of SDG.
- PO2** Skills to DoE (Design of experiment) to analyze data on the basis of basic concepts and theories.
- PO3** An aptitude to attain the skills in handling laboratory instruments, scheduling and execution of laboratory experiments to meet preferred needs with sustainable approach in biotechnology.
- PO4** Students will establish their involvement in the biotechnology discipline through internship or research and to go through with outreach activities specific to biotechnology to solve the social problems.
- PO5** An ability to investigate the specified scientific data analytically and the ability to draw the objective fulfill.
- PO6** Students will attain competency in laboratory safety and demonstrate according to the needs.
- PO7** Students will acquire the writing skill in terms of research writing, proposal writings, short communication writing.
- PO8** An ability to generate creative thinking (divergently and convergent) to propose innovative ideas and new solution to the problems also helps students in protection their intellectual property.
- PO9** Multidisciplinary nature of biotechnology program helps in providing better solutions and new designs for the sustainable developments, ability to tackle environment issues and to generate Cognizance of contemporary issues of the time and provide appropriate solutions with biotechnological mindset.
- PO10** To Develop a up-to-date and scientific mindset or vision with respect to science but also in all aspects of life also provide biotechnological solutions to the underprivileged areas also helps in solving the problem of clean water and sanitation, waste treatment, food scarcity, agriculture, carbon reduction, climate change, energy etc..
- PO11** Developed aptitude by participating in various national and international conferences, workshops, symposia, training etc. willingly, in order to acquire knowledge, creating awareness about the environmental, social, global issues.
- PO12** Developed as a trained biotechnologists, academician or industrial person.

Program Specific Outcome

Programme Specific Outcome M.Sc. BT I year:

- PSO1** Ability to enhance the skill in terms of analysis of biochemical process, molecular biology immunology etc. and expertise to Design of experiment to analyze data on the basis of basic concepts and theories.
- PSO2** To develop awareness of various ethical issues in terms of IPR, patent human genome RDT etc in biotechnology research.
- PSO3** Develop skill to present the work through visual, oral and written presentations, including an original research proposal after studying the bio entrepreneurship development course.

Programme Specific Outcome M.Sc. BT II Year:

- PSO1** Ability to enhance the core biotechnology skills in the field of industrial biotechnology environment biotechnology RDT etc.
- PSO2** Students will establish their involvement in the biotechnology discipline through internship or research and to go through with outreach activities specific to biotechnology to solve the social problems.
- PSO3** Industry/academia suitable candidates are prepared after completion of Master in Biotechnology program.

6. Admission:

- The number of seats shall be in accordance with the directives by the university.
- B.Sc. Biology/ Biotechnology/Microbiology or BMLT with 6 months Internship with min. 40 % marks
- The admission to the course will be on the basis of the merit and according to the guidelines from the university and Government of Uttar Pradesh. After the term-end examination at the end of each semester, the student will be provisionally admitted to the next semester. Each semester will be followed by a break not exceeding 15 days.
- The admission policy and procedure shall be decided from time to time by the Board of Studies (BOS) of the University based on the guidelines issued by the UGC/NEP and Ministry of Education (MoE), Government of India. Seats are also made for Non-Resident Indians and foreign nationals, who satisfy the admission eligibility norms of the University.

7. Eligibility in all year as NEP:

- ❖ B.Sc. Biology/ Biotechnology/Microbiology or BMLT with 6 months Internship with min. 40 % marks

8. Curriculum /Syllabus:

The Course curriculum would be as per CBCS & NEP 2020. The course of study shall contain the subjects of applied sciences in the form of core subjects, Discipline Specific Subjects, Generic Elective Subjects, Skill Enhancement and Ability Enhancement courses. The marks shall be awarded to the candidates pursuing the programme for the written papers, mini/ major project report/industrial visits/ presentation /viva-voce examinations,

if any as specified in the scheme of Examinations.(Evaluation Scheme of each semester enclosed in Evaluation scheme chapter of Academic Handbook 1)

For the purpose of awarding degrees, the curriculum for all M.Sc. Biotechnology programs is structured to have a minimum of credits+ NCC (Non-credit Audit Courses) as specified in the evaluation scheme approved by the Board of Studies and spread out across four semesters of study.

9. **Medium of Instruction:** The medium of instruction for the course shall be English.

10. **Choice base Credit system (CBCS)/LOCF/OBE:**

Specific features of CBCS System

Choice Based Credit System (CBCS) is a proven, flexible mode of learning in higher education which facilitates a student to have guided freedom in selecting his/her own choices of courses in the curriculum for completing a degree program.

CBCS offers a flexible system of learning.

The system permits a student to

- (i) Learn at their own pace through flexible registration process.
- (ii) Choose electives from a wide range of courses offered by parent and other departments.
- (iii) Undergo additional courses to acquire the required number of credits for obtaining M.Sc. degree in Biotechnology program.
- (iv) Undergo additional courses in their special areas of interest.
- (v) Adopt an interdisciplinary approach in learning.
- (vi) Avail transfer of Credits.
- (vii) Gain Non – CGPA credits to enhance skill/employability by taking up project work, entrepreneurship, co-curricular and vocational training.
- (viii) Make the best use of the expertise of available faculty.
- (ix) Learn and earn credits through MOOC, and Project Based Learning.
- (x) Enhance their Knowledge, Skill and Attitude through participation in innovative Curriculum Design, Delivery and Assessments.

The Curriculum is designed to take into the factors listed in the Choice Based Credit System (CBCS) with focus on Project Based Learning and Industrial Training to enable the students to become eligible and fully equipped for employment in industries choose higher studies or entrepreneurship in the field of Biotechnology.

Definitions of Key Words related with CBCS:

- i. **Academic Year:** Two consecutive semesters constitute one academic year. The CBCS provides choice for students to select from the prescribed courses (core, elective or minor or soft skill courses).
- ii. **Credit Based Semester System (CBSS):** Under the CBSS, the requirement for awarding a degree or diploma or certificate is prescribed in terms of number of credits to be completed by the students.
 - ❖ To get a certificate course in Biotechnology, a candidate has to qualify minimum 46 Credits as per NEP and the duration of certificate course is one year.
 - ❖ To get a Diploma in Biotechnology, a candidate has to qualify minimum 92 Credits as per NEP and the duration of diploma course is two years.
 - ❖ To get Bachelor degree in Biotechnology, a candidate has to qualify minimum

- ❖ 120 Credits as per NEP and the duration of diploma course is three years.
- ❖ To get Master degree in Biotechnology, a candidate has to qualify minimum 184 Credits as per NEP and the duration of diploma course is three years.
- ❖ To get Master degree in Biotechnology, a candidate has to qualify minimum 230 Credits as per NEP and the duration of diploma course is three years.

Table 3: Distribution of Biotechnology program in year as per NEP-2022

M.Sc. (Biotechnology)	P.G. Diploma in Biotechnology	After one Year
	Master of Science (Biotechnology)	After Two Years

- iii. **Credit:** A unit by which the course work is interpreted. It functions the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week.
- iv. **Cumulative Grade Point Average (CGPA):** It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the sum total of the credit points obtained by the student in various courses in all semesters and the sum of the total credits of all courses in all the semesters.
- V. **Semester Grade Point Average (SGPA):** It is index of performance of all performance of work in a semester. Its total credit points obtained by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.

Types of Courses: Courses in the programme are of three kinds:

- a) Core Course
 - b) Elective Course
 - IIa. Discipline Specific Skill Elective (DSE) Course
 - IIb. Generic Elective (GEC) Course
 - c) Ability Enhancement Course
 - IIIa. “AECC” courses
 - IIIb. Skill Enhancement Courses (SEC)
- I. Core Course:** A course, which should compulsorily be studied by a candidate as a basic requirement to complete the program, is termed as a Core course. There are Core Theory (CT) and Core Practical (CP) Courses in every semester.
- II. Elective Course:** A course which can be chosen from a very specific or advanced subject of study or which provides an extended scope or which enables exposure to some other domain or expertise, is called an Elective Course. Elective courses may be of two types.
- IIa. Discipline Specific Skill Elective (DSE) Course:** Elective courses offered by the main subject of study are referred to as Discipline Specific Elective. The Institute may also offer discipline related Elective courses of interdisciplinary nature. An elective may be “Discipline Specific Electives (DSE)” gazing on those courses which add intellectual efficiency to the students.
- IIb. Generic Elective (GEC) Course:** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

III. Ability Enhancement Courses (AEC): The Ability Enhancement (AE) Courses may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC).

IIIa. “AECC” courses: are the courses based upon the content that leads to Knowledge enhancement (i) Environmental Science and ecology, (ii) English/MIL Communication, (iii) Human values and (iv) Professional skills. These are mandatory for all disciplines.

IIIb. Skill Enhancement Courses (SEC): SEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, Indian and foreign languages etc. These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based knowledge. NPTEL and Spoken courses are added as per program under Skill Enhancement Courses.

IV. Other courses

- ❖ Research Project-RP (Minor & Major)
- ❖ Internship (Industrial/Research)
- ❖ MOOCS
- ❖ Minor Certification Integrated with UG Degree
- ❖ NCC is added in each semester as per availability of seats
- ❖ Sport is integrated in the curriculum as a non-credit compulsory course.
- ❖ Generic Elective Courses are also added in the curriculum.

11. Registration for course in a semester:

In the beginning of the semester the candidate will choose the subjects of his choice and will register for the current semester within the three days of commencement of the semester.

12. Attendance:

Student shall not be permitted to appear in semester examination, unless he/she has regularly attended not less than 75% classes held in aggregate of all subjects. The university however may, condone the shortage in attendance up to 10% in each subject for any of the following reasons.

- Participation in NCC/ NSS Camps.
- Participation in University/ Inter-university/ State-level Games.
- Participation in other extra-curricular activities at University/Inter-university/State level.
- Prolonged Illness
- The student is however permitted to avail Academic Leave up to 10% for attending academic related activities like, Industrial Visits, Seminars, Conferences, Competitions etc., with the prior approval of the HoD. After the event, the student should submit the relevant documents for proof to the HoD for approval of the Academic Leave.

12.1. Condonation for medical cases

For medical cases, submission of complete medical history and records with prior information from the parent / guardian to Dean (Students Welfare) is mandatory. The assessment of such cases will be done by the attendance sub-committee on the merit of the case and put-up

recommendations to the Vice-Chancellor. Such condonation is permitted only twice for a student in the entire duration of the program.

12.2. Additional Condonation

The Vice-Chancellor, based on the recommendation of the attendance sub-committee may then give condonation of attendance, only if the Vice-Chancellor deems it fit and deserving. But in any case, the condonation cannot exceed 10%.

13. Assessment procedure:

A student is expected to follow the right conduct as per the ethical and socio-cultural norms set by the University for Day-to-day living. Also, student has to follow the rules and guidelines, set by the University for Different Activities. Each Core paper shall be of 100 marks, out of which internal and external assessments will carry 25 marks and 75 marks respectively. While the Ability Enhancement Courses will be of 50 marks out of which internal and external assessments will carry 15 marks and 35 marks respectively. Skill Enhancement Courses will carry the weight age of 50 marks.

Internal Assessment (IA) / External Assessment (EA)

Two set of question papers will be prepared by the external/internal examiners. Each set will contain three sections namely A, B and C. There would not be any repetition of questions in both the sets as well as the questions would be distributed throughout the entire syllabus so that a candidate can be judged on the basis of the knowledge of the entire subject

The Internal and external assessment marks awarded to the students should be forwarded to the Controller of Examinations at least one week before the commencement of the semester examination. The internal and external assessment marks shall be based on factors such marks secured in Sessional examinations, submission of written assignments, classroom participation and attendance. The weightage given to each of these factors for a paper shall be decided and announced at the beginning of the semester.

Table: 4 Internal and External Assessment of Theory

INTERNAL AND EXTERNAL ASSESSMENT FOR THEORY			
Internal Assessment	Marks	External Assessment	Marks
Sessional	15	End Semester Final Examination	75
Assignment	5	-	-
Attendance	5	-	-
Total	25		75

Practical Assessment

Table 5: Internal and External Assessment of practical

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL			
Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6

-	-	Record	4
Total	20	Total	30

14. Research Project/Semester Project Assessment Criteria:

The general guidelines for assessment of Project/Internship are given in Table 6.

Table 6: Assessment pattern for Research Project / Semester Project

No.	Review/Examination scheme	Broad Guidelines	Weightage
1	First Review	Concept/Abstract	10%
2	Second Review	Review literature	10%
3	Third Review	Experiment/Analysis	20%
4	Final Review	Project report and Viva – Voce, Results and Conclusion	60%

Table 7: Evaluation scheme for final year project (III/IV Semester)

S. No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1.	Industrial Training/ Research Project	MBT-RP-231	Industrial Training/ Survey/ Research Project				4	25	75	100
2.	Industrial Training/ Research Project	MBT-RP-241	Industrial Training/ Survey/ Research Project				20	75	225	300

For the final year project and Viva – Voce end semester examination, the student shall submit a Project Report in the prescribed format issued by the University. The first three reviews will be conducted by a committee constituted by the Head of the Department. The end-semester assessment will be based on the project report and a viva on the project conducted by a committee constituted by the Controller of examination. This may include an external expert. The student shall submit a Project Report (3 Copies) in the prescribed format issued by the University.

15. Internship – Research / Industrial Internship:

A student has to compulsorily to complete the project work at end of III/IVth semester internship during 2nd year. In lieu of summer/winter internship, the student is permitted to register for undertaking project work under a faculty of the Department and carry out the project. In both the cases, the internship report in the prescribed format duly certified by the faculty in-charge shall be submitted to the HoD. The evaluation will be done through presentation and viva. The course will have a weightage as defined in the respective curriculum.

At the end of the internship completion, for end semester examination, the student shall submit a Project Report in the prescribed format issued by the University. The reviews will be

conducted by a committee constituted by the Head of the Department. The end-semester assessment will be based on the project report and a viva on the project conducted by a committee constituted by Controller of examination. This may include an external expert.

16. For non – credit courses / audit courses:

The Assessment will be done based on the respective assessment as per rubrics issued by the Head of the Department (BOS). The University has provided USR (University Social Responsibility Course) and Sports as a Non- credit / Audit Courses.

17. Credit weightage: While there is flexibility for the department in allocation of credits to various courses offered, the general formula would be:

- All core courses will be restricted to a maximum of 4 credits
- All electives will be restricted to a maximum of 4 credits
- All ability enhancement courses will be restricted to a maximum of 3 credits
- Projects will be restricted to a maximum of 4 credits

Credits are the weightages, assigned to the courses based on the following general pattern:

For theory One Hour = 1 credit

For Lab Two Hours = 1 credit

Table 8: Credit Value per Course & Structure of Syllabus

Name of course	Number of Papers during entire Master degree program	Credit per course	Total number of credit
Core (theory)	6	4	24
DSE (theory)	3	4	12
AECC	1	3	3
GE (theory)	2	4	8
SEC	2	2	4
Core (Practical)	6	2	12
DSE (Practical)	3	2	6
Industrial training (IIIrd sem)	2	2	4
Project IV the sem			20
Total Credit during the M.Sc. Biotechnology Program			93

18. Maximum duration of programme/promotion policy:

A student may complete the programme at a slower pace than the regular pace, but in any case, in not more than N+2 years. After the term-end examination at the end of each semester, the student will be provisionally admitted to the next semester. Each semester will be followed by a break not exceeding 15 days. A candidate shall be promoted to the next higher semester if he/she passes at least 50% of the papers prescribed in the semester failing which he/she shall be declared as fail in that semester and he/she shall be required to get re-admission in the failed semester and shall have to appear in all the papers currently in force.

A candidate shall have to pass all the four semesters examinations within a maximum period of Five Years of his/her admission to the first semester of M.Sc. programme respectively failing which he/she will be deemed to be unfit for the programme.

19. Maximum gaps between semester/year:

- (a) If a candidate, who has passed the second semester examination, but could not

continue his studies, for legitimate and justified reasons, may be permitted to join third semester within two years of his passing the second semester examination.

- (b) The Internal Assessment awards of a candidate, who fails in any external exam, would be awarded the same marks as he/she has obtained when he/she was therein the semester.
- (c) A student may be permitted by the Vice- Chancellor to withdraw from the entire programme for a maximum of two semesters for reasons of ill health, start – up venture or other valid reasons as recommended by a committee consisting of Head of Department, Dean of School, and Dean (Student Welfare).

20. Credit system & grading CGPA/SGPA:

The grading system will be calculated by COE Office.

21. Class / division:

The list of successful candidates after the four semesters examinations of **Master in Science** course shall be arranged as under in two divisions on the basis of the aggregate marks obtained in all semester examinations taken together, and the division obtained by the candidate will be stated in his degree.

- (a) First Division those who obtain 60% or more of the aggregate marks.
- (b) Second Division those who obtain 50% or more but less than 60% of the aggregate marks.
- (c) Those who pass all semester examinations in the first attempt obtaining 75% or more marks in the aggregate shall be declared to have passed with **DISTINCTION**.
- (d) Each successful candidate shall receive a copy of detailed marks card on having passed the Semester Examination.
- (e) Any dispute arising on account of implementation of this ordinance shall be referred to a committee of three members to be appointed by the Vice-Chancellor and its decision shall be final and binding on all.

22. Transfer of credit /Academic Credit Bank

1. Within the broad framework of these regulations, the Academic Council, based on the commendation of the Credit Transfer Committee so constituted may permit students to transfer part of the credit earned in other approved Universities of repute & status in the India or abroad.
2. The Academic Council may also approve admission of students who have completed a portion of course work in another approved Institute of repute under Multiple entry & Exit system, based on the recommendation of the credit transfer committee on a case-to-case basis.
3. Students who have completed coursework, at least first year, at some university other than the university to which transfer is sought may request for transfer of admission to this university. A student may be granted admission only through an admission process that will follow the same policy as for fresh admissions. However, a uniform credit system must be followed by all universities to effect transfer of credits.
4. Credit Transfer request can be submitted only after the student has been admitted in the concerned program and the following conditions are met:
 - i. The course work has been completed at a UGC approved and accredited University through fulltime formal learning mode.

- ii. The university accreditation grade/ ranking are not lower than that of the university to which the transfer is sought.
- iii. The courses prescribe to the common minimum syllabus under UGC CBCS system.
- iv. The letter grade obtained in the courses is “B” or better.
- v. The number of credits to be transferred does not exceed the prescribed limit.
- vi. The program in question must have a similar credit system, in particular, modular or semester and the same numeric and letter grading system along with common meaning of the term “credit” in numerical terms.

The aspect of shelf life of courses needs to be considered while accepting credits as obsolescence of knowledge of certain field in terms of its current relevance needs to be investigated. The time lapsed between successful completion of certain courses of the program and the admission to which program transfer is sought needs to be considered. The maximum number of credit points that may be considered under a credit transfer needs to be specified. Contextual variables such as teaching-learning approach adopted, learning facilities offered, use of evaluation modes may also be considered while preparing the credit transfer policy.

23. Change of discipline:

If any Student of Biotechnology program wants to change from Biotechnology to any program/ any discipline as per their eligibility they are permitted to change on or before 30 calendar days from the first day of commencement of program as per academic calendar.

24. Use of technological intervention

The use of technology will reduce dependency on human intervention and be error free. The following functions will be automated:

- (a) Registration of students and generating unique PRN
- (b) Filling up of examination form,
- (c) Generation of seat numbers and admit cards/hall tickets,
- (d) Preparation of list of paper setter,
- (e) Use of question bank system to draw question sets, question paper generation,
- (f) Online distribution of question papers on the day of examination with system of encryption,
- (g) Barcode system for answer books (this will eliminate issues related to errors, avoid malpractices etc.),
- (h) Digitization of answer scripts and onscreen evaluation of answer sheets,
- (i) Tracking of student’s performance,
- (j) Marks submission through online software,
- (k) Viewing of result through online system,
- (l) Online verification and revaluation system,
- (m) Digitization of certificates and mark sheets (to avoid tampering and easy retrieval)
- (n) Certificate authentication system,
- (o) Submission of various other applications through online system.
- (p) OBE framework has been incorporated and faculties are trained to update their work.
- (q) All the students have been taught through various technological apps such as Google classroom, Zoom, Google Meet, Microsoft team etc. Faculties as well as Students have been given regular training to acquaint with technology, its use and functions to work in a friendly manner.

The above will lead to conduct of functions of the examination system in an efficient and transparent manner and timely availability of information to students.

It also included workplace technology, intranet opportunities to provide a learning organizational culture, socio-material perspective on technology, and trust in virtual teams. It also included new technology plate-forms like massive open online courses (MOOCs) and open educational resources (OER), are opening up possibilities to make higher education more available, affordable, and responsive to audiences that would otherwise not have access. An MOOC is defined as an online course aimed at large-scale interactive participation and open access via the web. MOOCs have been one of the emerging themes in online learning in higher education. Many university libraries are finding OER to be a powerful tool for students and faculty. OER are defined as freely accessible and open licensed intellectual properties for teaching and learning, such as documents and media.

25. **Student Discipline:** A student is expected to follow the right conduct as per the ethical and socio cultural norms set by the University for Day-to-day living. Also, student has to follow the rules and guidelines, set by the University for Different Activities.
26. **Student Welfare:** Any act of indiscipline of a student reported to the Dean and Head of the Department will be referred to a Discipline Committee constituted for the purpose. The Committee will enquire into the charges and decide on a suitable punishment if the charges are substantiated. The committee will also authorize the Dean (Students Welfare) to recommend to the Vice-Chancellor for the implementation of the decision. The student concerned may appeal to the Vice-Chancellor, whose decision will be the final.
27. **Ragging:** Ragging in any form is a criminal and offence in our country. The current State and Central legislations provide stringent punishments including imprisonment. Once the involvement of a student(s) is established in ragging, offending fellow students/staff, harassment of any nature to the fellow students/staff etc. the student(s) will be liable to be dismissed from the University, as per the laid down procedures of the UGC / Govt. /Institute. Every senior student at the University, along with their parent, shall give an undertaking every year in.
28. **Examination code of conduct**
 - a) Enter examination hall 15 minutes before the scheduled time. Students coming 30 minutes after the commencement of the examination will not be permitted to enter the examination hall or to write the examination.
 - b) Occupy the assigned seats only.
 - c) All the students must carry their University Identity Card and Admit Card along with them. Without I-card and Admit Card, no student will be permitted to enter the Exam Hall. In case if a student has lost college I-card, other valid identity proof (Aadhar Card / Driving License / Voter Card) can be used for the purpose of personal verification of the Student. On the day of next examination student must carry provisional college I-card issued from the Dean of the College.
 - d) Read all instructions carefully written on the answer sheet & complete all entries of the cover page carefully. It is the responsibility of the student to fill all the particulars in the answer-sheet correctly. **In case of any discrepancy found on the cover page of answer sheet, which may lead to non-declaration or delay in the declaration of**

result, the student shall be solely responsible. To avoid any trouble in future the student must fill all the entries on the cover page of the answer sheet carefully.

- e) Use of mobile phones and other electronic gadgets are prohibited in the examination hall.
 - f) The students should not carry any other material which may directly or indirectly amount to use of unfair means in the examination.
 - g) The students should bring their own pen, pencil, eraser, general or scientific calculator (if permitted), scale & other materials required for the examination.
 - h) The students must behave decently & cooperate with the invigilator(s) or members of the flying squad in performing their duties.
 - i) The flying squad members and invigilator are authorized to conduct a thorough physical check of clothes, shoes etc. during the examination.
 - j) Murmuring or talking with fellow students comes under UFM rules.
 - k) The Student shall not leave the examination room without the permission of the invigilator.
 - l) **The Student shall not write his/her name or leave any identification mark in the answer sheet. Any such act will be deemed to be use of unfair means.**
 - m) Calculation etc. can be done in the answer sheet itself. No separate sheet will be given for the same. Cancelled portion will not be marked by the evaluator.
 - n) No student shall loiter around stairs, veranda and in front of the exam room, after the commencement of the examination.
 - o) Students are not allowed to leave the examination room before the time is over. In case of emergent conditions, a Student may be allowed to leave examination hall with the special permission of Centre Superintendent after submitting question paper and answer sheet.
 - p) Writing anything on the desks or walls of the exam hall/room is also considered as malpractice / UFM.
 - q) If a Student is caught resorting to UFM, he/she will be provided with a new answer sheet to continue his/her examination. Students need not repeat answers which he/she had already answered in the first answer sheet. Evaluator will mark both answer sheets. But the result will be declared after the decision of the unfair means committee / examination discipline committee.
 - r) Students must wear their I-Cards or keep them on their table during the time of examination.
 - s) Students must write their roll number on the top given right side of the question paper before starting to attempt the same. Except roll number nothing should be written on the question paper otherwise it will be a case of UFM.
- 29. Power of modify:** Notwithstanding all that has been stated above, the Academic Council is vested with powers to modify any or all the above regulations from time to time, if required, subject to the approval by the Board of Studies and Final approval by Vice-Chancellor.
- 30. Entry/Exit point**
Entry points:
- The students will enter the program on the basis of 12th percentage after completing the B.Sc. curriculums.

- The next entry point is to take admission in second year in Master of Science and will be after the completion of 1-year Post graduation Diploma in Biotechnology on the basis of academic credits completed required for the program.

Exit Points:

The post-graduate degree will be of 2 year duration, with one exit options within this period, will be after the completion of 1-year Post graduation Diploma in Biotechnology.

31. NC/Credit Course:

USR (University Social Responsibility) and Sports

Evaluation Scheme

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEMEREVISED SYLLABUS 2024-2025 AS PER NEP 2020
M.Sc. BIOTECHNOLOGY I YEAR, 1stSemester

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 13	MBTC-NP-114	Biochemistry & Metabolic Pathways	4	0	0	4	25	75	100
2	Core 14	MBTC-NP-115	Advance Immunology	4	0	0	4	25	75	100
3	DSE 7	MBTDSE-NP-116a	Bioinformatics & Biostatistics	4	0	0	4	25	75	100
		MBTDSE-NP-113b	Biophysics and Structural Biology							
4.	AECC 5	NHU-N-111	English Communication	3	0	0	3	15	35	50
5.	Gen E	GENCC-701	NCC	2			2			
6.	USEC	NECC-472	University Social Responsibility				0	25	0	NC
7	VAC-1	BNY-112	Yoga Education	2	0	0	2	15	35	50
PRACTICALS										
1.	Core 13	MBTC-NP-114P	Biochemistry & Metabolic Pathways lab	0	0	2	2	20	30	50
2.	Core 14	MBTC-NP-115P	Advance Immunology Lab	0	0	2	2	20	30	50
3.	DSE 7	MBTDSE-NP-116aP	Bioinformatics & Biostatistics Lab	0	0	2	2	20	30	50
		MBTDSE-NP-113bP	Biophysics and Structural Biology lab							
			TOTAL					190	385	550
4.	USEC	SPT-471	Sports	0	0	0	0	50	0	NC

23 (25 including NCC)

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME REVISED SYLLABUS 2024-2025 AS PER NEP 2020
M.Sc. BIOTECHNOLOGY I YEAR, II Semester

S. No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 15	MBTC-NP-121	Industrial Biotechnology	4	0	0	4	25	75	100
2	Core 16	MBTC-NP-122	Molecular Biology	4	0	0	4	25	75	100
3	DSE 8	MBTDSE-NP-126a	Advanced Plant Biotechnology	4	0	0	4	25	75	100
		MBTDSE-NP-123b	Genomics & Proteomics							
4.	GE 4	MBTGE- NP-124a	IPR, Patent, Trademarks & Bioethics	4	0	0	4	25	75	100
		MBTGE- NP-124b	Bio- entrepreneurship Development							
5.	Gen E	GENCC-801	NCC	2			2			
6	AECC 6-		Research & Publication Ethics	3	0	0	3	15	35	50
7	USEC	NECC-482	University Social Responsibility				0	25	0	NC
8	SEC 4 (2 Cr.)	NECC-484	MOOCs/ SWAYAM	2	0	0	2	50	0	50
9	VAC 2		Sanskrit	2	0	0	2	15	35	50
PRACTICALS										
1.	Core 15	MBTC-NP-121P	Industrial Biotechnology Lab	0	0	2	2	20	30	50
2.	Core 16	MBTC-NP-122P	Molecular Biology Lab	0	0	2	2	20	30	50
3.	DSE 8	MBTDSE-NP-126aP	Advanced Plant Biotechnology lab	0	0	2	2	20	30	50
		MBTDSE-NP-123bP	Genomics & Proteomics Lab							
			TOTAL					265	460	700
4.	USEC	SPT-481	Sports	0	0	0	0	50	0	NC

29 (31 including NCC)

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME REVISED SYLLABUS 2024-2025 AS PER NEP 2020
M.Sc. BIOTECHNOLOGY II YEAR, III Semester

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 17	MBTC-NP-231	Bio-separation and downstream processing	4	0	0	4	25	75	100
2	Core 18	MBTC-NP-232	Environmental Biotechnology	4	0	0	4	25	75	100
3	DSE 9	MBTDSE-NP-236a	Advancements in Recombinant DNA Technology	4	0	0	4	25	75	100
		MBTDSE-NP-233b	Animal Biotechnology							
4.	GE 4	MBTGE- NP-234a	Nanobiotechnology	4	0	0	4	25	75	100
		MBTGE- NP-234b	Bioenergetics and Metabolomics							
5.	Industrial Training/Research Project	MBT-RP-231	Industrial Training/ Survey/ Research Project				4	25	75	100
6	VAC-3		Indian Ethos and Modern Management	2	0	0	2	15	35	50
7.	Gen E	GENCC-901	NCC	2			2			
8.	USEC	NECC-592	University Social Responsibility				0	25	0	NC
PRACTICALS										
1.	Core 17	MBTC-NP-231P	Bio-separation and downstream processing Lab	0	0	2	2	20	30	50
2.	Core 18	MBTC-NP-232P	Environmental Biotechnology Lab	0	0	2	2	20	30	50
3.	DSE 9	MBTDSE-NP-236aP	Advancements in Recombinant DNA Technology lab	0	0	2	2	20	30	50
		MBTDSE-NP-233bP	Animal Biotechnology lab							
			TOTAL					225	500	700
4.	USEC	SPT-591	Sports	0	0	0	0	50	0	NC

28 (30 including NCC)

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME REVISED SYLLABUS 2024-2025 AS PER NEP 2020
M.Sc. BIOTECHNOLOGY I YEAR, IV Semester

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1.	Industrial Training/Research Project	MBT-RP-241	Industrial Training/ Survey/ Research Project				16	75	225	300
2.	Gen E	GENCC-X01	NCC	2			2			
3.	USEC	NECC-5X2	University Social Responsibility				0	25	0	NC
4.	SEC 5 (2 Cr.)	NECC-5X4	MOOCs/ SWAYAM	2	0	0	2	50	0	50
			TOTAL					150	225	350
4.	USEC	SPT-5X1	Sports	0	0	0	0	50	0	NC

18 (20 including NCC)

Format-2

DEPARTMENT OF BIOTECHNOLOGY
B.Sc. BIOTECHNOLOGY

Program me	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
CERTIFICATE COURSE IN BIOTECHNOLOGY (52 credits)	FIRST YEAR	SEMESTER -I	i) C1- Introduction to Biotechnology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i)C1- Introduction to Biotechnology	Unit=5/Period=60	N/A	N/A
			ii) C2- Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C2- Microbiology	Unit=5/Period=60	N/A	N/A
			iii) AECC-1- Environment & Ecology (Th.4 Cr+ P 1Cr)	4+1	6	60+30	iii) AECC-1- Environment & Ecology	Unit=5/Period=60	N/A	N/A
			iv) DSE-1- Bioanalytical Techniques / Computational biology and Design of Experiment (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iv) DSE-1- Bioanalytical Techniques / Computational biology and Design of Experiment	Unit=5/Period=60	N/A	N/A
			V) VAC-1 Yoga (Th 2 Cr)	2	2	30	V) Yoga	Unit=5/Period=30	N/A	N/A
		SEMESTER -II	i) C 3- Biochemistry and Metabolism (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i)C 3- Biochemistry and Metabolism	Unit=5/Period=60	N/A	N/A
			ii) C4- Plant Tissue Culture and applications (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C4- Plant Tissue Culture and applications	Unit=5/Period=60	N/A	N/A
			iii) AECC-2- English Communication (Th.3 Cr)	3	3	45	iii) AECC-2- English Communication	Unit=5/Period=45	N/A	N/A
			iv) Certification/MOOCs/Swayam (Th.1+1)	1+1	2	30	iv) SEC-1 Certification/MOOCs/Swayam	Unit=5/Period=30	N/A	N/A
			v) DSE-2-Immunology/Molecular Diagnostics (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	v) DSE-2- Immunology/Molecular Diagnostics	Unit=5/Period=60	N/A	N/A

			vi) GE 1- Entrepreneurship development (Th.4 Cr)	4	4	60	vi) GE 1- Entrepreneurship development	Unit=5/Period=60	N/A	Yes

Programme Outcome:

PO 1: Grasp of basic and advanced knowledge on various domains of biotechnology.
 PO 2: Aptitude to assimilate technologies through an inter-disciplinary approach.
 PO 3: Develop an independent thinking ability.
 PO 4: Ability to communicate effectively.
 PO 5: Equip the students with the laboratory skills in biotechnology.
 PO 6: To develop students in such a way that they are able to provide biotechnological solutions to the underprivileged areas also helps in solving the problem of clean water and sanitation, waste treatment, food scarcity, agriculture, carbon reduction, climate change, energy etc.
 PO 7: To develop understanding of their social, professional ethical specialized and ethical accountability also helps students in protection their intellectual property.
 PO 8: Capability of design of experiment skill and also develops the skill of analyzing and evaluating the results.
 PO 9: To generate Cognizance of contemporary issues of the time and provide appropriate solutions with biotechnological mindset and fulfillment of SDG.
 PO 10: To develop the understanding to recognize the societal needs and to involve them in life-long learnedness.
 PO 11: To inculcate the habit of team work to solve the industrial and environmental issues.
 PO 12: To inculcate the value added entrepreneurship skills and convert them as professional and mindful individuals.

Programme Specific Outcome B.Sc. BT I year:

PSO₁ To teach an ability to apply biotechnology skills in various subjects studied during the course.
 PSO₂ To provide students with the concepts of Biotechnology to develop interest in science.
 PSO₃ Prepare candidates for starting/entry level positions with a specific focus on individual, social, global and environmental perspectives and After completion of the course students will be awarded with Certificate in Biotechnology.

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
DIPLOMA COURSE (102 Credits) IN BIOTECHNOLOGY	SECOND YEAR	SEMESTER -III	i) C5- Basics of Molecular & Cell Biology	4+2	8	60+60	i)C5- Basics of Molecular & Cell Biology	Unit=5/Period=60	N/A	N/A
			ii) C6-Genetics	4+2	8	60+60	ii) C6- Genetics	Unit=5/Period=60	N/A	N/A
			iii) AECC-3- Professional Skills/ Human Values	3	3	45	iii) AECC-3- Professional Skills/ Human Values	Unit=5/Period=45	N/A	N/A

			DSE-3: Enzyme Technology / Sustainable approaches of Biotechnology for mankind	4+2	8	60+60	iv) DSE-3- Enzyme Technology / Sustainable approaches of Biotechnology for mankind	Unit=5/Period =60	N/A	N/A
			V) VAC-2 Sanskrit (Th 2 Cr)	2	2	30	V) Sanskrit	Unit=5/Period=30	N/A	N/A
			GE-2: Food Fermentation Technology/ Dairy and Agriculture Biotechnology	4	4	60	vi) GE-2: Food Fermentation Technology/ Dairy and Agriculture Biotechnology	Unit=5/Period=60	N/A	Yes
		SEMESTER - IV	i)C 7- Bioprocess & Fermentation Technology	4+2	8	60+60	i)C 7- Bioprocess & Fermentation Technology	Unit=5/Period=60	N/A	N/A
			ii) C 8- Nano-Biotechnology	4+2	8	60+60	ii) C8- Nano-Biotechnology	Unit=5/Period=60	N/A	N/A
			iii) AECC-4- Professional Skills/ Human Values	3	3	45	iii) AECC-4- Professional Skills/ Human Values	Unit=5/Period=45	N/A	N/A
			iv) Certification/ MOOCs/Swayam (Th.1+1)	1+1	2	30	iv) Certification /MOOCs/Swayam (Th.1+1)	Unit=5/Period=30	N/A	N/A
			v) DSE-4 - Biostatistics and Bioinformatics /Algal Biotechnology	4+2	8	60+60	v) DSE-4 - Biostatistics and Bioinformatics / Algal Biotechnology	Unit=5/Period=60	N/A	N/A

Programme Outcome:

PO 1: Grasp of basic and advanced knowledge on various domains of biotechnology.

PO 2: Aptitude to assimilate technologies through an inter-disciplinary approach.

PO 3: Develop an independent thinking ability.

PO 4: Ability to communicate effectively.

PO 5: Equip the students with the laboratory skills in biotechnology.

PO 6: To develop students in such a way that they are able to provide biotechnological solutions to the underprivileged areas also helps in solving the problem of clean water and sanitation, waste treatment, food scarcity, agriculture, carbon reduction, climate change, energy etc.

PO 7: To develop understanding of their social, professional ethical specialized and ethical accountability also helps students in protection their intellectual property.

PO 8: Capability of design of experiment skill and also develops the skill of analyzing and evaluating the results.

Programme Specific Outcome B.Sc. BT II year:

PSO₁ To impart an ability to apply biotechnology skills and its applications in core and allied fields.

PSO₂ Students are ale to apply the concepts and research approaches.

PSO₃ After completions of the two years course students will be awarded with Diploma in Biotechnology and prepare students for the job after completion of diploma in Biotechnology.

PO 9: To generate Cognizance of contemporary issues of the time and provide appropriate solutions with biotechnological mindset and fulfillment of SDG.

PO 10: To develop the understanding to recognize the societal needs and to involve them in life-long learnedness.

PO 11: To inculcate the habit of team work to solve the industrial and environmental issues.

PO 12: To inculcate the value added entrepreneurship skills and convert them as professional and mindful individuals.

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
UNDER GRADUATE DEGREE IN BIOTECHNOLOGY (152 Credits)	THIRD YEAR	SEMESTER - V	i)C9- Environmental Biotechnology	4+2	8	60+60	i)C9- Environmental Biotechnology	Unit=5/Period=60	N/A	N/A
			ii) C10- Recombinant DNA Technology & Genetic Engineering	4+2	8	60+60	ii) C10- Recombinant DNA Technology & Genetic Engineering	Unit=5/Period=60	N/A	N/A
			iii) DSE-5- Omics Biotechnology/ Animal Biotechnology	4+2	8	60+60	iii) DSE-5- Omics Biotechnology/ Animal Biotechnology	Unit=5/Period=60	N/A	N/A
			iv) GE 3 IPR & Bioethics	4	4	60	iv) GE 3 IPR & Bioethics	Unit=5/Period=60	N/A	Yes
			V) VAC-3 Indian Ethos and Modern Management (Th 2 Cr)	2	2	30	V) Indian Ethos and Modern Management	Unit=5/Period=30	N/A	N/A
			*Summer Training	4						
		SEMESTER - VI	i)C 11- Industrial Biotechnology and Down Stream Processing	4+2	8	60+60	i)C 11- Industrial Biotechnology and Down Stream Processing	Unit=5/Period=60	N/A	N/A
			ii) C 12- Approaches of Biotechnology in Medical and Forensic	4+2	8	60+60	ii) C 12- Approaches of Biotechnology in Medical and Forensic	Unit=5/Period=60	N/A	N/A

		iii) SEC-3 Certification/MOOCs/Swayam (Th.1+1)	1+1	2	30	iii) SEC-6 Certification/MOOCs/Swayam (Th.1+1)	Unit=5/Period=30	N/A	N/A
		iv) DSE-6 Green Biotechnology and Pollution Control/ Biosensors and drug design	4	4	60	iv) DSE-6 Green Biotechnology and Pollution Control / Biosensors and drug design	Unit=5/Period=60	N/A	N/A
		*Research project/ Industry Training/ Internship Survey	4	4	60				

*Research Topic may be selected from any one of 02 core papers.

Programme Outcome:

- PO 1: Grasp of basic and advanced knowledge on various domains of biotechnology.
 PO 2: Aptitude to assimilate technologies through an inter-disciplinary approach.
 PO 3: Develop an independent thinking ability.
 PO 4: Ability to communicate effectively.
 PO 5: Equip the students with the laboratory skills in biotechnology.
 PO 6: To develop students in such a way that they are able to provide biotechnological solutions to the underprivileged areas also helps in solving the problem of clean water and sanitation, waste treatment, food scarcity, agriculture, carbon reduction, climate change, energy etc.
 PO 7: To develop understanding of their social, professional ethical specialized and ethical accountability also helps students in protection their intellectual property.
 PO 8: Capability of design of experiment skill and also develops the skill of analyzing and evaluating the results.
 PO 9: To generate Cognizance of contemporary issues of the time and provide appropriate solutions with biotechnological mindset and fulfillment of SDG.
 PO 10: To develop the understanding to recognize the societal needs and to involve them in life-long learnedness.
 PO 11: To inculcate the habit of team work to solve the industrial and environmental issues.
 PO 12: To inculcate the value added entrepreneurship skills and convert them as professional and mindful individuals.

Programme Specific Outcome B.Sc. BT III year:

- PSO₁ To prepare students in such a way that they understand the impact of the biotechnological solutions in social and environmental context and demonstrate the knowledge of the requirement for sustainable development
 PSO₂ To provide students with the conceptions from basics to advance research in the field of Biotechnology and enhance their career in higher studies.
 PSO₃ To impart exhaustive and thorough knowledge of Hands on practical to students in several thrust areas of biotechnology to meet out the interface of academia and industry and After completion of the three years course students will be awarded with Degree in Biotechnology.

M.Sc. BIOTECHNOLOGY

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
UNDER GRADUATE DEGREE (R) (204 Credits)	FOURTH YEAR	SEMESTER - VII	i) C13- Biochemistry & Metabolic Pathways	4+2	8	60+60	i) C13- Biochemistry & Metabolic Pathways	Unit=5/Period=60	N/A	N/A
			ii) C14- Advance Immunology	4+2	8	60+60	ii) C14- Advance Immunology	Unit=5/Period=60	N/A	N/A
			iii) DSE7- Bioinformatics & Biostatistics / Biophysics and structural biology	4+2	8	60+60	iii) DSE7- Bioinformatics & Biostatistics / Biophysics and structural biology	Unit=5/Period=60	N/A	N/A
			iv) AECC 5- English Communication	3	3	45	iv) AECC 5- English Communication	Unit=5/Period=45	N/A	N/A
			v) VAC-1 Yoga (Th 2 Cr)	2	2	30	V) Yoga	Unit=5/Period=30	N/A	N/A
		SEMESTER - VIII	i) C15 Industrial Biotechnology	4+2	8	60+60	i) C15 Industrial Biotechnology	Unit=5/Period=60	N/A	N/A
			ii) C16- Molecular Biology	4+2	8	60+60	ii) C16- Molecular Biology	Unit=5/Period=60	N/A	N/A
			iii) DSE8- Advanced Plant Biotechnology / Genomics & Proteomics	4+2	8	60+60	iii) DSE8- Advanced Plant Biotechnology / Genomics & Proteomics	Unit=5/Period=60	N/A	N/A

			iv) G E 3 IPR, Patent, Trademarks & Bioethics / Bio-Entrepreneurship development	4	4	60	iv) G E3- IPR, Patent, Trade marks & Bioethics / Bio-Entrepreneurship development	Unit=5/Period=60	N/A	Yes
			v) SEC 4- MOOCs/ SWAYAM	1+1	2	30	v) SEC 4- MOOCs/ SWAYAM	Unit=5/Period=30	N/A	N/A
			vi) AECC 6- Research & Publication Ethics	3	3	45	vi) AECC 6- Research & Publication Ethics	Unit=5/Period=45	N/A	N/A
			Vii) VAC-2 Sanskrit	2	2	30	Vii) Sanskrit	Unit=5/Period=30	N/A	N/A

***Dissertation report will be evaluated by external & internal examiners & Research topic may be selected from the main core paper**

Programme Outcome:

PO 1: To develop better understanding of the significant principles of biotechnological function at an advanced level for research emphasis and fulfillment of SDG.

PO 2: Skills to DoE (Design of experiment) to analyze data on the basis of basic concepts and theories.

PO 3: An aptitude to attain the skills in handling laboratory instruments, scheduling and execution of laboratory experiments to meet preferred needs with sustainable approach in biotechnology.

PO 4: Students will establish their involvement in the biotechnology discipline through internship or research and to go through with outreach activities specific to biotechnology to solve the social problems.

PO 5: An ability to investigate the specified scientific data analytically and the ability to draw the objective fulfill

PO 6: Students will attain competency in laboratory safety and demonstrate according to the needs.

PO 7: Students will acquire the writing skill in terms of research writing, proposal writings, short communication writing.

PO 8: An ability to generate creative thinking (divergently and convergent) to propose innovative ideas and new solution to the problems also helps students in protection their intellectual property.

PO 9: Multidisciplinary nature of biotechnology program helps in

Programme Specific Outcome M.Sc. BT I year:

PSO₁ Ability to enhance the skill in terms of analysis of biochemical process, molecular biology, immunology etc. and expertise to design of experiment to analyze data on the basis of basic concepts and theories.

PSO₂ To develop awareness of various ethical issues in terms of IPR, patent human genome RDT etc in biotechnology research.

PSO₃ Develop skill to present the work through visual, oral and written presentations, including an original research proposal after studying the bioentrepreneurship development course.

providing better solutions and new designs for the sustainable developments, ability to tackle environment issues and to generate Cognizance of contemporary issues of the time and provide appropriate solutions with biotechnological mindset.

PO 10: To Develop a up-to-date and scientific mindset or vision with respect to science but also in all aspects of life also provide biotechnological solutions to the underprivileged areas also helps in solving the problem of clean water and sanitation, waste treatment, food scarcity, agriculture, carbon reduction, climate change, energy etc..

PO 11: Developed aptitude by participating in various national and international conferences, workshops, symposia, training etc. willingly, in order to acquire knowledge, creating awareness about the environmental, social, global issues.

PO 12: Developed as a trained biotechnologists, academicians or industrial person.

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
POST GRADUATE DEGREE (235 Credits)	FIFTH YEAR	SEMESTER -IX	i) C17 Bio-separation and downstream processing	4+2	8	60+60	i) C17 Bio-separation and downstream processing	Unit=5/Period=60	N/A	N/A
			ii)C18- Environmental Biotechnology	4+2	8	60+60	ii)C18- Environmental Biotechnology	Unit=5/Period=60	N/A	N/A
			iii) DSE9- Advancements in Recombinant DNA Technology / Animal Biotechnology	4+22	8	60+60	iii) DSE9- Advancements in Recombinant DNA Technology / Animal Biotechnology	Unit=5/Period=60	N/A	N/A
			v) GE 4: Nanobiotechnology/ Bioenergetics and Metabolomics	4	4	60	v) GE 4: Nanobiotechnology/ Bioenergetics and Metabolomics	Unit=5/Period=60	N/A	yes
			Industrial Training/Survey/ Research Project	4						
		SEMESTER - X	SEC 5- MOOCs/ SWAYAM	2			SEC 5- MOOCs/ SWAYAM	Unit=5/Period=30		
			*Research project/ Industry Training/ Internship Survey	16						
		*Research topic is to be selected from main core paper.								

Programme Outcome:

Programme Outcome:

PO1: To develop better understanding of the significant principles of biotechnological function at an advanced level for research emphasis and fulfillment of SDG.

PO2: Skills to DoE (Design of experiment) to analyze data on the basis of basic concepts and theories.

PO3: An aptitude to attain the skills in handling laboratory instruments, scheduling and execution of laboratory experiments to meet preferred needs with sustainable approach in biotechnology.

Programme Specific Outcome M.Sc. BT II Year:

PSO₁ Ability to enhance the core biotechnology skills in the field of industrial biotechnology environment biotechnology RDT etc.

PSO₂ Students will establish their involvement in the biotechnology discipline through internship or research and to go through with outreach activities specific to biotechnology to solve the social problems.

PSO₃ Industry/academia suitable candidates are prepared after completion of Master in Biotechnology program.

PO4: Students will establish their involvement in the biotechnology discipline through internship or research and to go through with outreach activities specific to biotechnology to solve the social problems.

PO5: An ability to investigate the specified scientific data analytically and the ability to draw the objective fulfill

PO6: Students will attain competency in laboratory safety and demonstrate according to the needs.

PO7: Students will acquire the writing skill in terms of research writing, proposal writings, short communication writing.

PO8: An ability to generate creative thinking (divergently and convergent) to propose innovative ideas and new solution to the problems also helps students in protection their intellectual property.

PO9: Multidisciplinary nature of biotechnology program helps in providing better solutions and new designs for the sustainable developments, ability to tackle environment issues and to generate Cognizance of contemporary issues of the time and provide appropriate solutions with biotechnological mindset.

PO10: To Develop a up-to-date and scientific mindset or vision with respect to science but also in all aspects of life also provide biotechnological solutions to the underprivileged areas also helps in solving the problem of clean water and sanitation, waste treatment, food scarcity, agriculture, carbon reduction, climate change, energy etc..

PO11: Developed aptitude by participating in various national and international conferences, workshops, symposia, training etc. willingly, in order to acquire knowledge, creating awareness about the environmental, social, global issues.

PO12: Developed as a trained biotechnologists, academician or industrial person.

Format-3

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: Biotechnology		Year: I
Certificate/Diploma/Degree/PG		Semester: I
Class: M.Sc. Biotechnology		
Credits: 6	Subject: Biochemistry and Metabolic Pathways	
Theory: 4		
Practical: 2		
Course Code:MBTC-NP-114	Title: Biochemistry and Metabolic Pathways	
Course Objectives:		
CO 1	To aware students about the biomolecule, forces, structure, classifications of biomolecules and transport mechanisms.	
CO 2	To aware students about biomolecules classification, inhibition and its regulations, purifications process and various methods involved in purifications.	
CO 3	To aware students about major metabolic pathways and their regulations also the inborn error of metabolism	
CO 4	To aware students about various tools and techniques associated with biochemical analysis of different biomolecules which equip the students and provide skill based learning. .	
CO 5	To aware students about advanced microscopy and spectroscopy its various types and its role in biotechnology.	
CO 6	To study the quantitative chemistry, principles and application, cytochemistry, and various Molecular diagnostic techniques also provide advanced concepts of metabolic engineering.	
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
50% Marks / 2 Credits		
L:4		
T:		
P:2(In Hours/Week)		
Theory - 1 Hr. = 1 Credit		
Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Biomolecules: Introduction to Biochemistry, Principle of thermodynamics, pH and buffers, Structure of biomolecules (Carbohydrates, Proteins, Lipids, Nuclie acids, vitamins and minerals), Amino acid structure, primary, secondary, tertiary and quaternary structure, Introduction to Enzymes: classification, Kinetics and regulation of enzyme activities. Clinical significance of biomolecules.	14
II	Carbohydrate metabolism- Glycolysis, Pentose Phosphate Pathway and its regulation, Citric acid cycle & its regulation, Biosynthesis of starch, Glycogenolysis, Gluconeogenesis. Regulation of carbohydrate metabolism.	12
III	Lipid and Protein Metabolism- Fatty acid oxidation, Biosynthesis of Cholesterol, steroid hormones, inborn errors of metabolism, essential and	

	non-essential amino acids, Protein Biosynthesis, and genetic code, conversion of amino acids to specialized products,	
IV	Techniques to separate the biomolecule: Chromatography, Paper chromatography, Thin Layer Chromatography, column chromatography, affinity chromatography, Gel filtration, Ion exchange chromatography, HPLC, Gas chromatography, Electrophoresis- SDS PAGE, Agarose gel electrophoresis, immune-electrophoresis, Southern, Northern and Western blotting,	12
V	Diagnostic techniques: Molecular diagnostic techniques, PCR, modifications in PCR, real-time PCR, Microscopy-types and role in biotechnology, compound microscope, and phase contrast microscope, fluorescence microscopy, SEM, TEM, CT- scan, Spectrophotometry	12

Reference / Text Books:

1. Nelson D.L. and Cox M., Lehninger Principles of Biochemistry (2017), Eighth edition, Macmillan Learning, USA
2. Berg J.M., Stryer L., Tymoczko J.L., Gatto G. J., Biochemistry, (2015) Eighth edition, Macmillan Learning, USA
3. Harper's Biochemistry 26th edition
4. Wilson K. and Walker J., Principle and techniques of Biochemistry and Molecular Biology (2010), Cambridge University Press, UK.
5. Voet D., Voet J., Pratt C.W., Fundamentals of Biochemistry: Life at the molecular level, (2016) Fifth Edition, Wiley Publishers, USA

If the course is available as Generic Elective then the students of following departments may opt it.NO

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	-
5) ESE	75
Total:	100

Prerequisites for the course: Graduation in Life Science/Biotechnology/basic knowledge of biomolecules and central metabolic pathway

Course Learning Outcomes: after completion of the course

CLO1: Students acquired knowledge of different types of biomolecules, biomolecule, forces, structure, classifications of biomolecules and transport mechanisms, enzymes, classification, factors affecting, Enzyme kinetics, inhibition and its regulations.

CLO2: Students acquired knowledge about the metabolic pathways, regulations and inborn errors associated with metabolic pathways.

CLO3: Students acquired knowledge of various biomolecules separation techniques, quantity estimation, purifications process and various methods involved in purifications.

CLO4: Students equipped with various tools and technology associated with biochemical analysis of different types of biomolecules.

CLO5: Students equipped with the knowledge of advanced microscopy and spectroscopy its various types and its role in biotechnology.

CLO6: Students acquired knowledge of molecular techniques, cytochemistry, principles and

application, quantitative chemistry and various Molecular diagnostic techniques also provide advanced concepts of metabolic engineering.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learner also done during the course commencement.
10. For Slow learner, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

MBTC-NP-114P: Biochemistry and Metabolic Pathways Lab

Marks: 50

Duration: 60 hours (2 credits)

1. Specific tests for carbohydrates; Polysaccharide iodine test, Fehling's test, Barfoed's Test and Seliwanoff's Test
2. Amino acids separation and identification through paper chromatography.
3. Protein separation through SDS PAGE.
4. Demonstration of Microscopy: Light and Electron microscope.
5. Separation of nucleic acids by gel electrophoresis
6. Identification and Separation of sugars/lipids by TLC.
7. To determine the concentration of Proteins by Lowry's method.
8. PCR demonstration and applications.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme:Biotechnology Certificate/Diploma/Degree/PG Class: M.Sc. Biotechnology		Year: I Semester: I
Credits: 6 Theory: 4 Practical: 2	Subject: Immunology	
Course Code:MBTC-NP-115	Title: Advance Immunology	
Course Objectives: CO1. To study the immunity, its types, cells and organs involved in immune systems. CO2. To study the antigen, antibody, immunoglobulins its type, structure and factors influencing immunogenicity. CO3. To study the Diversity in Immune system, Major histocompatibility complex, genes and products and also antigen processing and presentation. CO4. To study the Complement, its types, complement activation, Cytokines and types of vaccines and their characteristics. CO5. To study the Autoimmunity, Immune tolerance, transplantation, hypersensitivity, immunodeficiency diseases and, Antigen-Antibody reactions. CO6. To study various types of techniques used in immunology.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Preamble to Immunology, history, types, Cells involved in immune responses: myeloid progenitor cell, Lymphoid progenitor. Introduction to the immune system: Innate and acquired immunity. Organs involved in the adoptive immune response: secondary lymphoid organ and primary lymphoid organ.	10
II	Nature of antigen and antibody: antigenicity vsImmunogenicity, factors influencing immunogenicity, adjuvants, mitogens, haptens, and epitopes,. Immunoglobulins: structure and types& genetic diversity, isotypic, ideotypic variants and allotypic.	12
III	Major histocompatibility complex (MHC) genes, its typesand products: role of MHC antigens in immune responses, Polymorphism of MHC genes, antigen processing and presentation. Generation of Diversity in Immune system: T-cells maturation and activation, B-cell maturation and activation.	12
IV	Cytokines: interferons (α , β & γ), TNF chemokines, hematopoietins and interleukins (1-16). Complement systems: Alternative, lectinand Classical pathway of complement activation, biological consequence of complement	12

	activation, regulation of complement system. Vaccines immunizations: types of vaccines and their characteristics, major breakthrough in Corona vaccines.	
V	Autoimmunity, Immune tolerance, transplantation, hypersensitivity, monoclonal antibody and Hybridoma technology, immunodeficiency diseases, Antigen-Antibody reactions in vitro: agglutination reactions, precipitation reactions (Immuno electro phoretic and Immunodiffusion method), Immuno-blotting, fluorescence immunosorbent assay, ELISA, immuno-electronmicroscopy, RIA, latest advancement in immunology research.	14

Reference / Text Books:

1. Janeway's Immunobiology by Kenneth Murphy. Garland Publishing, 9th Edition (March, 2016)
2. How the Immune System Works by Lauren M. Sompayrac Publication: Wiley-Blackwell; 5th Edition (September 2015)
3. Kuby Immunology by Thomas J. Kindt, Barbara A. Osborne, Richard Goldsby. Publisher: W. H. Freeman; 6th edition edition (October 2006)
4. Immunology: A Short Course by Richard Coico, Geoffrey Sunshine Publication: John Wiley & Sons, (Jan-2015)
5. Textbook of Immunology by Arvind Kumar Publication: The Energy and Resources Institute (TERI), 01-Jan-2013 Chang, J.H., Jiang, Y., Pillarisetty, V.G., 2016. Role of immune cells in pancreatic cancer from bench to clinical application: An updated review. Medicine 95(49), e5541.
6. Liu, J., Cao, X., 2015. Regulatory dendritic cells in autoimmunity: A comprehensive review. Journal of Autoimmunity 63, 1-12.
7. Ng, S., Galipeau, J., 2015. Concise review: engineering the fusion of cytokines for the modulation of immune cellular responses in cancer and autoimmune disorders. Stem Cells Transl Med 4(1), 66-73.
8. Spagnolo, P., Rossi, G., Cavazza, A., Bonifazi, M., Paladini, I., Bonella, F., Sverzellati, N., Costabel, U., 2015. Hypersensitivity Pneumonitis: A Comprehensive Review. J Invest Allergol ClinImmunol 25(4), 237-250; quiz follow 250.
9. Stenken, J.A., Poschenrieder, A.J., 2015. Bioanalytical chemistry of cytokines--a review. AnalyticaChimicaActa 853, 95-115.
10. Varzaneh, F.N., Keller, B., Unger, S., Aghamohammadi, A., Warnatz, K., Rezaei, N., 2014. Cytokines in common variable immunodeficiency as signs of immune dys-regulation and potential therapeutic targets - a review of the current knowledge. J ClinImmunol 34(5), 524-543.
11. Verbik, D., Joshi, S., 1995. Immune cells and cytokines - their role in cancer-immunotherapy (review). Int J Oncol 7(2), 205-223.
12. Weber, R.L., Iacono, V.J., 1997. The cytokines: a review of interleukins. Periodontal Clin Investig 19(1), 17-22.
13. Yang, C.A., Chiang, B.L., 2015. Inflammasomes and human autoimmunity: A comprehensive review. Journal of Autoimmunity 61, 1-8.

If the course is available as Generic Elective then the students of following departments may opt it.NO

Evaluation/Assessment Methodology	
	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/ Attendance	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	-
5) ESE	75
Total:	100

Prerequisites for the course: Graduation in Life Science/Biotechnology

Course Learning Outcomes:

- CLO1: Student will study the types of immunity, cells and organs involved in immune systems.
CLO2: Student will be aware antigen, immunoglobulins its type, structure and factors influencing immunogenicity.
CLO3: Student will study the diversity in Immune system, Major histocompatibility complex types and antigen processing and presentation.
CLO4: Student will be aware types of complement, Cytokines, interferon and types of vaccines and their characteristics.
CLO5: Student will study the Immune tolerance, hypersensitivity, transplantation, Immunodeficiency diseases and, Antigen-Antibody reactions.
CLO6: Student will able to perform various types of techniques used in immunology and also understand about latest advancements in immunology research.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learner also done during the course commencement.
10. For Slow learner, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

MBTC-NP-115P: Advance Immunology Lab

Marks: 50

Duration: 60 hours (2 credits)

1. To perform Radial Immunodiffusion (RID) by Mancini's technique.
2. To perform Double Immunodiffusion (DID) by using Ouchterlony method.
3. To perform the Quantitative precipitation assay-test.
4. To perform *haemagglutination* assay for ABO blood group typing determination of and Rh factor.
5. To learn the technique of rocket Immuno-electrophoresis.
6. To perform Immuno-electrophoresis of given sample.
7. To determine the concentration of antigen by sandwich ELISA method.
8. To determine Total Leukocytes Count (TLC) of the given sample.
9. To determine Differential Leukocytes Count (DLC) of the given sample.
10. Isolation of lymphocytes from peripheral blood by ficoll method and check the viability of isolated lymphocytes.
11. Amplification of Interleukin-28b gene using Polymerase Chain Reaction assay.
12. Lysis of red blood cells (hypotonic lysis with H₂O and ammonium chloride).

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL			
Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: Biotechnology Certificate/Diploma/Degree/PG Class: M.Sc. Biotechnology		Year: I
Credits: 6 Theory: 4 Practical: 2		Semester: I
		Subject: Bioinformatics & Biostatistics
Course Code: MBTDSE-NP-116a		Title: Bioinformatics & Biostatistics
Course Objectives: CO1. To study the history, scope of bioinformatics, databases and BLAST. CO2. To study the Sequence and Phylogeny analysis, sequence alignment, its various types. CO3. To study the Databases, Data Submission tools and Genome Annotation. CO4. To study the <i>in silico</i> tools for <i>rDNA</i> technology. CO5. To study the elementary Statistics, data types, frequency curves, standard deviation, median, quartiles and various types of test. CO6. To study the Probability, probability laws, probability rules and Introduction of statistical sampling.		
Nature of Paper: DSE-7a		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	New proposed	No. of Lectures Allotted
I	Bioinformatics: The background, applications, and breadth of bioinformatics. Tools for Aligning Sequences, FASTA and BLAST, Sequence Directionality, Database Types, EST, Genome informatics: artificial neural networks, genome sequencing technology and analytic techniques, transcription factor regulation and motif identification.	10
II	Phylogenetic Trees: Definition and description, types of trees, Methods& Applications. Rooted and unrooted trees, Bootstrap, Distance-based methods. Primary Sequences Analysis: primer designing, Nucleotide and amino acid composition, codon usage and statistics.	12
III	Protein and nucleic acid databases: SWISS PROT, Gen Bank, DDBJ, INTERPRO, EMBL, UNIPROT, Types of Databases. Resources from the NCBI, PUBMED, derived databases, genomic databases, MEDLINE, patent database, structural databases, and in silico tools for rDNA technology are just a few examples.	12
IV	Basic Statistics: Fundamental Statistics Data representation using polygons, histograms, frequency curves, and discrete and continuous data. The data's median, skewness, standard deviation, quartiles, and mean variability A	12

	goodness of fit test Student t-test, chi-square test, and small sample tests.	
V	Probability: Experimental Probability, probability rules for combined events, subjective probabilities, probability when outcomes are equally likely, probability laws, Bayes's Theorem, conditional probability and independent events, Probability theorem, Introduction of statistical sampling from a population, Probability sampling	14
Reference / Text Books:		
1. Dr.S.P Gupta, Statistical Method, Sultan Chand & Sons Publications,2021 2. Khan I.A., Statistics, Ukaaz Publications, Sixth Edition 2020. 3. Blair R.C., Taylor R., Biostatistics for the Health Sciences, Pearson, USA, 2009 4. Rastogi, S.C., Mendiratta, N., Rastogi, P., Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery, Prentice Hall India Learning Private Limited, India, 2013 5. Negi ,K.S. Biostatistics AITBS Publications, 2010 6. Diniz, W.J., Canduri, F., 2017. Bioinformatics: an overview and its applications. Genetics and molecular research: GMR 16(1).		
If the course is available as Generic Elective then the students of following departments may opt it.NO		
Evaluation/Assessment Methodology		
		Max. Marks
1) Class tasks/ Sessional Examination		16
2) Presentations /Seminar		5
3) Assignments		
4) Research Project Report		4
Seminar On Research Project Report		-
5) ESE		75
Total:		100
Prerequisites for the course: Graduation in Life Science/Biotechnology		
Course Learning Outcomes:		
CLO1 Student will be aware statistics, data types, standard deviation and various types of test.		
CLO2 Student will study the probability its laws, its rules and introduction of statistical sampling.		
CLO3 Student will be aware history, scope and research of bioinformatics, databases and BLAST.		
CLO4 Student will study the Sequences types, Phylogeny analysis and sequence alignment and its types.		
CLO5 Student will study the Databases, Data Submission tools and its resource at NCBI.		
CLO 6 Student will able to study the <i>in silico</i> tools for <i>r DNA</i> technology.		
Instructional Method and Pedagogy		
1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course. 2. Various teaching aids are used for smooth conduction of Lectures. 3. 75% attendance in academic sessions is mandatory. 4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics. 5. PPT presentation method is also incorporated in teaching. 6. Case-study based learning will also be used. 7. Promotion of Ex-situ and In-situ learning. 8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc. 9. Identification of slow and fast learner also done during the course commencement. 10. For Slow learner, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics. 11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are		

incorporated.

PRACTICALS

MBTDSE-NP-116a P: BIOINFORMATICS AND BIOSTATISTICS LAB

Marks: 50

Duration: 60 hours (2 credits)

1. Discuss various protein resources like PIR, PDB, and SWISS-Prot.
2. Perform comparative analysis by using BLAST program.
3. To identify the phylogenetic relationship between different species.
4. To perform sequence retrieval tool.
5. Information regarding various nucleotide resources likes EMBL, GEN BANK, DDBJ.
6. Discuss various types of data with their graphical representation.
7. Draw hypothesis (t-Test) test with their application in biotechnological research.
8. Perform protein modeling by using software program.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: Master of Science in Biotechnology Certificate/Diploma/Degree/UG/PG Class: M.Sc. Biotechnology	Year: I Semester: I	
Credits: 6 Theory: 4 Practical: 2	Subject: Biophysics and Structural Biology	
Course Code:MBTDSE-NP-113b	Title: Biophysics and Structural Biology	
COURSE OBJECTIVES		
CO1 To endow with the knowledge of biophysics and structural biology.		
CO2 To aware students about the basic functioning of the cell and membrane transport.		
CO3 To understand the use of different tools and techniques for identify the biological structures.		
CO4 To give the knowledge of different structures of proteins.		
CO5 To aware students regarding various advanced work in the subject with case studies.		
CO6 To aware students about radiation biophysics, quantum biology and cell electronics.		
Nature of Paper: DSE-7b		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Central Dogma, Genetic code, gene and operon, Structure of DNA and RNA, Biomolecules, components of biological systems, cell signaling, Conformational Changes in DNA Molecules, signal transduction, cell circuits, The Biophysics of RNA, Thermodynamics of bimolecular structures, The Ionic Hypothesis and Rules of Ionic Electricity, gel electrophoresis, polymerase chain reaction (PCR), radiation biophysics, quantum biology	15
II	Electrical Phenomena in Excitable Cells, Basics of protein structure, Electrically Excitable Cells, Membrane proteins, membrane transport, Functional Properties of Voltage-Gated Ion Channels, structures and functions of Molecular Motors: Kinesin, Dynein and Myosin	13
III	Polypeptide chain geometrics, estimates of potential energy, results of potential energy calculations, protein architecture, structural biology techniques, Macromolecular Crystallography, X-ray diffraction, XRD, 3D structure Visualization, Molecular Dynamics Simulation, Pulse Fourier NMR, UV-VIS Absorption Spectroscopy	10
IV	Primary structure sequencing of polypeptide, hemoglobin, homologies in proteins, Secondary structure alpha and beta confirmation, collagen structure, stability of alpha helix, Ramchandran plot, Tertiary structure,	10

	structure of myoglobin and hemoglobin, Quaternary structure, protein folding: thermodynamics and kinetics	
V	Case studies: protein structure and drug design, Ion pumping and Ion Channel rhodopsin and their use, Energy minimization basic technique for small molecules. Ramachandran plot, Torsional space minimization. Energy minimization in Cartesian space. Molecular mechanics basic principle. Molecular dynamics basic principles	12

Reference / Text Books:

1. Carl Ivar Branden and John Tooze., "Introduction to Protein Structure" 2nd 2001 Edition, Taylor and Francis
2. Introduction to Protein Architecture: The Structural Biology of Proteins, 2001 Arthur M. Lesk, Oxford University Press; 1st edition.
3. Creighton. T.E., Proteins, Structure and Molecular Properties, 2nd Edition, 1993
4. W.H. Freeman and Co McPherson, A. "Introduction to Macromolecular Crystallography", 2nd 2009 edition, Wiley-Blackwell.
5. Drenth, J., "Principles of Protein X-Ray Crystallography", 3rd edition, 2007 Springer.
6. The Biophysics of RNA. *ACS Chem. Biol.* 2007 27440-444
7. Applied biopharmaceutics and pharmacokinetics (1999) Ed. Sargel L. (IV Edition) Prentice-Hall International, London.

If the course is available as Generic Elective then the students of following departments may opt it.
1.No

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	
4) Research Project Report	4
Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: good knowledge of physics, especially statistical mechanics, prior knowledge of biology is required.

Course Outcome:

After completion of the course, the student would be able to aware of the molecular, structural and mechanistic basis of the various cellular functions, different advanced tools used in the field of Biophysics and structural biology.

CLO1 : Student would be able to endow with the knowledge of biophysics and structural biology.

CLO2 : Student would be able to aware students about the basic functioning of the cell and membrane transport.

CLO3 : Student would be able to understand the use of different tools and techniques for identify the biological structures.

CLO4 : Student would be able to give the knowledge of different structures of proteins.

CLO5 : Student would be able to aware students regarding various advanced work in the subject with case studies.

CLO6 : Student would be able to aware students about radiation biophysics, quantum biology and cell electronics

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.

2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learner also done during the course commencement.
10. For Slow learner, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

MBTDSE-NP-113bP: BIOPHYSICS AND STRUCTURAL BIOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

OBJECTIVE:

1. To aware students about different tools and instrumentation used in the syllabi.
2. To aware about the crystallization process.
3. To provide advanced knowledge of the field.
4. To offer the information about determining the various structures and also focused on student readiness to solve and design the case studies on the subject.
5. To aware students about the working of radiation biophysics.

List of Experiments:

1. DNA Electrophoresis
2. Molecular weight determination by SDS PAGE.
3. Study of peptide/ligand DNA interaction
4. Lysozyme Crystallization and examination of its crystals in the polarizing microscope.
5. Conformational energy plot for tripeptide monophosphates and obtain lowest energy conformation.
6. Conformational energy plot for dinucleotide monophosphates and obtain lowest energy conformation
7. Plasmid isolation
8. Case study on radiation biophysics
9. Case study on Applications of NMR in the study of Biomolecules

COURSE OUTCOME:

After successful completion of the course the students will be able to demonstrate and performed various tools and instrumentation used in the subject also design and solve the various case studies of the field.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: Master of Science in Biotechnology		Year: I
Certificate/Diploma/Degree/UG/PG		Semester: II
Class: M.Sc. Biotechnology		
Credits: 6	Subject: Industrial Biotechnology	
Theory: 4		
Practical: 2		
Course Code:MBTC-NP-121	Title: Industrial Biotechnology	
COURSE OBJECTIVES		
CO1: To convey information regarding industrial biotechnology with an eye towards achieving the sustainable development objective.		
CO2: To comprehend how living organisms—such as bacteria, yeast, algae, or parts of cells like enzymes—are used in industrial processes and production, particularly in the agro- and food industries.		
CO3: To learn techniques for genetically modifying microbes to increase the production of bioproducts, bioreactors, and primary metabolites.		
CO4: To impart knowledge about the microbial manufacturing of medications.		
CO5: To impart knowledge about the production of biofuels.		
CO6: To impart knowledge with the objective to provide clean and green fuel (SDG 7).		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
50% Marks / 2 Credits		
L: 4		
T:		
P:2(In Hours/Week)		
Theory - 1 Hr. = 1 Credit		
Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Primer to Industrial Biotechnology: Overview of fermentation and other industries with their commercial products employing the use of microorganisms; strain improvement through mutation and recombination in industrial microorganisms, Integrated Strain improvement program (Precision Engineering Technology), biosynthetic technology, Industry development, integrated bio product development	15
II	Microbes in food industry and agriculture: Beneficial soil microorganisms, bio fertilizers and biopesticides, SCP, microbial production of wine, beer and vinegar; bio preservatives (Nisin), cheese, biopolymers, vitamins; Bioflavours and bio pigments; microbial production of flavours and fragrances; microbial pigments in textile and food industry.	13
III	Bioreactors, Production of cell biomass, primary metabolites and enzymes: Different type of Bioreactors and Bioreactor design, Production of ethanol, acetone, butanol, citric acid, dextran and amino acids, Production of	10

	industrial enzymes such as proteases, amylases, lipases, cellulases, whole cell bio catalysis, Applications of bioconversion, transformation of steroids and sterols	
IV	Microbial production of pharmaceuticals and other bio products: Antibiotics, enzyme inhibitors and specialty chemicals; production of Vitamin B2 and B12, glutamic acid, L-Lysine. Transformation of nonsteroidal compounds, anticancer drugs.	10
V	Bioenergy -fuel from biomass, production and economics of biofuels, biogas, bio-refineries, Microbial Enhanced Oil Recovery (MEOR), green energy through bio nano technology route to meet out SDG 7.	12

Reference / Text Books:

1. P.F. Stansbury and A. Whitaker, Principles of Fermentation Technology: An Introduction to Current Concepts, Pergamon Press,, 1993
2. C. Vogel and C.L. Tadaro, Fermentation and Biochemical Engineering, 1996
3. Wulf Cruger and Anneliese Crueger, Biotechnology: A Textbook of Industrial Microbiology, Panima Publishing Corporation,2003
4. Glazer AN, Nikaido H : Microbial Biotechnology: Fundamentals of Applied Microbiology, 2007

If the course is available as Generic Elective then the students of following departments may opt it.

1.No

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	
4) Research Project Report Seminar On Research Project Report	4
5) ESE	75
Total:	100

Prerequisites for the course: Basic knowledge of cell, enzymes, microbiology, bioprocess technology, environment required.

Course learning outcome:

CLO1	Understand the role of industrial biotechnology in improving microbial cells as bioreactor/factories.
CLO2	Apply knowledge of applications of microorganisms in commercial production of flavours, fragrance, and microbial pigment in textile and industry.
CLO3	Comprehend with the different types of bioreactors and the production aspects of metabolites.
CLO4	Apply the process for commercial production of enzyme, antibiotics and different bioproducts from industrial biotechnology.
CLO5	Understand the concept of biofuels and the process of Microbial Enhanced Oil Recovery and Microbial Leaching.
CLO6	Student will developed the understanding of the SDGs in order to provide clean and green fuel (SDG 7).

PRACTICALS

MBTC-NP-121P: INDUSTRIAL BIOTECHNOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

COURSE OBJECTIVE:

1. To make different bioproducts from tissues and cells.
2. To identify and separate the microorganisms that is vital to industry.
3. To learn techniques for isolation and purification of bioproducts.
4. To impart knowledge on how to identify several key features of industrially significant enzymes.

List of Experiments:

1. Isolation and identification of microorganism for the production of primary metabolite.
2. Production and partial purification of Enzyme/Amylase in shake flask culture.
3. Production of Citric acid using *Aspergillus* species.
4. Comparative studies of ethanol production using different substrates.
5. Determination of cellulolytic activity by DNS method.
6. Enzyme assay; activity and specific activity determination of amylase.
7. Production of lactic acid.
8. Isolation of industrially important microorganism from natural resource.

COURSE OUTCOME:

After successful completion of the course the students will be able to:

1. Able to isolate microorganism responsible for the production of metabolites.
2. Show how bioproducts including ethanol, citric acid, and amylase are produced.
3. Isolate microorganisms.
4. Purify the proteins and enzymes that are crucial to industry.
5. Conduct and analyze the enzymatic assay.
6. Understand and produce lactic acid at lab level.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: Biotechnology Certificate/Diploma/Degree/PG Class: M.Sc. Biotechnology		Year: I Semester: II
Credits: 6 Theory: 4 Practical: 2	Subject: Molecular Biology	
Course Code:MBTC-NP-122	Title: Molecular Biology	
Course Objectives: CO1. To study the nucleic acids, its types, DNA replication, Recombination and Repair of DNA. CO2. To study the Transcription, its machinery of eukaryotes and prokaryotes cells and Post-transcriptional processes. CO3. To study the Translation, its steps in eukaryotes and prokaryotes cells and genetic code. CO4. To study the Post-translational processes such as Protein modification, folding, chaperones, transportation, signal hypothesis and protein degradation. CO5. To study the Gene regulation and expression in prokaryotes, Eukaryotes, bacteriophage. CO6. To study the post transcriptional gene silencing and regulation of gene expression.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Preamble to Genetic material: Nucleic acids as genetic material, Structure of DNA and RNA; conformational analysis of DNA; melting of DNA. DNA replication: Arrangement of replicons in a genome, Various modes of replication, Enzymes involved in replication, replication fork and priming, leading and lagging strand, elongation, termination, action of topoisomerases, telomere, single stranded DNA replication, Relationship between DNA replication and cell cycle, DNA copy number maintenance. Recombination and Repair of DNA: DNA repair and recombination, DNA Mismatch Repair, Double Strand Break Repair, Recombination repair, SOS repair, chromatin remodeling.	14
II	Transcription: Transcription machinery of prokaryotes and eukaryotes, various transcription enzymes and cofactors, initiation, elongation and termination, sigma factors,RNA polymerase and cofactors, promoters, enhancers, silencers, activators, regulation of transcription. Post-transcriptional processes: RNA processing, splicing, capping and polyadenylation, post-transcriptional gene regulation.	14

III	Translation: The genetic code and protein structure, Mechanisms of translation in prokaryotes, Mechanisms of translation in eukaryotes, initiation complex, ribosomes and tRNA, factors, elongation and termination, <i>Ex-vivo</i> immune capture and its role in molecular biology.	10
IV	Gene regulation and expression: regulation of gene transcription in prokaryotes (operon model, negative and positive regulation of <i>lac operon</i> and <i>trp operon</i>), transcriptional switch in bacteriophage, regulation of transcription in eukaryotes, post transcriptional gene silencing and regulation of gene expression.	10
V	Post-translational processes: Protein modification, folding, chaperones, transportation, the signal hypothesis, protein degradation. Report on cellular reference atlas of human lung, rapid biosynthesis of glycoprotein therapeutics.	12

Reference / Text Books:

1. Lewin's Genes XII by Krebs J.E., Goldstein E.S., Kilpatrick S.T., Jones and Bartlett Publishers (2017)
2. Molecular Biology of the Gene by Watson J.D., Baker T.A., Bell S.P., Gann A., Levine M., Lodish R., Pearson Education (2013)
3. Molecular Cell Biology by Lodish H.F., Berk A., Kaiser C.A., Krieger M., Bretscher A., Ploegh H., Amon A., Martin K.C., 8th edition, Macmillan Publishers (2016).
4. Cell and Molecular Biology: Concepts and Experiments by Gerald Karp. 8th Edition, John Wiley & Sons Inc, (2016)

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: Graduation in Life Science/Biotechnology/Microbiology

Course Learning Outcomes:

CLO1 Student will come up with the knowledge of nucleic acids structure, its types, replication and various repair mechanism in DNA.

CLO2 Student will be aware Transcription machinery of eukaryotes and prokaryotes cells and its Post-transcriptional modifications.

CLO3 Student will come up with the knowledge of Translation in eukaryotes and prokaryotes cells and genetic code.

CLO4 Student will acquire the knowledge of the Post-translational processes for proteins and its protein degradation.

CLO5 Student will be aware gene regulation and expression in prokaryotes, Eukaryotes and bacteriophage.

CLO 6: Student will be aware about post transcriptional gene silencing.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

MBTC-NP-122P: MOLECULAR BIOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

1. To prepare various Standard solutions for molecular biology lab.
2. Isolation of pure genomic DNA from plant tissue
3. To determine the concentration and purity of extracted DNA using UV spectrophotometer.
4. Quantitative and qualitative analysis of DNA by UV-spectrophotometer
5. Agarose Gel electrophoresis
6. Isolation and purification of Protein
7. SDS-PAGE gel electrophoresis
8. To amplify the specific region of DNA by polymerase chain reaction
9. To optimize different process parameters that effects the result of PCR experiment
10. To familiarize with common PCR hitches: PCR troubleshooting
11. Application of restriction enzymes

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme : Biotechnology Certificate/Diploma/Degree/ PG Class: M.Sc. Biotechnology		Year: I Semester: II
Credits: 6 Theory: 4 Practical: 2	Subject: Advanced Plant Biotechnology	
Course Code: MBTDSE-NP-126a	Title: Advanced Plant Biotechnology	
Course Objectives: CLO1. Students will learn about plant biotechnology history, scope, and application. CLO2: Students will get knowledge about Cell suspension culture, callus culture, protoplast culture, Somatic hybridization. CLO3: Student will able to get concept about bioreactor, <i>Agrobacterium</i> mediated genetic transformation. CLO4: Students will learn about the production scale- up through bioreactors, secondary metabolite production, bioinsecticides, biopesticides. CLO5: Students will learn about micro-propagation from Callus to plant and somatic embryogenesis. CLO 6: The overall outcomes of the course are to provide advance and in-depth knowledge in the field of plant biotechnology to students.		
Nature of Paper: DSE-8a		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introductory history, Cellular tot potency, cyto-differentiation and morphogenesis, Laboratory requirements and general techniques, Basic Techniques of Plant Tissue Culture, basic sterilization techniques of Plant Tissue Culture, Laboratory Organization, Applications of Plant Tissue Culture and advantages.	12
II	Plant tissue culture media, Plant growth regulators and their uses. Types of plant tissue, Cell suspension culture, callus culture, protoplast culture, Types of Plant Tissue Culture-Organ Culture. Production of Haploids in vitro. Principles, Techniques of Plant Protoplast Culture.	12
III	Production of callus from explants, clonal propagation and production by micro propagation–meristem tip culture, shoot tip culture, Somatic embryogenesis, Zygotic embryo culture, somatic hybridization and cybridization, Somatic hybrid and cybrid.	12
IV	Bioreactors Used in Plant Tissue Culture, chemicals from plants, genetically	

	engineered plants, <i>Agrobacterium</i> Mediated Biotransformation, production of pathogen-free plants. Soma-clonal variation, embryo culture and embryo rescue and synthetic seeds.	12
V	Plant Tissue Culture applications -Production of secondary metabolites, bioinsecticides, biopesticides and bio-fertilizers, transgenic plants (production and uses). Preservation of plant genetics resources germplasm collection and conservation. Germplasm storage.	12

Reference / Text Books:

1. An Introduction to Plant Tissue culture by M K Razdan. Science publication, 2003.
2. Plant tissue culture by Bhojwani. S S and Razdan. M.K 2004.
3. Plant Propagation by Tissue Culture by E F George, M A. Hall, G D Klerk. Springer; 3rd edition (2008).
4. Introduction to Plant Biotechnology by H. S. Chawla, CRC Press, 3rd edition (January 2009)
5. Plant Biotechnology: B.D. Singh, Kalyani Publishers (2014)

If the course is available as Generic Elective then the students of following departments may opt it.NO

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/ Attendance	5
3) Assignments	
4) Research Project Report	4
Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: B.Sc. Degree in Biotechnology/Microbiology, knowledge of plant cell and its function.

Course Learning Outcomes:

- CLO1. Students will learn about plant biotechnology history, scope, and application.
- CLO2: Students will get knowledge about Cell suspension culture, callus culture, protoplast culture, Somatic hybridization.
- CLO3: Student will able to get concept about bioreactor, *agrobacterium* mediated genetic transformation.
- CLO4: Students will learn about the production scale- up through bioreactors, secondary metabolite production, bio insecticides, bio pesticides.
- CLO5: Students will learn about micro-propagation from Callus to plant and somatic embryogenesis.
- CLO 6: The overall outcomes of the course are to provide advance and in-depth knowledge in the field of plant biotechnology to students.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.

10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

MBTDSE-NP-126aP: Advanced Plant Biotechnology LAB

Marks: 50

Duration: 60 hours (2 credits)

1. Demonstration on to set up a plant tissue culture laboratory.
2. Aseptic isolation from of shoots from floral meristem.
3. Preparation and formulation of Murashig & Skoog's medium.
4. Explant selection, preparation and surface sterilization.
5. Aseptic handling of numerous explants.
6. To perform the isolation of protoplast from plants.
7. Demonstration of culturing, sub culturing and maintenance using selected explants.
8. Understanding Development of the process for synthetic seed production and Somatic embryogenesis
9. To demonstrate various steps of Micro-propagation
10. Callus production from explants *in-vitr*

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme:Biotechnology Certificate/Diploma/Degree/ PG Class:M.Sc. Biotechnology	Year: I Semester: II	
Credits: 6 Theory: 4 Practical: 2	Subject: Genomics & Proteomics	
Course Code: MBTDSE-NP-123b	Title: Genomics & Proteomics	
Course Objectives: CO1. To study about Organization and Structure of genome. CO2. To learn about the assembly of a contiguous DNA sequence- shotgun method. CO3. To get knowledge about mapping of genomes- Construction of genomic libraries, CO4. To get the knowledge about the scope of proteomics, Introduction to protein structure. CO5. To study about the tools for proteomics-protein separation techniques such as Gel filtration, SDS-PAGE etc. CO6. The overall course objective provides the advance knowledge of genomics and proteomics in the field of biotechnology.		
Nature of Paper: DSE-8b		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Preamble to Genomics: genomics and importance, Organization and Structure of genome, Unicellular and Multicellular genome, Model organisms and genome size. Evolution of genomes- Origin of gene families, Origin of macromolecules (DNA and RNA).	12
II	Significance of genomes- Bacteria, <i>Arabidopsis</i> , Yeast. The Human Genome Project, Structural genomics-Assembly of a contiguous DNA sequence- shotgun method, Whole genome sequencing, clone <i>contig</i> method.	12
III	Techniques- FISH and DNA fingerprinting. Mapping of genomes- Construction of genomic libraries, Physical maps, Genetic maps, Markers	10
IV	Proteomics: Introduction and scope of proteomics, Chemical properties of proteins, Physical interactions that determine the property of proteins, Introduction to protein structure. Capstone project on genomics and proteomics.	14
V	Introduction to Protein sequencing and Mass Spectrometry. Tools for proteomics-protein separation techniques- SDS-PAGE, Affinity	12

chromatography, Gel filtration, 2D electrophoresis, Ion exchange chromatography. Applications of proteomics.	
Reference / Text Books: 1. Principles of gene manipulation and genomics by S.B. Primrose and R.M. Twyman. Wiley India; 7th edition (2006) 2. Lewin's Genes XII by J.E. Krebs, E.S. Goldstein, S.T. Kilpatrick. Jones and Bartlett publishers; 12th edition (2017) 3. Discovering genomics, proteomics and bioinformatics by Campbell. Pearson Education India; 2nd edition (2007) 4. Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug by S. C. Rastogi N. Mendiratta and P. Rastogi. Prentice hall India learning private limited; 4th edition (2013) 5. Principles of Proteomics by R.M. Twyman Garland Science; 2nd edition (2013). 6. Gene Cloning and DNA Analysis by T.A. Brown. Blackwell Publishing, Oxford, U.K. 6th edition (2010).	
If the course is available as Generic Elective then the students of following departments may opt it.NO	
Evaluation/Assessment Methodology	
	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/ Assignment	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	
5) ESE	75
Total:	100
Prerequisites for the course: B.Sc. in Biotechnology/Microbiology/Life Science/ Thorough knowledge of Gene, protein, cell structure and function.	
Course Learning Outcomes: CLO1: Students will learn about Organization and Structure of genome. CLO2: Students will get knowledge about the assembly of a contiguous DNA sequence- shotgun method. CLO3: Students will able to understand about mapping of genomes- Construction of genomic libraries, CLO4: Students will learn the concept about the scope of proteomics, Introduction to protein structure. CLO5: Student will learn about the tools for proteomics-protein separation techniques such as Gel filtration, SDS-PAGE etc. CLO6: The overall course outcome provides the advance knowledge of genomics and proteomics in the field of biotechnology.	
Instructional Method and Pedagogy 1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course. 2. Various teaching aids are used for smooth conduction of Lectures. 3. 75% attendance in academic sessions is mandatory. 4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics. 5. PPT presentation method is also incorporated in teaching. 6. Case-study based learning will also be used. 7. Promotion of Ex-situ and In-situ learning. 8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc. 9. Identification of slow and fast learners also done during the course commencement.	

10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

MBTDSE-NP-123bP: GENOMICS & PROTEOMICS LAB

Marks: 50

Duration: 60 hours (2 credits)

1. Identify the genes present if any in the genomic sequence (web based)
2. To predict secondary structure of the protein sequences using bioinformatics tools.
3. Perform blast n program to find out similarity between two nucleotide sequences.
4. Perform blast p program to find out similarity between two protein sequences.
5. Analysis of Human Genome using web based bioinformatics tools.
6. Isolation of DNA from plant material.
7. To perform Agarose gel Electrophoresis.
8. Retrieving information from biomolecular databases.
9. Retrieving information from the NCBI with Entrez.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme:Biotechnology Certificate/Diploma/Degree/ PG Class: M.Sc. Biotechnology		Year: I Semester: II
Credits: 6 Theory: 4 Practical: 0	Subject: IPR, Patent, Trademarks &Bioethics	
Course Code: MBTGE- NP-124a	Title: IPR, Patent, Trademarks &Bioethics	
Course Objectives: CO1. This course meets the local to global requirements in terms of protection of intellectual property. The first objective of the course is to educate students about the IPR in India, trade secret, patent, copyright, variety protection and international patent laws. CO2. The second objective provides the information related with the Plant Breeder’s right, protection by PBR, farmers privilege and terminator and traitor technology. CO3. To aware students about the Risk assessment, biosafety levels, Biosafety of transgenic and genetically engineered products. CO4. To study the regulatory frame work in India governing GMOs, difference committees, food safety standard bill, National environmental policy and Cartagena protocol. CO5. To study the bioethical issues, public education of the process and ethical concerns of biotechnology research and innovation. CO6. The overall course content meets the industry requirement and provides the legislative framework to environment protection and also follows the policies and standards of RDAC, IBC, GEAC etc.		
Nature of Paper: GE-3a		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: P:0(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to IPR, IPR in India, trademarks, trades secret, patent,copyright,variety protection, international patent laws, roles of WIPO.	12
II	Plant Breeder’s right, UPOV,PPVFR act (2001) and patents, protection by PBR, breeder’s exemption, farmers privilege, farmer’s right, ICBD, terminator and traitor technology.	12
III	Biosafety – brief introduction, objectives, history, risk assessment (laboratory research, planned introduction, and biotechnological products), biosafety levels, Biosafety of transgenic, genetically engineered products.	12

IV	Regulatory frame work in India governing GMOs, difference committees (RDAC, IBC, GEAC, SBCC, DLC), recombinant DNA guidelines (1900), the food safety standard bill, National environmental policy, Cartagena protocol.	12
V	Bioethical issues- the legal and socioeconomics impacts of biotechnology- public education of the process of biotechnology involved in generation new forms of life for informed decision making - ethical concerns of biotechnology research and innovation.	12

Reference / Text Books:

1. Indian Patent Law and Practice, [Kalyan C. Kankanala](#), [Arun K. Narasani](#), [Vinita Radhakrishnan](#), Oxford University Press, 2010
2. Patent Law in India, [Medury Bhaskara Rao](#), [Manjula Guru](#), Kluwer Law International, 2010
3. Intellectual Property Laws (Acts, Rules & Regulations) (Latest Bare Act) Universal Law Publishing Co. , Edition : Latest Bare Act ,ISBN : 9788175349308,
4. PATENTS for Chemicals, Pharmaceuticals and Biotechnology - Fundamentals of Global Law, Practice and Strategy, Author : Philip W. Grubb & Peter R. Thomsen , 5th edition, 2010, Media : Hard Back, ISBN : 9780199575237,
5. Law Relating to Intellectual Property (in 3 Vols.)Author : Dr. Raghbir Singh (V-Chairman, Intellectual property Appellate Board), Edition : 3rd edition, 2014 , ISBN : 9789350354247,
6. Protection of Plant Varieties and Farmers' Rights Act, 2001 & Rules, 2003 & Regulations, 2006 (Latest Bare Act),Author : Private Publication, Edition : Latest Bare Act ,
7. Bioethics and Biosafety, Author : Prof. Ramamurthi Rallapalli & Prof. Geetha Bali, Edition : 2007, ISBN : 9788131302651
8. Bioethics and Biosafety, Author : M.K. Sateesh, Edition : 2008,Media : Paper Back ISBN : 9788190675703

If the course is available as Generic Elective then the students of following departments may opt it.

1. Department of Microbiology
2. Department of Zoology
3. Department of Botany
4. Department of basic Science

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/ Attendance	5
3) Assignments	4
4) Research Project Report Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: Graduation in Life Science

Course Learning Outcomes:

CLO1: Student will be aware IPR, trade secret, patent, copyright, variety protection and international patent laws.

CLO2: Student will study the Plant Breeder's right, farmer's privilege and terminator and traitor technology.

CLO3: Student will be aware Risk assessment, biosafety levels and Biosafety of transgenic and genetically engineered products.

CLO4: Student will study the regulatory frame work in India governing GMOs, food safety standard

bill, National environmental policy and Cartagena protocol.

CLO5: Student will study the bioethical issues, public education of the process and ethical concerns of biotechnology research.

CLO6: The overall course content outcome meets the industry requirement and provides the legislative framework to IPR protection and also follows the policies and standards of RDAC, IBC, GEAC etc.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme:Biotechnology		Year: I
Certificate/Diploma/Degree/PG		
Class:M.Sc. Biotechnology		Semester: II
Credits: 6	Subject: Bio-entrepreneurship Development	
Theory: 4		
Practical: 0		
Course Code: MBTGE- NP-124b	Title: Bio-entrepreneurship Development	
Course Objectives: The objective of this course emphasized to enhance the skills of students by converting their basic biotechnology knowledge into sustainable and eco-friendly business by providing new solutions to the existing challenges in the field. Also it aims to provide better alternatives to the existing approaches. The syllabus fulfills the requirement of SDG 8 and SDG 9. CO1. The course content aims to make the student understand about entrepreneur and entrepreneurship. CO2. To get the knowledge about developing a new skills in entrepreneurship field. CO3. To study the development of various new technological advancements as bio entrepreneur. CO4. To study about various lucrative fields of biotechnology CO5. To understand the working of technology incubators and startup firms. CO6. To understand and study about proposal writings, IPR and biostart-ups.		
Nature of Paper: GE- 3b		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 Theory - 1 Hr. = 1 Credit		
Unit	Contents	No. of Lectures Allotted
I	Introduction, Concept of Entrepreneur, Entrepreneurship and Enterprise, Definition of Entrepreneurship, Objectives of Entrepreneurship Development, Phases of Entrepreneurship Development, Role of Entrepreneurship, The Entrepreneurial Mindset, Characteristics of Entrepreneurship, Traits of Entrepreneurship, Introduction to Entrepreneurship Skills	12
II	Meaning and define of Entrepreneurship skill, Types of Entrepreneurship Skills: Business management skills, Teamwork and leadership skills, Communication and listening, Customer service skills, Financial skills, Analytical and problem-solving skills, Critical thinking skills, Strategic thinking and planning skills, Technical skill, Gender Equality and Women’s Empowerment, Eco entrepreneurship, Green Jobs	12
III	Bio economy, 3Rs and energy recovery in industrial waste management, Construction and demolition waste, implementation of waste recycling and treatment plants, functions of national bodies like DBT, DST, CPCB, BIRAC, BCIL, emerging biotechnology enterprise, Role of agencies assisting entrepreneurship: DICs, SSIs, NSICs, EDII, NIESBUD, NEDB,	12

	Entrepreneurship Development Institute (EDI)	
IV	Health preneurs, Molecular Diagnostics, Agri Biotech: Biocontrol agents, Bio fertilizers, Bioinformatics service solutions, Cell culture labs, Protein purification, Protein characterization, Drug discovery, Concept of sustainability in Bio-entrepreneurship development, Green entrepreneurship, Eco entrepreneurship, green employment	12
V	Technology Incubators and Start-Ups, Current statistics of Biotechnology start-ups in India, case study on technology Incubators and Biotech Start-Up Companies and case studies of Biotech companies, biotechnology product development, biotechnology market development, grant writing, proposal writing	12

Reference / Text Books:

1. Biotechnology Entrepreneurship: Leading, Managing, and Commercializing Innovative Technologies by Craig Shimasaki ISBN 978-0-12-815585-1 Copyright © 2020 Elsevier Inc. All rights reserved 2020.
2. Entrepreneurship: New Venture Creation : David H. Holt.
3. Patterns of Entrepreneurship : Jack M. Kaplan.
4. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.

If the course is available as Generic Elective then the students of following departments may opt it.
YES

1. Department of Microbiology
2. Department of Zoology
3. Department of Botany
4. Department of Basic Science
5. Department of food and Nutrition

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	
3) Assignments	5
4) Research Project Report	
Seminar On Research Project Report	4
5) ESE	75
Total:	100

Prerequisites for the course: This is an applied self-developing course, student must aware about all the basics of professional skill and communication and Biotechnology. It comprised of the applicability of Biotechnology in business field and start-ups.

Course Learning Outcomes:

- CLO1. Students will attain knowledge about entrepreneur and entrepreneurships.
CLO2. Students developed new skills in entrepreneurship field.
CLO3. Students will achieve knowledge about the development of various new technological advancements as bio entrepreneur.
CLO4. Students will gain knowledge about various lucrative fields of biotechnology
CLO5. Students become skilled at about the working of technology incubators and startup firms.
CLO6. Students will comprehend with the technical aspects of proposal writing, grant writing, research writing etc.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: III

Programme: Master of Science in Biotechnology Certificate/Diploma/Degree/PG Class: M.Sc. Biotechnology		Year: II Semester: III
Credits: 6 Theory: 4 Practical: 2	Subject: Bio-separation and downstream processing	
Course Code:MBTC-NP-231	Title: Bio-separation and downstream processing	
COURSE OBJECTIVES CO1. The key objective of this course is to impart the knowledge of the subject and skill them to operate bioreactor for production of various Bio-products and their cost effectiveness of the process for economic development. CO2. This course is formulated to teach about various removal and isolation process of insoluble. CO3. The course aims to provide knowledge of various purification and separation techniques to purify and separate biomolecules from various biological systems. CO4. To make proficient so that students learn and critically examine and opt best suitable purification strategy for the separation of the bioproducts. CO5. To learn about various analytical tools such as chromatography, centrifugation, extraction, and mass spectroscopy. CO6. To make proficient so that students choose the suitable downstream steps within the constraints of biosafety and process economics, also to aware students about various product polishing techniques to equip the students in terms of enhancement of their skill. .		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	INTRODUCTION TO BIOSEPARATION PROCESS: Role and importance of bioseparation in biotechnological processes: Problems and requirements of bioproducts purification - Properties of Biomolecules - Characteristics of fermentation broth - Biological activity, Analysis of purity-Process economics: Capital and operating cost analysis.	12
II	REMOVAL OF INSOLUBLES: Cell disruption methods for intracellular products: Physical, chemical and mechanical - Removal of insolubles: Biomass and particulate debris separation techniques - flocculation - Sedimentation - centrifugation and filtration methods.	12
III	ISOLATION OF PRODUCTS: Adsorption: Principles, isotherms,	12

	Extraction: Principle, Batch and continuous, Precipitation: Methods of precipitation, Filtration: Principle and methods, Membrane based separations: Micro and ultra-filtration, Centrifugation: Principle and methods	
IV	PURIFICATION OF BIOPRODUCTS: Basic principles of Chromatographic separations: ion- exchange, affinity, Electrophoretic separation techniques: capillary - isoelectric focusing-2D gel electrophoresis -Hybrid separation technologies: GC-MS and LC-MS.	12
V	PRODUCT POLISHING: Crystallization: Principles-Nucleation- Crystal Batch crystallizers: Scale-up and design, Drying: Principles-Water in biological solids, Drying equipments description and operation-Vacuum shelf - rotary dryer-Freezer dryer-Spray dryer, process integration and biosafety.	12

Reference / Text Books:

1. Raja Ghosh, "Principles of Bioseparations Engineering", World Scientific Publishing, 2006
2. Ladisch. M. R, "Bioseparation Engineering: Principles, Practice and Economics", John Wiley & sons, New York. 2001
3. Asenjo.J.M, "Separation processes in Biotechnology" Marcel Dekker Inc. 1993
4. Bailey & oils, Biochemical Engg. Fundamentals, McGraw-Hill 1990
5. Roger G. Harrison, Paul Todd, Scott R. Rudge, Demetri P. Petrides, "Bioseparation science and Engineering" Oxford University press. 2003
6. Sivasankar, B., "*Bioseparation: Principles and Techniques*", Prentice Hall India (2005).

If the course is available as Generic Elective then the students of following departments may opt it.
1.No

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	
4) Research Project Report Seminar On Research Project Report	4
5) ESE	75
Total:	100

Prerequisites for the course: Basic knowledge of microbiology, biochemistry, analytical tools in biotechnology, enzymes, and environment required.

Course learning outcome:

CLO1	Isolation, characterization for their composition, size and structure and purification biomolecules from different types of biological samples and cost analysis of integrated process.
CLO2	Removal of insoluble through technology.
CLO3	Isolation of bio products by means of various technology and process incorporation.
CLO4	To design, optimized and operate the making procedure, students will learn the ability to handle bioreactors to carry out different purification processes for taking out the bioproducts.
CLO5	The students will be skilled in choosing a correct integrated approach for bioproducts development.
CLO6	Students will able to design the significant equipment, estimate the production yield, and degree of purification also develop skill for product polishing for commercial purpose and skill enhancement.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

MBTC-NP-231P: BIO-SEPARATION AND DOWNSTREAM PROCESSING LAB

Marks: 50

Duration: 60 hours (2 credits)

OBJECTIVE:

1. To produce various bioproducts from cells and tissues.
2. To isolate the industrially important bioproducts.
3. To study various techniques for isolation and purification of bioproducts.
4. To develop understanding of bioseparation.
5. To develop understanding of downstream processing.

List of Experiments

1. Characteristics of Bioproducts: Flocculation and conditioning of broth
2. Partial purification and Production of primary metabolite in shake flask culture.
3. Production of pellets of Citric acid.
4. Membrane based separation
5. Disruption of microbial cells
6. Chromatography separation
7. Adsorption on the surface of biomaterial
8. Mechanical separation: Filtration and Centrifugation
9. Vacuum evaporation
10. Product crystallization and drying

COURSE OUTCOME:

Upon completion of this course students would be able to

CLO1: Understand and elucidate the principles of bio-separation involved in purification of bio-products.

CLO2: Practical hand holding on making Citric acid pellets.

CLO3: Understand how Chromatographic and electrophoresis methods used to analyze purity and yield of biomolecules.

CLO4: Analyze the adsorption process on the surface of matrix used.

CLO5: Understand the procedure of Filtration, Centrifugation and Vacuum evaporation

CLO6: Understand the procedure of Product crystallization and drying.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL			
Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: III

Programme: Master of Science in Biotechnology		Year: II
Certificate/Diploma/Degree/UG/PGPG		Semester: III
Class: M.Sc. Biotechnology		
Credits: 6		Subject: Environmental Biotechnology
Theory: 4		
Practical: 2		
Course Code: MBTC-NP-232		Title: Environmental Biotechnology
COURSE OBJECTIVES		
This course enables the students to:		
CO 1 To teach basics of environment and its challenges in terms of pollution due to various activities, also aware the sustainable development goals and Eco-green technology		
CO 2 develop understanding of different biological remediation technology with case studies also aware students about nature based solutions of different environmental issues.		
CO 3 convey information related with core engineering design of bioreactor/bio-digester for solid waste treatment using biological process.		
CO 4 develop designing and critical skills requisite to design and operate waste water treatment system and activated sludge treatment technology and sewage treatment plant to enhance student's key learning skills. (SDG 6).		
CO 5 aware students about waste to wealth technology in terms of treatment and waste to energy production technology (WTE) (SDG 7).		
CO 6 aware students about bioenergy and its production technology by various types of bioreactors.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4		
T:		
P:2(In Hours/Week)		
Theory - 1 Hr. = 1 Credit		
Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	UNIT I: Environmental Pollution, Environmental changes and strategies: Environmental pollution; global environmental change; drastic effects of existing technologies such as Incineration, Landfills, and improper waste management: Eco/green technologies for addressing the problems of pollution; Biopesticides; Biofertilizers. Different legislations and act, Work and profile of CPCB, Sustainable development goal, Climate resilient and adaptation framework, carbon mitigation and Ecological footprint, Carbon sequestration.	15
II	UNIT II: Bioremediation: Phytoremediation, microbial bioremediation, microbial desulphurization, biodegradation of xenobiotics, Bioremediation	13

	of heavy metals, use of GEMs, Enrichment of ores by microorganisms-bioaccumulation and wastewater and ground water characteristics, biomineralization. Advanced bioreactor configuration for environmental clean-up, Nature based solutions.	
III	UNIT III: Solid Waste Management: Bioconversion: Biodegradation and biodegradability of substrate; biochemistry and process parameters of bio methanation; biogas digester types; digester design and biogas utilization; economics of biogas plant with their environmental and social impacts; Vermicomposting, Bioenergy, biofuel,	10
IV	UNIT IV: Wastewater treatment: Composition of sewage, new approaches to sewage treatment, Types of sewage treatment plants: Attached and suspended growth processes: Activated Sludge Plant, Rotating biological contactors, Aerated lagoons, submerged aerated filters, Suspended media filters, Trickling filter process, Membrane bioreactor and anaerobic processes.	10
V	UNIT V: Energy from waste-thermo chemical conversion: Clean and green fuel, Sources of energy generation, incineration, pyrolysis, gasification of waste using gasifiers; strategies for reducing environmental impact: Biofuels: First, second, third and fourth generation of biofuels, Biodiesel production by microalgae, Bioethanol, Biodiesel and Biohydrogen production, algal bio refinery, Different Case studies: Photo bioreactor design and light conversion, Biodegradable Plastics production by microorganisms, Microbial fuel cell	12

Reference / Text Books:

1. Wastewater Engineering Metcalf & Fuddy, 3rd ed. 2013.
2. Essentials of Ecology & Environmental Science, S.V.S. Rana, Prentic Hall India, 2006.
3. Bionanotechnology towards Sustainable Management of Environmental Pollution by Naveen Dwivedi and Shubha Dwivedi, CRC Press 2022.
4. Environmental Biotechnology B.C. Bhattacharya & Ritu Banerjee, Oxford Press 2007.
5. Bionanotechnology towards Green Energy: Innovative and Sustainable Approach by Shubha Dwivedi and Naveen Dwivedi CRC Press 2023.
6. Naveen Dwivedi, Shubha Dwivedi and Maulin P Shah. "Integrated biotechnological solutions for the treatment of industrial wastewater for a healthy and sustainable environment" (Edited book- Publisher: Elsevier).
7. Charles Oluwaseun Adetunji, Julius Kola Oloke, Naveen Dwivedi, Sabeela Beevi Ummalyma, Shubha Dwivedi and Daniel Ingo Heff. "Next-Generation Algae, Volume 1: Applications in Agriculture, Food and Environment" (Publisher: Wiley–Scrivener, ISBN: 9781119857273, 2023).
8. Phytoremediation: novel approaches and sustainable solutions for environmental cleanup by Deepa Sharma and Shubha Dwivedi, Bluerose publishers, 2023. (ISBN: 978-93-5819-002-1)
9. Role of biotechnology for global strides in just transitions and innovation ecosystem by Shubha Dwivedi, Navneet Sharma and Deepa Sharma, Bluerose publishers, 2023. (ISBN: 978-93-5819-020-5)

If the course is available as Generic Elective then the students of following departments may opt it.

1.No

Evaluation/Assessment Methodology	
	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5

3) Assignments	4
4) Research Project Report Seminar On Research Project Report	75
5) ESE	100
Total:	100
Prerequisites for the course: B.Sc. Biotechnology/ Microbiology/Environmental Science/Life Science	
COURSE LEARNING OUTCOMES	
Ability to understand, connect-up and explain basics and advanced aspects of Environment Biotechnology in fulfilling of the sustainable development goal 6 and 7. The major attribute in terms of CLO of this course is to enhance the technicality and skill of the student.	
Course Outcome	Description
CLO1	To understand the global climate issues due to pollution enables students to learn about Eco-safe technological innovation.
CLO2	Enables students to learn with practical approach about various bioremediation procedures as potential solution of water treatment
CLO3	Enables students about the production procedure of biogas in reference to model development of biogas plant.
CLO4	Enables students to learn about various types of wastewater treatment technology using various types of reactor.
CLO5	Enable students about various wastes to energy conversion methods, biofuel production and hydrogen production.
CLO6	The overall outcome of the course enables students friendly with green biotechnology remedies for environmental issues and provides solutions in sustainable way.
Instructional Method and Pedagogy	
1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course. 2. Various teaching aids are used for smooth conduction of Lectures. 3. 75% attendance in academic sessions is mandatory. 4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics. 5. PPT presentation method is also incorporated in teaching. 6. Case-study based learning will also be used. 7. Promotion of Ex-situ and In-situ learning. 8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc. 9. Identification of slow and fast learners also done during the course commencement. 10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics. 11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.	
PRACTICALS	
MBTC-NP-232P: ENVIRONMENT BIOTECHNOLOGY LAB	
Course Objective: To impart practical understanding and hands on training in the field of water technology and environment.	
Marks: 50	Duration: 60 hours (2 credits)
1. Culturing of microorganisms with a potential of bioremediation 2. Biodegradation of hydrocarbons by microorganisms 3. Determination of dissolve oxygen in water. 4. To analyze and check of BOD (Biochemical Oxygen Demand) in waste water sample	

5. To analyze and check of COD (Chemical Oxygen Demand) in waste water sample
6. Examination of total hardness of given water sample.
7. Working model on production of biogas from organic waste.
8. Total solids determination in given water sample.
9. Alkalinity determination of given water sample.
10. To find out the acidity of water.
11. Proximate analysis of waste samples
12. Preparation of bioadsorbents and its proximate analysis

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: III

Programme: Biotechnology Certificate/Diploma/Degree/UG/PG Class: M.Sc. Biotechnology		Year: II Semester: III
Credits: 6 Theory: 4 Practical: 2	Subject: Recombinant DNA Technology	
Course Code: MBTDSE-NP-233a	Title: Recombinant DNA Technology\	
Course Objectives: CO1. To study the tools and techniques used in genetic engineering for modifications of organisms. CO2. To study the DNA and protein analysis methods, Polymerase Chain Reaction and its types. CO3. To study the markers, different types of molecular markers its application in forensic and disease prognosis. CO4. To study the molecular mapping of genome, Product of DNA technology and transgenic plants. CO5. To study the applications of genetic diseases-Detection and Diagnosis, Transgenic animals, Biosafety and Bioethics. CO6. The overall objective of the course to impart knowledge in development of genetically engineered biotherapeutics, vaccines and their manufacturing.		
Nature of Paper: DSE-9a		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Tools and Techniques in genetic engineering- Vectors in gene cloning- Phasmids, Cosmid, Plasmid, Phages, Advanced cloning vectors- PAC, BAC, YAC, DNA modifying enzymes and restriction enzymes for Genetic engineering, Transfection and Transformation, genomic DNA and cDNA library	12
II	Methods of DNA and protein analysis- Electrophoretic techniques, Northern, Western and Southern Blotting, Isolation and purification of DNA, Preparation of probes, SDS-PAGE, two-dimensional PAGE and Native PAGE analysis of proteins, DNA fingerprinting and its application. Polymerase Chain Reaction- Concept of PCR, Real Time PCR, Various kinds of PCR, Applications of PCR, Ligation Chain Reaction, RAPD fingerprinting.	12
III	Molecular markers in genome analysis- AFLP, RFLP, SSR, RAPD and SNP analysis (molecular markers linked to disease resistance genes), Application of molecular markers in forensic, disease prognosis, MALDI-TOF.	12

IV	Molecular mapping of genome -physical mapping and map-based cloning, Genetic and physical maps, choice of mapping population, transgenic plants, Product of DNA technology.	12
V	Applications -Transgenics and animal cloning: Creating transgenic animals and plants. Animal cloning, Biosafety and Bioethics, case study reported in cloning. Genetic diseases-Detection and Diagnosis, DNA fingerprinting, genetically engineered biotherapeutics, vaccines and their manufacturing, DNA marker technology in plants, Transgenic animals and Bio-pharming.	12

Reference / Text Books:

1. Biotechnology- Expanding Horizons by B.D. Singh (2014), Kalyani Publication
2. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
3. Clark DP and Pazdernik NJ. (2009). Biotechnology-Appling the Genetic Revolution. Elsevier Academic Press, USA.
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	4
4) Research Project Report	
Seminar On Research Project Report	-
5) ESE	75
Total:	100

Prerequisites for the course: Undergraduate in Life Science

Course Learning Outcomes:

- CLO1: Student will study different tools and techniques involved in genetic engineering for modifications of organisms.
- CLO2: Student will be aware the methods of DNA and protein analysis, PCR its types and applications.
- CLO3: Student will study various molecular markers its application in forensic and disease diagnosis.
- CLO4: Student will be aware the molecular mapping of genome, and transgenic plants and its applications.
- CLO5: Student will study the applications of genetic diseases detection and Diagnosis, Transgenic animals and Bioethics.
- CLO6: The overall outcome of the course to impart knowledge in development of genetically engineered bio therapeutics, vaccines and their manufacturing.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

PRACTICALS

MBTDSE-NP-233aP: RECOMBINANT DNA TECHNOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

1. Isolation of RNA by CTAB method.
2. Northern Blotting.
3. DNA Extraction by Spooling Method.
4. Isolation of *E.coli* Bacterial Genomic DNA.
5. Study of DNA sequencing methods.
6. Demonstration of genetic recombination in bacteria by conjugation.
7. Protein Isolation and separation by SDS PAGE.
8. DNA Fingerprinting using RAPD Technique.
9. Study about comparison of plasmid and bacteriophage cloning vectors.
10. Demonstration of production of transgenic and knockout mice.
11. Demonstration of Basic mechanism of cloning.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: III

Programme: Biotechnology Certificate/Diploma/Degree/PG Class: M.Sc. Biotechnology		Year: II Semester: III
Credits: 6 Theory: 4 Practical: 2	Subject: Animal Biotechnology	
Course Code: MBTDSE-NP-233b	Title: Animal Biotechnology	
Course Objectives: CO1. To study about brief history, mammalian cell products & sources of Animal Biotechnology. CO2. To study about animal culture, preservation and maintenance of cell lines, cryopreservation and transport of animal germplasm. CO3. To study about Organ culture, artificial skin, hybridoma technology. CO4. To get knowledge about transgenic animals, in-vitro fertilization and embryo transfer. CO5. To study about Gene Therapy and its types. CO6. To study about Animal biotechnology lab requirement and structuring.		
Nature of Paper: DSE-9b		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction, brief history, mammalian cell products & sources (use of animal cell culture for production), cell adhesion, cell proliferation, apoptosis, differentiation, de-differentiation, cell signaling, cell culturing in animal bioreactor, immobilized cell cultures.	13
II	Culture, preservation and maintenance of cell lines, cryopreservation and transport of animal germplasm, cell line banking, quantification (species verification, tests for microbial contamination etc.), gene cloning techniques for mammalian cells, stem cell culturing. Animal cell bioreactor.	12
III	Organ culture, artificial skin, hybridoma technology. Genetic modification in Medicine, human genetic engineering, brief concept of trioma & thymoma, micromanipulation of embryos.	10
IV	Transgenic animals, in-vitro fertilization and embryo transfer, molecular biological techniques for rapid diagnosis of genetic diseases. Biotechnology in disease diagnosis and disease treatment, organ transplantation.	13
V	Gene Therapy- types of gene therapy (ex-vivo and in-vivo) target for	12

	gene therapy, vector used in gene therapy, Animal biotechnology lab requirement and structuring.	
Reference / Text Books: 1. Textbook of Animal Biotechnology by B. Singh and S. K. Gautam. The Energy and Resources Institute, TERI (December 2013). 2. Animal Biotechnology by M.M. Ranga. Agrobios India, 3rd edition (January 2007) 3. Animal Biotechnology: Models in Discovery and Translation by A. Verma and A. Singh. Academic Press, 1st edition (December 2013) 4. Cell Therapy: cGMP Facilities and Manufacturing by Adrian P. Gee. Publisier- Springer US, 1st edition (November 2010). 5. The Cell: A Molecular Approach by Geoffrey M. Cooper, Robert E. Hausman. Sinauer Associates Inc; 7th edition (October 2015).		
Prerequisite: B.Sc. Degree in Biotechnology/ B.Sc. Degree in Life Science		
If the course is available as Generic Elective then the students of following departments may opt it. NO		
Evaluation/Assessment Methodology		
	Max. Marks	
1) Class tasks/ Sessional Examination		16
2) Presentations /Seminar/Attendance		5
3) Assignments		
4) Research Project Report		4
Seminar On Research Project Report		
5) ESE		75
Total:		100
Prerequisites for the course: Basic knowledge of cell biology		
Course Learning Outcomes: CLO1: Students will learn about brief history, mammalian cell products & sources of Animal Biotechnology. CLO2: Students will get knowledge about animal culture, preservation and maintenance of cell lines, cryopreservation and transport of animal germplasm. CLO3: Students will get the concept about Organ culture, artificial skin, hybridoma technology, brief concept of trioma&thymoma. CLO4: Student will learn about transgenic animals, in-vitro fertilization and embryo transfer. CLO5: Student will learn about Gene Therapy and its types.		
Instructional Method and Pedagogy 1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course. 2. Various teaching aids are used for smooth conduction of Lectures. 3. 75% attendance in academic sessions is mandatory. 4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics. 5. PPT presentation method is also incorporated in teaching. 6. Case-study based learning will also be used. 7. Promotion of Ex-situ and In-situ learning. 8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc. 9. Identification of slow and fast learners also done during the course commencement. 10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics. 11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are		

incorporated.

PRACTICALS
MBTDSE-NP-233b: ANIMAL BIOTECHNOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

Course Objective:

1. Packing and sterilization of glass & plastic wares for cell culture.
2. Preparation of reagents & media for cell culture.
3. Sources of contamination and decontamination measures
4. Preparation of tissue culture medium & membrane filtration.
5. Preparation of Minimal Essential Growth medium
6. Isolation of genomic DNA from blood sample.
7. Purification and quantification of isolated DNA sample.
8. Maintenance of animal cell culture laboratory.

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL

Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: III

Programme: Biotechnology Certificate/Diploma/Degree/PG Class: M.Sc. Biotechnology		Year: II Semester: III
Credits: 4 Theory: 4 Practical: 0	Subject: Nano biotechnology	
Course Code: MBTGE- NP-234a	Title: Nano biotechnology	
Course Objectives: CO1. To study definitions and principles relevant regarding the introduction, history, and applications of nano-biotechnology. CO2. To understand about Formation of regularly arranged Nano-particles and also to impart knowledge related with bio nanomaterials. CO3. To discover more about Microbial Nanoparticle Production. CO4. For comprehension about DNA-Protein Nanostructures and various technologies associated with Nano biotechnology. CO5. To impart knowledge of Nano biotechnology in various advanced the biotechnology sector. CO6. The course's fundamental objective is to create Nano biotechnology as potential tools in providing advance applications towards environmental solutions.		
Nature of Paper: GE-4A		
Minimum Passing Marks/Credits:40% Marks / 4 Credits		
L:4 T:0 P:2(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	UNIT I: Introduction to Nanoscience and Nanotechnology/nano biotechnology: Basic idea of quantum mechanics, History of Nanotechnology, Nanoscience in nature, Nano biotechnology and Bio nano technology, history of nano biotechnology, Biological production of metal nano particles/ nano materials, macro molecular assemblies and nanocomposites.	12
II	UNIT II: Biomolecules as Nanomaterials: Artificial, Natural and Bio nano materials, DNA, RNA, lipids and carbohydrates as Nanomaterials, Nano bio motors, Nano bio machines and Biocompatible artificial nano material, Environmental issues and energy sectors.	12
III	UNIT III: Synthesis of Nanomaterials: Top down method, Bottom up method, Chemical Vapor Deposition (CVD) technique, Lithography, Green chemistry technique of nanoparticles synthesis, Use of synthetic nanomaterials and nanoparticles, Different types of nanostructure- Quantum dot, nano wire, Carbon nanotubes (CNT)	12
IV	UNIT IV: Techniques used in Nanotechnology: Nanostructure imaging	12

	techniques- FTIR, SEM, TEM, AFM, X-ray diffraction, Fabrication of nanomaterials, Surface modification techniques	
V	UNIT V: Application of Bio nano technology: Preparation of nano drug, liposome as drug vesicle, General idea of drug delivery, Bio nano technology in diagnostics, Cancer targeting, Biosensors, use of nanoparticles in renewable energy production, conversion of waste into nanomaterial and its use in bioenergy production.	12

Reference / Text Books:

1. Nano bio technology: Concepts, Applications and Perspectives, Christ of M. Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley Publishers, April 2004.
2. Nanotechnology: A Gentle Introduction to Next Big Idea, Mark Ratner and Daniel Ratner, Low Price edition, Third Impression, Pearson Education
3. Bio nano technology towards Sustainable Management of Environmental Pollution by Naveen Dwivedi and Shubha Dwivedi, CRC Press 2022.
4. Nano technology, William Illsey Atkinson, JAICO Publishing House, Second Impression-2008.
5. Bio nano technology towards Green Energy: Innovative and Sustainable Approach by Shubha Dwivedi and Naveen Dwivedi CRC Press 2023.
6. Bio molecular computation for Bio nanotechnology, Liu and Shimohara, Artech House-London, 2007
7. T Pradeep, NANO: The Essentials: Understanding Nanoscience and Nanotechnology, 1 edition, McGraw Hill Education.
8. Thomas Varghese & K.M. Balakrishna (2012), Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials, Atlantic Publication.
9. Jon Cooper and Tony Cass, Biosensors II edition, Oxford Publication.
10. Mansi Karkare (2004), Nanotechnology, I.K International Publication.

If the course is available as Generic Elective then the students of following departments may opt it.

1. Basic Science
2. B.Tech. Civil Engineering
3. Department of Microbiology
4. Department of Botany

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/ Attendance	
3) Assignments	5
4) Research Project Report Seminar On Research Project Report	4
5) ESE	75
Total:	100

Prerequisites for the course: Graduation in biotechnology/Nano science

Course Learning Outcomes:

At the end of the course the student will be:

CLO1: Gain a fundamental understanding of nano-biotechnology's principles and applications in the life sciences.

CLO2: Assess how diverse nano bio technology theories and methods can be applied to advance and innovate biotechnology.

CLO3: Take into account how biomolecules interact with surfaces made up of various chemical and physical species.

CLO4: Take into consideration the creation and uses of diverse nano-structured material kinds.
CLO5: The basic outcome of the course is to create Nano bio technology as potential tools in providing advance applications.
CLO6: The course's overall outcome is to create Nano bio technology as advance field of research in providing advance applications towards environmental solutions.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: III

Programme: Biotechnology Certificate/Diploma/Degree/PG Class: M.Sc. Biotechnology		Year: II Semester: III
Credits: 4 Theory: 4 Practical: 0		Subject: Bioenergetics and Metabolomics
Course Code: MBTGE- NP-234b		Title: Bioenergetics and Metabolomics
Course Objectives: CO1. To study the Concept of Free and standard energy; Relationship between change in standard free-energy. CO2. To study about Biological oxidation: Oxidation & reduction; Oxidation-reduction and Nernst equation. CO3. To get the knowledge about Mitochondrial Electron Transport Chain and Oxidative Phosphorylation. CO4. To study about Metabolites and metabolite profiling, Metabolomics - applications and its role in systems biology. CO5. To impart knowledge related with targeted and untargeted metabolomics and its application in advance research. CO6. To study Software tools available for metabolomics analysis.		
Nature of Paper: GE-4b		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T: P:0(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Bioenergetics: Concept of Free and standard energy; Relationship between change in standard free-energy and equilibrium constant; Coupled reactions; High-energy compounds.	12
II	Biological oxidation: Oxidation & reduction; Oxidation-reduction half reactions; Nernst equation, measurement of standard reduction potentials; Calculation of reduction potentials; Enzymes involved in oxidation and reduction (oxidases, dehydrogenases, hydro peroxidases and oxygenases).	12
III	Mitochondrial Electron Transport Chain and Oxidative Phosphorylation: Mitochondrial Transport Systems; Nature, order and organization of the components of electron transport chain; electron flow from NADH and FADH2 to O2, sites of ATP production; inhibitors of electron transport chain	12
IV	Coupling between oxidation and phosphorylation; Chemiosmotic hypothesis of oxidative phosphorylation; Mechanism of ATP synthesis,	12

	Control of oxidative phosphorylation. Metabolites and metabolite profiling, Metabolomics - applications and its role in systems biology with case studies.	
V	Targeted and untargeted metabolomics, General work flow including quenching and sample preparation, Detection and quantification of metabolites by advanced analytical techniques (NMR/Mass spectroscopy, HPLC). Pathway and metabolome databases. Software tools available for metabolomics analysis.	12

Reference / Text Books:

1. Metabolomics: From Fundamentals to Clinical Applications (Advances in Experimental Medicine and Biology, 965) 1st ed. 2017 Edition.
2. Bioenergetics by Garby, Lars; Larsen, Poul S.
3. The handbook of Metabolomics by John, Jeremy, Nicholson and E.Holmes, 2007.

If the course is available as Generic Elective then the students of following departments may optit.

1. Basic Science
2. Department of Biochemistry
3. Department of Nutrition
4. Department of Nursing
5. Department of Food Science

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/Attendance	5
3) Assignments	
4) Research Project Report	4
Seminar On Research Project Report	-
5) ESE	75
Total:	100

Prerequisites for the course: Graduation in Biotechnology/Biochemistry

Course Learning Outcomes:

CLO1: Students will learn about the Concept of Free and standard energy; Relationship between change in standard free-energy.

CLO2: Students will get knowledge about Biological oxidation: Oxidation & reduction; Oxidation-reduction and Nernst equation.

CLO3: Students will learn about Mitochondrial Electron Transport Chain and Oxidative Phosphorylation.

CLO4: Students will study about Metabolites and metabolite profiling, Metabolomics - applications and its role in systems biology.

CLO5: Student will come up with the knowledge related with targeted and untargeted metabolomics and its application in advance research.

CLO 6: Students will able to do analysis of metabolomics by using Software tools.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.
9. Identification of slow and fast learners also done during the course commencement.
10. For Slow learners, there is a provision of arrangements of extra classes/weakened classes/remedial classes for their improvement in academics.
11. For fast learner students, extra exposure to field visit, guest lectures on advanced topics are incorporated.

School of Life Science & Technology

ACADEMIC HAND BOOK



**ORDINANCE & ACADEMIC
REGULATIONS
MASTER OF SCIENCE (ZOOLOGY)**

1. Preamble:

Zoology is a major subject which deals with all aspects of animal science. The advancements in biological Science's needs, a zoology student to be a master of many areas in the subject. The Postgraduate degree program of M. Sc. (Zoology) comprises of four semesters. It is useful for those biology students interested in higher education (academic), research and scientific filed. The course is especially designed for job oriented and self-employment purpose because of having skill development & specialization papers. The syllabus covers almost all the advance knowledge along with basic knowledge.

2. Definitions and Nomenclatures:

In these Regulations, unless the context otherwise requires:

1. "Programme" refers Degree Programme like. M.Sc. Zoology
2. "Course" refers a theory or practical subject that is studied in a semester.
3. "Vice – Chancellor of IIMT - University" is the Head of the University.
4. "Registrar" is the Head of all Academic and General Administration of the University.
5. "Dean" indicates the authority of the school who is responsible for all academic activities of various programmes and implementation of relevant rules of these Regulations pertaining to the Academic Programmes.
6. "Controller of Examinations" is the authority of the University who is responsible for all activities related to the University Examinations, publication of results, award of grade sheets and degrees.
7. "Dean – Student Welfare" is responsible for all student related activities including student discipline, extra and co-curricular activities, attendance and meetings with class representatives, Student Council, and parent – teacher meet.
8. "HoD" refers the Head of the Department concerned.
9. "University" refers IIMT - University, Meerut.
10. "TCH" is Total Contact Hours – refers to the teaching – learning periods.
11. "DEC" refers Department Exam Committee.
12. "BOS" is Board of Studies.
13. "ACM" refers Academic Council meeting the highest authoritative body for approval for all Academic Policies.
14. "Class Co - ordinator" is a faculty of the class who takes care of the attendance, academic performance, and the general conduct of the students of that class.
15. "IA" is Internal Assessment which is assessed for every student for every course during the semester.
16. "ESE" is End Semester Examination conducted by the University at the End of the Semester for all the courses of that semester.
17. "UGC" means University Grants Commission.
18. "MHRD" is Ministry of Human Resource Development, Govt. of India.
19. "HEI" is Higher Education Institutions.
20. "AICTE" is All India Council of Technical Education.

3. Vision and mission of the School:

Vision: To become the finest institution and to create social, economic and intellectual well-being of the students through discovery, learning and innovations.

Mission: To fulfill the educational needs of students through imparting value based knowledge and innovative skills in an unbiased manner to meet greater challenges involving food, farming, fiber, feed, families, health, energy water and environment.

Vision and mission of the Department:

Vision: *To Impart sound knowledge of animal world and promotes discovery and learning at all levels of biological organization.*

Mission: The mission of the Zoology Department is to impart knowledge and innovative skills in Zoological Science and to develop the attitude of the students to concentrate on teaching and research aspects.

4. Program Educational objectives:

- Expertise the student to analyze problems, formulates a hypothesis, evaluate and validate results, and produce conclusions.
- To develop problem solving skills and creativity through assignments, seminars and research project work
- Prepare students for pursuing research or careers in fisheries, Entomology toxicology and applied fields
- Prepare students for teaching jobs in Schools, Colleges and Universities.

5. Program outcome:

PO-1: Apply the understanding of the numerous fields of zoology intended for graduate-level and post graduate-level courses and higher education.

PO-2: Describe basic concepts of zoology at molecular, cellular level, anatomy, physiology and reproduction at individual level.

PO-3: Learn the role of biosystematics in animal studies and acquire knowledge of animals including non-chordates and chordates.

PO-4: Learn the importance of biodiversity, ecological factors, conservation of environment and pollution control.

PO-5: Understand various applied fields of zoology like prawn culture, apiculture, sericulture, lac culture, vermi culture, fisheries, poultry, dairy farms etc.

PO-6: Expertise in handling various laboratory equipment and accomplish the laboratory experiments.

PO-7: Students will get in-depth understanding of zoology through seminar presentations, project work, field visits and the combination of theoretical knowledge and practical skills.

6. Program Specific outcome:

Program Specific outcome (M. Sc. Zoology Ist year):

PSO-1: Students get familiarized about the variety of animal species, their habitats, life cycle, and evolutionary processes.

PSO-2: Students learnt about the external features, anatomy, physiological process, development, and reproductive process of animals.

PSO-3: Students learnt about molecular biology and cytogenetics with special reference to heredity and its importance in human health.

PSO-4: Student gain knowledge about the infections and illnesses that harm the animals.

PSO-5: Understand biodiversity, conservation processes and its significance and causes of environmental pollution can help students for maintaining ecological balance.

Program Specific outcome (M. Sc. Zoology IInd year):

PSO-1: Understand recent concepts in fisheries science and endangered species management.

PSO-2: Learnt the general classification of fishes, economically important fishes and fishery products.

PSO-3: Students gained knowledge of zoological science for its application in apiculture, sericulture, aquaculture, agriculture and modern medicine.

PSO-4: Students gained practical knowledge of handling the animals and using them as model organism

PSO-5: Students understand high standards of learning in animal sciences

7. Admission:

The number of seats shall be in accordance with the directives by the university. The admission to the course will be on the basis of the merit and according to the guidelines from the university and Government of Uttar Pradesh. After the term-end examination at the end of each semester, the student will be provisionally admitted to the next semester. Each semester will be followed by a break not exceeding 15 days.

8. Eligibility in all year as NEP (entry & exit) as per NEHQF and NSQF (if applicable)

A Candidate who after having secured the B.Sc. degree with at least 40% Marks from a recognized University with a B.Sc. (ZBC)/B.Sc (Hons.) in Zoology/subjects of Life Science, shall be eligible for admission to the course.

9. Curriculum:

For the purpose of awarding degrees, the curriculum for M.Sc (ZOOLOGY) program is structured to have a minimum of credits as specified in the evaluation scheme approved by the university's Board of Studies and spread out across four semesters of study.

Under CBCS, the degree program will consist of the following categories of courses:

1. Core Course
2. Skill Enchantment Course – SEC

3. Generic Elective Course – GEC
 4. Discipline Specific Elective – DSE
 5. Ability Enhancement Compulsory Courses – AECC
- 10. Medium of Instruction:**
The medium of instruction is ENGLISH for examinations, seminar presentations and project reports.
- 11. Choice base Credit system (CBCS)/LOCF/OBE:**
The Course curriculum would be as per CBCS and NEP 2020.
The course of study shall contain the subjects of applied sciences and Skill Enhancement. The marks shall be awarded to the candidates pursuing the programme for the written papers, mini/major project report/industrial visits/presentation/viva-voce examinations, if any as specified in the scheme of Examinations. The student shall make the choice of course in consultation with the Class Coordinator and as stipulated from time to time.
- 12. Registration for course in a semester:**
In the beginning of the semester the candidate will choose the subjects of his choice and will register for the current semester within the three days of commencement of the semester.
- 13. Attendance:**
The faculty handling a course must finalize the attendance, 3 calendar days before the last instructional day of the course and submit to the HoD through the class teacher. A regular student shall not be permitted to appear in semester examination, unless he/she has regularly attended not less than 75% classes held in aggregate of all subjects. The university however may, condone the short age in attendance upto 10% in each subject for any of the following reasons.
- 13.1 Condonation of medical cases**
For medical cases, submission of complete medical history and records with prior information from the parent / guardian to Dean (Students Welfare) is mandatory. The assessment of such cases will be done by the attendance sub – committee on the merit of the case and put-up recommendations to the Vice-Chancellor. Such condonation is permitted only twice for a student in the entire duration of the program.
- The Vice-Chancellor, based on the recommendation of the attendance sub - committee may then give condonation of attendance, only if the Vice-Chancellor deems it fit and deserving. But in any case, the condonation cannot exceed 10%.
- 13.2 Additional Condonation:**
Additional condonation may be considered in rare and genuine cases which includes, approved leave for attending select NCC / Sports Camps, cases requiring prolonged medical treatment and critical illness involving hospitalization. For such select NCC/Sports Camps prior permission for leave shall be obtained by the respective faculty coordinator / Director of sports from the designated authority, before reporting the students.
- 14. Assessment procedure:**

Each Core paper shall be of 100 marks, out of which internal and external assessments will carry 25 marks and 75 marks respectively. While the Skill enhancement and Ability Enhancement Courses will be of 50marks, out of which internal and external assessments will carry 15 marks and 35 marks for Ability Enhancement courses and Skill Enhancement Courses will carry only internal assessment based on the certificates and credits. University Social Responsibility Courses are merely qualifying courses. However, the awarded marks will not be included in the grand total.

14.1 Internal Assessment (IA) & External Assessment (EA):

The Internal Assessment marks awarded to the students should be forwarded to the Controller of Examinations at least one week before the commencement of the semester examination. The internal assessment marks shall be based on factors such marks secured in Sessional examinations, submission of written assignments, classroom participation and attendance. The weightage given to each of these factors for a paper shall be decided and announced at the beginning of the semester.

ASSESSMENT:

INTERNAL AND EXTERNAL ASSESSMENT FOR THEORY			
Internal Assessment	Marks	External Assessment	Marks
Sessional	16	End Semester Final Examination	75
Assignment	5	-	-
Attendance	4	-	-
Total	25		75

14.2 Practical Assessment

Internal Assessment (IA) and External Assessment (EA) are of 20 and 30 marks respectively. External Assessment will be done by the External Examiner appointed by the University outside of the university while Internal Assessment of 20 marks will be based on the laboratory work, Lab attendance, Viva Voce and lab behavior etc.

15. Field Visit/Survey/Research Project Assessment Criteria:

Students will have to do a Field Visit/Survey/research project during IV semester. Only Internal assessment of 25% and External assessment of 75% will be done. The project can be under the guidance of any external faculty too. (Outside the University) with the prior permission of the Dean of the said school.

For the assessment of the project, student has to deliver a presentation regarding his work and give Viva voce in front of the external examiner appointed by the University. The student shall submit the project report (4 copies) in the format prescribed by the University.

16. Internship – Research / Industrial Internship:

A student may do an internship during summer and winter break.

17. For non – credit courses / audit courses:

The University has provided USR course and sports as non-credit /audit course.

18. Credit weightage:

Credits are the weightages, assigned to the courses based on the following general pattern:

For theory One Hour= 1 Credit
For Practical Two Hour= 1 Credit

19. Maximum duration of programme/promotion policy:

A student may complete the program at a slower pace than the regular pace, but in any case, in not more than N+2 years. A student completing the degree programs in the extended period will not be eligible for university ranking.

20. Maximum gaps between semester/year:

A student maybe permitted by the Vice Chancellor to withdraw from the entire program for maximum of two semester for reason of ill health, start-up venture or other valid reason as recommended by the committee consisting of Head of the Department, Dean of the School and Dean student's Welfare.

21. Credit system & grading CGPA/SGPA:

IIMT-University implemented the UGC guidelines to all Universities in 2015 for implementation of the choice-based credit system with a view to offer student's choice of courses within a program with a flexibility to complete the program by earning credits at a pace decided by the students themselves. The system allowed students to choose inter-disciplinary, intra-disciplinary courses according to their learning needs, interest and aptitude. It was considered as a cafeteria approach and was expected to provide mobility to students.

As per the Current credit system practiced in institutions needs comprehensive reforms as they offer very little flexibility, choice and are less learner centric. Degrees offered today are more self-contained focusing on a specialization area and depend a lot on knowledge available with the faculty from the department only. Though the most requisite credit system does exist, wherein students are given a wide choice and flexibility, these exist as small islands in the vast ocean of thousands of educational institutes in India. In such institutions, the curriculum is frequently designed which is learner centric and offering a wide specialization area for students to pick and choose courses from. The institutions shall make attempts wherein the design of the credit system and the teaching and evaluation modes shall be the responsibility of individual course teachers. The students should have the freedom to opt for courses from other specializations and not just from their core specialization. For this there has to be stronger collaborations between departments of the University and outside.

CGPA/ SGPA/ Grading will be done by the COE of the University.

22. Class / division:

The list of successful candidates after the four semesters examination of Master of Science (ZOOLOGY) course shall be arranged in as under in two divisions on the basis of the aggregate marks obtained in all semester examinations taken together, and the division obtained by the candidate will be state in his degree.

- First division those who obtain 60% or more of the aggregate marks.
- Second division who obtained 50% or more but less than 60% of the aggregate marks
- Those who passed all semester examinations in the first attempt obtaining 75% or more marks in the aggregate shall be declared to have passed with **DISTINCTION**.

- Each successful candidate shall receive a copy of detailed marks card on having passed the semester Examination

23. Transfer of credit /Academic:

- 23.1.** Within the broad framework of these regulations, the Academic Council, based on the recommendation of the Credit Transfer Committee so constituted may permit students to transfer part of the credit earned in other approved Universities of repute & status in the India or abroad.
- 23.2.** The Academic Council may also approve admission of students who have completed a portion of course work in another approved Institute of repute under Multiple entry & Exit system, based on the recommendation of the credit transfer committee on a case - to-case basis.
- 23.3.** Students who have completed coursework, at least first year, at some university other than the university to which transfer is sought (may request for transfer of admission to this university. A student may be granted admission only through an admission process that will follow the same policy as for fresh admissions. However, a uniform credit system must be followed by all universities to effect transfer of credits.
- 23.4.** Credit Transfer request can be submitted only after the student has been admitted in the concerned program and the following conditions are met:
- i. The course work has been completed at a UGC approved and accredited University through fulltime form all earning mode.
 - ii. The university accreditation grade/ranking is not lower than that of the university to which the transfer is sought.
 - iii. He courses prescribe to the common minimum syllabus under UGCCBCS system.
 - iv. The letter grade obtained in the courses is “B” or better.
 - v. The number of credits to be transferred does not exceed the prescribed limit.
 - vi. The program in question must have a similar credit system, in particular, modular or semester and the same numeric and letter grading system along with common meaning of the term “credit” in numerical terms.

The aspect of shelf life of courses needs to be considered while accepting credits as obsolescence of knowledge of certain field in terms of its current relevance needs to be investigated. The time lapsed between successful completion of certain courses of the program and the admission to which program transfer is sought needs to be considered.

The maximum number of credit points that may be considered under a credit transfer needs to be specified. Contextual variables such as teaching-learning approach adopted, learning facilities offered, use of evaluation modes may also be considered while preparing the credit

transfer policy.

24. Change of discipline:

Within 15 Days of the commencement of the classes if seats are available and eligibility matches.

25. Use of technological intervention:

With the prolife ration of different types of access devices, especially mobile access devices, technology has the potential to augment traditional classroom practices and revolutionize learning and evaluation methods. Technology, in fact can be an important driver to enable lifelong learning. Learning and engagement of students is facilitated by use of technology through several modes such as synchronous learning, semi-synchronous learning, blended learning, collaborative learning, flipped classroom etc. MOOC's, especially provided through SWAYAM, are a window of opportunity for lifelong learning and are offered through technology-based plat forms. Learning management systems (LMS) may be used by institutions to integrate the entire teaching, learning and evaluation process.

For a typical examination department of an institution will be an autonomous body right from registration of student to convocation through an integrated system. In fact, steps must be taken to implement a complete examination management system that considers the complete life cycle of examination process. The use of technology will reduce dependency on human intervention and be error free. The following functions will be automated:

- i. Registration of students and generating unique PRN,
- ii. Filling up of examination form,
- iii. Generation of seat numbers and admit cards/hall tickets,
- iv. Preparation of list of papers better,
- v. Use of question bank system to draw question sets, question paper generation,
- vi. Online distribution of question papers on the day of examination with system of encryption,
- vii. Bar code system for answer books (this will eliminate issues related to errors, avoid malpractices etc.),
- viii. Digitization of answers cripts and on screen evaluation of answer sheets,
- ix. Tracking of student's performance,
- x. Marks submission through online software,
- xi. Viewing of result through online system,
- xii. Online verification and revaluation system,

- xiii. Digitization of certificates and mark sheets (to avoid tampering and easy retrieval),
 - xiv. Certificate authentication system,
 - xv. Submission of various other applications through online system.
The above will lead to conduct of functions of the examination system in an efficient and transparent manner and timely availability of information to students.
- 26. Student Discipline:**
Every student is required to observe utmost discipline and decorum both inside and outside the campus and not to indulge in any activity which may affect adversely the prestige reputation of the University.
- 27. Student Welfare:**
Any act of indiscipline of a student reported to the Dean (Students Welfare) and Head of the Department will be referred to a Discipline Committee constituted for the purpose. The Committee will enquire into the charges and decide on a suitable punishment if the charges are substantiated. The committee will also authorize the Dean (Students Welfare) to recommend to the Vice-Chancellor for the implementation of the decision. The student concerned may appeal to the Vice-Chancellor, whose decision will be the final.
- 28. Ragging:**
Ragging in any form is a criminal and non-bailable offence in our country. The current State and Central legislations provide stringent punishments including imprisonment. Once the involvement of a student(s) is established in ragging, offending fellow students/staff, harassment of any nature to the fellow students/staff etc. the student(s) will be liable to be dismissed from the University, as per the laid down procedures of the UGC / Govt. / Institute. Every senior student at the University, along with their parent, shall give an undertaking every year in this regard and the same should be submitted at the time of Registration.
- 28. Power of modify :**
Notwithstanding all that has been stated above, the Academic Council is vested with powers to modify any or all the above regulations from time to time, if required, subject to the approval by the board of Studies and Final approval by Vice-Chancellor.
- 30. Exit point:** Not applicable for post graduate courses.
- 31. NC/Non Credit Course:** USR (University Social Responsibility) and Sports

EVALUATION SCHEME

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME
M.Sc. ZOOLOGY I YEAR, Ist Semester
(2024-2025)

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 1	MSZC-NP-111	Biosystematics, Taxonomy & Evolution	4	0	0	4	25	75	100
2	Core 2	MSZC-NP-112	Structure and Functions of Invertebrates	4	0	0	4	25	75	100
3	DSE 1	MSZDSE-NPR-113a	Cell Biology	4	0	0	4	25	75	100
		MSZDSE-NPN-113b	Natural Resources & Sustainable Development							
4.	AECC 5	NHU-N-111	English Communication	3	0	0	3	15	35	50
5.	Gen E	GENCC-701	NCC	2			2			
6	USEC	NECC-472	University Social Responsibility				0	25	0	NC
7	VAC-1	VAC-001	Indian Ethos and Modern Management	2	0	0	2	20	30	50
PRACTICALS										
1.	Core 1	MSZC-NP-111P	Biosystematics, Taxonomy & Evolution Lab	0	0	2	2	20	30	50
2.	Core 2	MSZC-NP-112P	Structure and Function of Invertebrates Lab	0	0	2	2	20	30	50
3.	DSE 1	MSZDSE-NPR-113aP	Cell Biology Lab	0	0	2	2	20	30	50
		MSZDSE-NPN-113bP	Natural Resources & Sustainable Development Lab							
			TOTAL					170	380	550

23 (Excluding NCC)

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME
M.Sc. ZOOLOGY I YEAR, II Semester
(2024-2025)

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 3	MSZC-NP-121	Structure and Functions of Vertebrates	4	0	0	4	25	75	100
2	Core 4	MSZC-NP-122	Molecular Biology	4	0	0	4	25	75	100
3	DSE 2	MSZDSE-NPR-123a	Environmental Science and Wildlife Management	4	0	0	4	25	75	100
		MSZDSE-NPR-123b	Biochemistry and Instrumentation Techniques							
4.	GE 1	MSZGE- NP-124a	Intellectual Property Rights	4	0	0	4	25	75	100
		MSZGE- NPN-124b	Immunology							
5.	GENE	GENCC-801	NCC	2			2			
6.	AECC-2		Research publication Ethics	3	0	0	3	15	35	50
7	USEC	NECC-482	University Social Responsibility				0	25	0	NC
8	SEC 1 (2 Cr.)	NECC-484	MOOCs/ NPTEL	2	0	0	2	50		50
PRACTICALS										
1.	Core 3	MSZC-NP-121P	Structure and Function of Vertebrates Lab	0	0	2	2	20	30	50
2.	Core 4	MSZC-NP-122P	Molecular Biology Lab	0	0	2	2	20	30	50
3.	DSE 2	MSZDSE-NPR-123aP	Environmental Science and Wildlife Management Lab	0	0	2	2	20	30	50
		MSZDSE-NPR-123bP	Biochemistry and Instrumentation Lab							
			TOTAL					225	425	650

27 (Excluding NCC)

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME
M.Sc. ZOOLOGY II YEAR, III Semester
(2023-2024)

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 5	MSZC-NP-231	Animal Physiology	4	0	0	4	25	75	100
2	Core 6	MSZC-NP-232	Animal Behavior	4	0	0	4	25	75	100
3	DSE 3	MSZDSE-NP-233a	Fish Biology	4	0	0	4	25	75	100
		MSZDSE-NP-233b	Entomology							
4.	GE 2	MSZGE-NP-234a	Biostatistics and Bioinformatics	4	0	0	4	25	75	100
		MBTDSE-NP-233a	Recombinant DNA Technology							
5.	Gen E	GENCC-901	NCC	2			2			
6.	USEC	NECC-592	University Social Responsibility				0	25	0	NC
PRACTICALS										
1.	Core 5	MSZC-NP-231P	Animal Physiology Lab	0	0	2	2	20	30	50
2.	Core 6	MSZC-NP-232P	Animal Behavior Lab	0	0	2	2	20	30	50
3.	DSE 3	MSZDSE-NP-233aP	Fish Biology Lab	0	0	2	2	20	30	50
		MSZDSE-NP-233bP	Entomology Lab							
			TOTAL					160	390	600
4.	USEC	SPT-591	Sports	0	0	0	0	50	0	NC

22 (24 including NCC)

IIMT UNIVERSITY, MEERUT
STUDY & EVALUATION SCHEME
M.Sc. ZOOLOGY II YEAR, IV Semester
(2023-2024)

S.No.	Course Type	Course Code	Subject	Study Scheme			Credit	Evaluation Scheme		
				L	T	P		Internal	External	Total
1	Core 7	MSZC-NP-241F	Fish Physiology	4	0	0	4	25	75	100
2	Core 8	MSZC-NP-242F	Fish Culture and Fisheries Science	4	0	0	4	25	75	100
3	DSE 4	MSZDSE-NP-243aF	Applied Fisheries	4	0	0	4	25	75	100
		MSZDSE-NP-243bF	Fish Pathology and Microbiology							
4.	Industrial Training/ Research Project	MSZ-RP-241	Field visit/ Survey/ Research				4	25	75	100
5.	Gen E	GENCC-901	NCC	2			2			
6.	USEC	NECC-5X2	University Social Responsibility				0	25	0	NC
7	SEC 2 (2 Cr.)	NECC-5X4	MOOCs/ SWAYAM	2	0	0	2	50	0	50
PRACTICALS										
1.	Core 7	MSZC-NP-241FP	Fish Physiology Lab	0	0	2	2	20	30	50
2.	Core 8	MSZC-NP-242FP	Fish Culture and Fisheries Science Lab	0	0	2	2	20	30	50
3.	DSE 4	MSZDSE-NP-243aFP	Applied Fisheries Lab	0	0	2	2	20	30	50
		MSZDSE-NP-243bFP	Fish Pathology and Microbiology Lab							
			TOTAL					210	390	600
4.	USEC	SPT-5X1	Sports	0	0	0	0	50	0	NC

24 (26 including NCC)

Format-1

NEP-2020 IMPLEMENTATION 3 STEPS PLAN (FORMAT-1,2 & 3)
CBSS: Statement of Credits distribution

Format 1

College/ School: Life Science & Technology Programme: M.Sc. Zoology Duration: 4 Semesters/ 2 Years	Credit range: 80 for PG (Suggested by CBCS-NEP Committee)

COU RSE	CRE DIT	SEMES TER	CORE (Th 4+P 2) Major	DSE (Th 4+P 2) Minor	AECC (Th 3)	SEC (Th 1+1)	GE (Th 4) Interdiscipl inary	Gen eral Elect ive (2)	Value Added Course (VAC)(2)	Industrial Training/ Survey/Research Project (4)	Total Credits
Master of Science in Zoology	50	1 st	C1- Biosyste matics, Taxonom y & Evolution C 2- Structure and Functions of Invertebra tes	DSE-1: Cell Biology/Natural Resources & Sustainable Development	AECC 5- English Communi cation			NCC	VAC- 1:(India n Ethos and Modern Manage ment)		23 (Excluding NCC) s
		2 nd	C3- Structure and Functions of Vertebrat es	DSE-2: Environmental Science and Wildlife Management/Bio chemistry and Instrumentation	AECC 6- Research & Publicatio n Ethics	SEC 1- MOOCs/ SWAYA M	GE 1: Intellectual Property Rights/Imm unology	NCC			27(Excludin g NCC)

			C4-Molecular Biology	Techniques							
Master of Science in Zoology	56	3 rd	C5-Animal Physiology C6-Animal Behavior	DSE-3: Environmental Impact Assessment & Disaster Management / Applied Zoology			GE2: Biostatistics and Bioinformatics / Recombinant DNA Technology	NCC	VAC-3- (Traditional System of Medicine)	Seminar/Industrial Training/Research (Credits-4)	28 (Excluding NCC)
		4 th	C7-Fish Physiology C8-Fish Culture and Fisheries Science	DSE- 4: Biology of Fishes/Fish Processing Technology		SEC 2-MOOCs/ SWAYAM		NCC		Research Project (Credits-10)	28 (Excluding NCC)

Format-2

IIMTU-NEP Implementation:

Format-2

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Code	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
Master of Science in Zoology	FIRST YEAR	SEMESTER -I	i) C1: Biosystematics, Taxonomy & Evolution (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	MSZC-NP-111	V	B.Sc(CBZ)/ B.Sc.(Zool) Hons.	
			ii) C2: Structure and Functions of Invertebrates (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	MSZC-NP-112	V		
			iii) DSE-1: Cell Biology/Natural Resources & Sustainable Development (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	MSZDSE-NPR-113a/ MSZDSE-NPN-113b	V		
			iv) AECC-1 English Communication (Th. 3 Cr.)	3	3	60	NHU-N-111	V		
			v) GE-NCC (2 Cr.)	2	-	-	GENCC-701	VI		
			vi) VAC-1: (Indian Ethos and Modern Management)	2	2	30	VAC-001			

		SEMESTER - II	i) C3: Structure and Functions of Vertebrates (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	MSZC-NP-121	V		
			ii) C4: Molecular Biology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	MSZC-NP-122	V		
			iii) DSE2: Environmental Science and Wildlife Management/Biochemistry and Instrumentation Techniques (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	MSZDSE-NPR-123a/ MSZDSE-NPR-123b	V		
			iv) AECC-2: Research Publication Ethics (Th. 3 Cr.)	3	3	60	MSZGE- NP-124a/ MSZGE- NPN-124b	V		
			v) SEC-1:MOOCs/ NPTEL	2	2	60	GENCC-801	V		
			vi) GE 1: Intellectual Property Rights/Immunology (Th.4 Cr)	4	4					
			vii) GE-NCC (2 Cr.)	2	2					
Master of Science in Zoology	SECOND YEAR	SEMESTER -III	i) C5 :Animal Physiology (Th. 4 Cr. + P 2Cr.)	4+2	8	60+60	MSZC-NP-231	V		
			ii) C6 :Animal Behavior (Th. 4 Cr. + P 2Cr.)	4+2	8	60+60	MSZC-NP-232	V		
			iii) DSE-3:Fish Biology / Entomology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	MSZDSE-NP-233a/MSZDSE-NP-233b	V		
			iv) GE-2 Biostatistics and Bioinformatics /Recombinant DNA Technology	4	4	60	MSZGE-NP-234a/MSZGE-NP-234b	V		

		SEMESTER - IV	i) C7 :Fish Physiology (Th. 4 Cr. + P 2Cr.)	4+2	8	60+60	MSZC-NP-241F	V		
			ii) C8: Fish Culture and Fisheries Science (Th. 4 Cr. + P 2Cr.)	4+2	8	60+60	MSZC-NP-242F	V		
			iii)SEC-2: MOOCs/ SWAYAM	2	2	30	NECC-5X4			
			iv) DSE-4: Applied Fisheries/Fish Pathology and Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	MSZDSE-NP-243aF/MSZDSE-NP-243bF	V		
			Field Visit / Survey /Research Project	4	-	-	MSZ-RP-241			
Programme Outcome: PO-1: Apply the understanding of the numerous fields of zoology intended for graduate-level and post graduate-level courses and higher education. PO-2: Describe basic concepts of zoology at molecular, cellular level, anatomy, physiology and reproduction at individual level. PO-3: Learn the role of biosystematics in animal studies and acquire knowledge of animals including non chordates and chordates. PO-4: Learn the importance of biodiversity, ecological factors, conservation of environment, pollution control, sustainable development, natural resources and disaster management. PO-5: Understand various applied fields of zoology like prawn culture, apiculture, , sericulture, lac culture, vermiculture, fisheries ,poultry, dairy farms etc PO-6:- Expertise in handling various laboratory equipment and accomplish the laboratory experiments. PO-7. Students will get in-depth understanding of zoology through seminar presentations, project work, field visits and the combination of theoretical knowledge and practical skills.					Programme Specific Outcome: PSO-1. Students get familiarized about the variety of animal species, their habitats, life cycle, and evolutionary processes. PSO-2. Students learnt about the external features, anatomy, physiological process, development and reproductive process of animals. PSO-3.Students learnt about molecular biology and cyto genetics with special reference to heredity and its importance in human health. PSO-4: Gain knowledge about the infections and illnesses that harm the animals. PSO-5. Understand biodiversity conservation processes and its significance and causes of environmental pollution can help students for maintaining ecological balance. PSO-6 Students learnt about natural resources, sustainable development, environmental impact assessment and disaster management. PSO-7 Students learnt about natural resources, sustainable development, environmental impact assessment					

Format-3

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: Master of Science in Zoology Certificate/Diploma/Degree/ /PG/Ph.D. Class: M.Sc. Zoology		Year: I
Credits: 6 Theory: 4 Practical: 2		Semester: I
Course Code: MSZC-NP-111		Subject: Zoology
Course Objectives: CO1: To develop the understanding on biosystematics and taxonomic importance in the biological science. CO 2: To develop the basic understanding on speciation, species concepts and origin of reproductive isolation. CO 3: To understand the International Code of Zoological Nomenclature, Its operative principle and scientific nomenclature. CO 4: To develop the concept of evolution and theories of organic evolution, Natural selection, Mutation, Genetic drift, Migration. CO 5: To analyses of quantitative traits, and construction of a phylogenetic tree.		Title: Biosystematics, Taxonomy and Evolution
Nature of Paper: Core/DSE/SEC/GE/AECC: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L:4 T: 0 P: 2 (In Hours/Week) 8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Basic concept of animal taxonomy. Classical taxonomy to systematic: A historical review; taxonomic terms; taxonomy; classification and nomenclature; phenon, taxon and category; α , β and γ taxonomy Modern concepts and recent trends: chemotaxonomy, cytotoxonomy, serotaxonomy and molecular taxonomy ,Importance of application of systematics in biology	12
II	Dimensions of speciation, Mechanisms of speciation , Species concept- Species category, different species concept, subspecies and other infra specific categories, Theories of Biological classification and Taxonomic characters	12
III	Taxonomic procedures – collection, preservation, process of identification ,Taxonomic keys – different kinds of taxonomic keys, their merits and demerits, Systematic publication – different kinds of publication ,Process of typification of different zoological types, International code of Zoological nomenclature(ICZN)-its operative	12

	principles, interpretation and applications of important rules	
IV	Concept of evolution and theories of organic evolution with an emphasis on Darwinism: Micro and Macro-evolution, Neo-Darwinism, Hardy – Weinberg law of genetic equilibrium, a detailed account of destabilizing forces: Natural selection, Mutation, Genetic drift, Migration	12
V	Genetics of quantitative traits in populations: Analysis of quantitative traits, Quantitative traits and natural selection, Genotype-environment interactions, Inbreeding depression and heterosis, Molecular analysis of quantitative traits, Phenotypic plasticity, Molecular phylogenetics, How to construct phylogenetic trees	12

Reference / Text Books:

“Descriptive Taxonomy: The Foundation of Biodiversity Research (Systematics Association Special Volume Series)” by Mark F Watson and Chris H C Lyl, Jan 2015

“Fundamental Of Biodiversity Taxonomy” by Jaspal Juneja, 2010

If the course is available as Generic Elective then the students of following departments may opt it.

1. NO
- 2.
- 3.
- 4.
- 5.
- 6.

Evaluation/Assessment Methodology

Max. Marks:100

1) Sessional Examination	16
2) Assignments	5
3) Presentations /Seminar /Attendance	4
4) ESE	75
Total:	100

Prerequisites for the course:

Course Learning Outcomes:

CLO1. Student will be able to explain recent concepts of taxonomy for example chemotaxonomy and molecular taxonomy.

CLO2. Student will be able to explain about biosystematics and evolution.

CLO3. Student will be able to explain speciation, species concept and reproductive isolation.

CLO4. Student learnt about various methods used for taxonomic procedures like collection, preservation, process of identification and nomenclature.

CLO5. Student will be interpreting the International code of Zoological Nomenclature and its various applications.

CLO6. Student will be able to explain evolution and different types of evolution.

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: Master of Science in Zoology Certificate/Diploma/ Degree/PG/Ph.D. Class: M.Sc. Zoology		Year: I Semester: I
Credits: 2 Theory: 0 Practical: 2		Subject: Zoology
Course Code: MSZC-NP-111P		TITLE: Biosystematics, Taxonomy and Evolution Lab
Course Objectives: CO1: To develop the understanding on Composition and assessment of the taxonomic diversity/biodiversity in a habitat CO2: To develop the general understanding on speciation, different species concepts and origin of reproductive isolation. CO3: To understand the Identification of fish species by using fin formula. CO4: To understand various scientists involved in the history of the biosystematics and taxonomy CO5: To analyses of quantitative traits, and construction of a phylogenetic tree.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)=8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No	List of Experiments	No. of Lectures Allotted
1.	Composition and assessment of the taxonomic diversity/biodiversity in a habitat (e.g. grassland, arid land, wet land etc.).	12
2.	Project: Preparation of models showing the status of certain taxa or species in a particular habitat.	12
3.	Identification of fish species by using fin formula.	12
4.	Describe the various scientists involved in the history of the taxonomy.	12
5.	To create a checklist of local ichthyofauna of Meerut.	12

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: Master of Science in Zoology Certificate/Diploma/Degree/PG/Ph.D.		Year: I
Class: M.Sc. Zoology		Semester: I
Credits: 4 Theory: 4 Practical: 0		Subject: Zoology
Course Code: MSZC-NP-112		Title: Structure and function of Invertebrates
Course Objectives: CO1: To understand the structure and organization of invertebrate animals. CO2: To study modifications in various functions of animals during transition from invertebrates. CO3: To study the evolutionary significance of larval forms of invertebrates. CO4: To identify invertebrates and homology, analogy and modifications of mouthparts in relation to feeding habits CO5: To understand affinities of minor and major phyla.		
Nature of Paper: Core/DSE/SEC/GE/AECC: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P: 2 (In Hours/Week) 8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Protozoa: General characters, outline classification, Flagellar and ciliary movement in protozoa and reproduction in protozoa. Porifera: General characters, outline classification, skeleton canal system and regeneration in sponges.	12
II	Coelenterata: General characters, outline classification, polymorphism and coral reefs Ctenophora: General characters outline classification and affinities. Helminths: General characters, outline classification of Platyhelminths and Nematelminthes	12
III	Annelida: General characters, outline classification, segmentation, coelom, nephridia, adaptive radiation and regeneration. Arthropoda: Important features, outline classification, mouth parts of insects, respiratory system and larval forms in crustacean. Onychophora: Important features outline, classification, general organization and affinities.	12
IV	Mollusca: General characters, outline classification, Modifications of foot, torsion and detorsion in gastropod. Echinodermata: Important features, outline classification, larval forms,	12

	water vascular system and regeneration	
V	Minor non coelomata phyla: General characters and classification and affinities of phylum rotifer and acanthocephalan. Minor coelomate phyla: General organization, classification and affinities of phylum chaetognatha, pogonophora, phoronida and brachiopoda. Hemichordata: General organization, classification and affinities.	12
Reference / Text Books: ▪ Structure and Functions of invertebrates” by Barrington E J W, July 2022. ▪ The Invertebrates by Hyman, L. H. McGraw Hill co New York,2017 ▪ Invertebrate Zoology, 3rd edition.; Barnes, R. D.,2006 If the course is available as Generic Elective then the students of following departments may opt it. NO		
Evaluation/Assessment Methodology		
		Max. Marks 100
1. Sessional Examination		16
2. Assignments		5
3. Presentations /Seminar /Attendance		4
4. ESE		75
Total:		100
Prerequisites for the course:		
Course Learning Outcomes: CLO1: Student will be able to explain general taxonomic rules of animal classification. CLO2: Student will be able to explain general characters and classification of Invertebrates. CLO3: Student will be able to explain process of adaptive radiation and regeneration. CLO4: Student will be able to explain modifications of foot, torsion and detorsion in gastropod. CLO5: Student will be able to explain affinities of minor and major phyla. CLO6: Student will be able to explain about affinities of hemich or data.		

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: Master of Science in Zoology Certificate/Diploma/Degree/ PG/Ph.D.		Year: I
Class: M.Sc. Zoology		Semester: I
Credits: 2 Theory: 0 Practical: 2		Subject: Zoology
Course Code:MSZC-NP-112P		TITLE: Structure and function of Invertebrates Lab
Course Objectives: CO1:To understand Identification and structure of protozoans . CO2: To understand Identification and structure of representatives from Porifera. CO3: To study identification and structure of animals of Coelenterata CO4: To understand Identification and structure of representatives from Annelida and Arthropoda. CO5: To identify larval stages of invertebrates.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)=8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No	List of Experiments	No. of Lectures Allotted
1.	Identification, classification & study of distinguishing features of representatives from various groups.	5
2.	Phylum Protozoa- <i>Polystomella</i> , <i>Formanifera</i> , <i>Opalina</i> , <i>Paramecium</i> (Fission & conjugation) <i>Vorticella</i> , <i>Euglena</i> , <i>Trypanosoma</i> , <i>Monocytis</i> , <i>Plasmodium</i>	5
3.	Phylum Porifera- <i>Sycon</i> L.S & T.S, <i>Spicules</i> , <i>Sponginfibres</i> , <i>Leucosolenia</i> , <i>Euplectella</i>	5
4.	Phylum Cnidaria- <i>Obelia</i> , (polyp& Medusa), <i>Millepora</i> , <i>Physalia</i> , <i>Pennatula</i> , <i>Metridium</i> , <i>Madrepora</i> , <i>Alcyonium</i> , <i>Gorgonia</i> , <i>Aurelia</i> .	5
5.	Phylum Helminthes- <i>Ascaris</i> , <i>Taenia</i> , <i>Planaria</i>	5
6.	Phylum Annelida - <i>Pontobdella</i> , <i>Aphrodite</i> , <i>Leech</i> <i>Polygordius</i> , <i>Chaetopterus</i> , <i>Neries</i> , <i>Heteroneris</i> , <i>Arenicola</i> .	5
7.	Phylum Arthropoda- <i>Cyclops</i> , <i>Peripatus</i> , <i>Balanus</i> , <i>Lepas</i> , <i>Hippa</i> , <i>Belostoma</i> , <i>Limulus</i> , <i>Eupagurus</i> , <i>Julus</i> , <i>Scolopendra</i> , <i>Praying mantis</i> .	5
8.	Phylum Mollusca- <i>Murex</i> , <i>Bulla</i> , <i>Cardium</i> , <i>Arca</i> , <i>Turritella</i> , <i>Pinctada</i> , <i>Cypraea</i> , <i>Octopus</i> , <i>Nautilus</i> . Phylum Echinodermata- <i>Echinus</i> , <i>Holothuria</i> , <i>Antedon</i> , <i>Asterias</i>	5
9.	Minor Phyla- <i>Bugula</i> , <i>Plumatella</i> , <i>Crestatella</i> , <i>Pectinella</i> , <i>Phoronis</i> , <i>Dendrostoma</i> .	5

10.	Larval Stages: <i>Planula, Redia, Miracidium, Sporocyst, Cercaria, Metacercaria Trochophore, Nauplius, Zoea</i>	5
11.	<i>Mysis, Phyllosoma, Trilobite larva of Limulus, Velligar, Bipinnaria, Echinopluteus, Auricularia, Tornaria</i>	5
12	<i>Dissections: Cockroach: General anatomy, Reproductive system, Nervous system Mouthparts: Cockroach & Mosquito (Through models and virtual lab)</i>	5

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D.		Year: I
Class: M.Sc. Zoology		Semester: I
Credits: 4 Theory: 4 Practical: 0		Subject: Zoology
Course Code: MSZDSE-NPR-113a		Title: Cell Biology
Course Objectives: CO1: To understand the structure and function of all the cell organelles. CO2: To know about chromatin structure and its location. CO3: To be familiar with the basic principle of life and growth of an organism. CO4: To understand cell communication with its neighboring cells. CO5: To understand steps of Protein synthesis and Uptake into ER.		
Nature of Paper: Core/DSE/SEC/GE/AECC: DSE		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T: 0 P: 2 (In Hours/Week)=8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Cell: Introduction and classification, History and Discovery of cell, the cell theory. Prokaryotic and Eukaryotic cell. Difference between Prokaryotic and Eukaryotic cell. Ultra structure of a eukaryotic cell. Transport across membranes: Active and Passive transport.	12
II	Cytoskeleton: Microfilaments, intermediate filaments and microtubules-structure and dynamics, Cell movements-Intracellular transport, role of kinesin and dynein	12
III	Cell –Cell Signaling and Cell Interaction: Introduction, Cell surface receptors, Second messenger system, MAP kinase pathways, Cell junctions ,Cell adhesion	12
IV	Cell cycle: Phases of cell division, Mitosis and meiosis. Cyclin and cyclin dependent kinases, Regulation of CDK – cyclin activity Chromosomes, Chromatin, and the Nucleosomes, Chromosome sequence and diversity.	12
V	Intracellular protein traffic: Protein synthesis, Uptake into ER, Membrane proteins, Golgi sorting, Post translational modifications, Apoptosis, Definition, mechanism and significance.	12
Reference / Text Books: 1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004). 2. Alberts et al: Molecular Biology of the Cell: Garland (2002). 3. Cooper: Cell: A Molecular Approach: ASM Press (2000). 4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).		

5. Lewin B. Genes VIII. Pearson (2004).
6. Watson et al. Molecular Biology of the Gene. Pearson (2004).
7. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis KubyKuby Immunology. W H Freeman (2007).

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

		Max. Marks:100
1. Sessional Examination		16
2. Assignments		5
3. Presentations /Seminar /Attendance		4
4. ESE		75
Total:		100

Prerequisites for the course:

Course Learning Outcomes:

- CLO1: After finishing this course the student will be able to explain cell and its functions.
 CLO2: Student will be able to explain cell signaling and cell interaction.
 CLO3: Student will be able to explain chromosome sequence and diversity.
 CLO4: Student will be able to handle microscopes in research lab.
 CLO5: Student will be able to explain Protein synthesis and Uptake into ER.
 CLO6: Student will be skilled to work in research institutions, industries, testing labs etc.

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: Master of Science in Zoology		Year: I
Certificate/Diploma/Degree//PG/Ph.D.		Semester: I
Class: M.Sc. Zoology		Subject: Zoology
Credits: 2		
Theory: 0		
Practical: 2		
Course Code: MSZDSE-NPR-113aP		TITLE: Cell Biology Lab
Course Objectives: CO1: To understand the structure and organization of invertebrate animals. CO2: To understand structure of Polytene chromosomes of salivary gland of Chironomus larva/Drosophila. CO3: To identify various stages of mitosis and meiosis. CO4: To study techniques of Barr body preparation in buccal epithelial cells CO5: To provide knowledge about light microscopic examination and preparation of tissue sections.		
Nature of Paper: DSE		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)=8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No	List of Experiments	No. of Lectures Allotted
1.	Study of Polytene chromosomes in salivary glands of Chironomus larva/Drosophila.	10
2.	Light microscopic examination and preparation of tissue sections.	10
3.	Study of mitotic and meiotic chromosomes from permanent prepared slides.	10
4.	Preparation of slides for mitotic study.	10
5.	Preparation of slides for meiotic study in the testis of grasshopper.	10
6.	Barr body preparation in buccal epithelial cells.	10

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D. Class: M.Sc. Zoology		Year: I Semester: I
Credits: 4 Theory: 4 Practical: 0	Subject: Zoology	
Course Code: MSZDSE-NPN-113b	Title: Natural Resources & Sustainable Development	
Course Objectives: CO1: To provide knowledge about basic of forest resources. CO2: To understand the knowledge about Natural resources and management. CO3: To understand sustainable development. CO4: To impart knowledge about nature and sustainable development goals. CO5: To provide knowledge about natural resources management.		
Nature of Paper: Core/DSE/SEC/GE/AECC: DSE/ Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P: 2 (In Hours/Week)= 8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Natural Resources: Meaning and Concept of resource, Classification of natural resources. Abiotic resources & Biotic resources, Major type of biotic resources-forests, grasslands, wildlife and aquatic (fresh water and marine). Fish and other marine resources:- Production, status, dependence on fish resource, unsustainable harvesting.	12
II	Forest Resources: Introduction, Uses of forest, Principal forest types in India, Causes of forest degradation (forest fires, forest land degradation, Illicit felling, grazing, shifting cultivation etc.), Forest conservation measures– Social forestry (Farm forestry, agro forestry, extension forestry), role of forestry in eco - development of rural areas. Concept of Joint Forest Management (JFM)	12
III	Water resources: Fresh Water ecosystem, Hydrological cycle, Factors influencing the surface water, Run off process and water resources of India. Conflicts over water, dams-benefits and problems with special reference to fish habitat. Use and over-utilization of surface and ground water, Impact of Urbanization on Water resources.	12
IV	Land Resources: Introduction, land degradation, man induced landslides, soil erosion and desertification. Food Resources: World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.	12

V	Sustainable Development: Introduction to sustainable development. Sustainable Development Goals (SDGs)- targets and indicators, challenges and strategies for SDGs. Role of individual in conservation of Natural Resources. Equitable use of resources for sustainable lifestyles.	12
Reference / Text Books: 1. A text book of Ecology and Environment, P.C. Joshi & Namita Joshi, Himalaya Publishing House, Mumbai 2. Ecology and Environment, P.D. Sharma, Rastogi Pub., New Delhi. 3. Ecology and Environment, H.R. Singh and Neeraj Kumar, Rastogi Publication. 4. Fundamentals of Ecology, E.P. Odum, W.B. Saunders Co., Philadelphia. 5. Essentials of Ecology & Environmental Science, S.V.S. Rana, Prentice Hall of India Pvt. Ltd., New Delhi. 6. Environmental Science, Santra S.C., New Central Book Agency Pvt Ltd., Kolkata., 2001		
If the course is available as Generic Elective then the students of following departments may opt it.		
1. Yes		
Evaluation/Assessment Methodology		
		Max. Marks:100
1. Sessional Examination		16
2. Assignments		4
3. Presentations /Seminar /Attendance		5
4. ESE		75
Total:		100
Prerequisites for the course:		
Course Learning Outcomes: CLO1: Student will be aware about nature and natural resources. CLO2: Student will be capable to explain natural resources and sustainable relationships. CLO3: Student will be able about natural resources and their control measures. CLO4: Student will be capable to describe the different types of natural resources. CLO5: Student will be able to explain about sustainable development with special reference to SDGs. CLO6: The overall course outcome focused on the use of natural resources in sustainable way.		

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: Master of Science in Zoology Certificate/Diploma/Degree/PG/Ph.D. Class: M.Sc. Zoology		Year: I Semester: I
Credits: 2 Theory: 0 Practical: 2		Subject: Zoology
Course & Code: MSZDSE-NPN-113bP		Title: Natural Resources & Sustainable Development Lab
Course Objectives: CO1: To understand the various biotic and abiotic components of Aquatic Ecosystem. CO2: To understand the various biotic and abiotic components of forest Ecosystem. CO3: To understand the Grassland Ecosystem. CO4: To understand Sustainable development goals (SDGs). CO5: To understand Natural resources conservation Days for Sustainable development.		
Nature of Paper: Core/DSE		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)=8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4 Hrs./Week=4 Credits)		
S.No	List of Experiments	No. of Lectures Allotted
1.	To study and enlist various biotic and abiotic components of Aquatic Ecosystem	8
2.	To study and enlist various biotic and abiotic components of forest Ecosystem.	8
3.	To study and enlist various biotic and abiotic components of Grassland Ecosystem.	8
4.	To study and enlist various biotic and abiotic components of Desert Ecosystem	8
5.	Biodiversity studies: (Map studies - One exercises to be given) A. Biodiversity Hotspots location in ▪ World ▪ India B. Protected Areas of India (National Parks, Biosphere Reserves)	12
6.	To prepare a list of various day for Natural Resources Conservation.	8
7.	To study and enlist Sustainable development goals (SDGs).	8

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D.		Year: I
Class: M.Sc. Zoology		Semester: II
Credits: 4 Theory: 4 Practical: 2		Subject: Zoology
Course Code: MSZC-NP-121		Title: Structure and functions of vertebrates
Course Objectives: CO1: To understand basis of classification of vertebrates. CO2: To learn general characters of different classes. CO3: To study different physiological body processes of vertebrates. CO4: To learn characteristics and significance of fish and amphibians. CO5: To learn characteristics and significance of birds and mammals.		
Nature of Paper: Core/DSE/SEC/GE/AECC: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T: 0 P: 2 (In Hours/Week) 8 Theory - 1 Hr. = 1 Credit Practical-2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Outline classification of vertebrates, Origin & Evolution of Chordate, General Organization & Affinities of Larvacea, Thaliacea and Cephalochordata. Vertebrate integument and its derivatives: Development, general structure and functions of skin & its derivatives (Glands, scales, feathers and hair).	12
II	Fish: General Characters, General Organization and Affinities of Ostracoderm & Coelacanthiformes. Amphibia: General Characters, Parental Care, Neoteny and paedogenesis.	12
III	Reptiles: General Characters, Types& Peculiarities of Dinosaurs. General Organization of Chelonia.	12
IV	Birds: General Characters, Flight Adaptation, Migration and Territorial Behaviour	12
V	Mammals: General Characters Of Mammals, Organization & Affinities of Prototheria. General Organization and Affinities of Marsupialia, Aquatic Mammals With Reference to Cetaceae.	12
Reference / Text Books: - Modern text book of Vertebrate Zoology by R.L. KOTPAL,2010 - Chordate Zoology by E.L. JORDAN, 2013		
If the course is available as Generic Elective then the students of following departments may opt it.		
1. NO		

Evaluation/Assessment Methodology	
Max. Marks:100	
1. Sessional Examination	16
2. Assignments	5
3. Presentations /Seminar /Attendance	4
4. ESE	75
Total:	100
Prerequisites for the course:	
Course Learning Outcomes: CLO1: Student will be able to explain unique characters and classification of vertebrates. CLO2: Student will be able to recognize life functions of vertebrates. CLO3: Student will be able to describe the diversity from Pisces to mammals. CLO4: Student will be able to explain how anatomical and physiological differences affect various functions in vertebrates. CLO5: Student will be able to explain general organization, classification and affinities of Proto chordates and Marsupials. CLO6: Student will be able to explain anatomy of the major vertebrate taxa.	

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: Master of Science in Zoology Certificate/Diploma/ Degree/PG/Ph.D.		Year: I
Class: M.Sc. Zoology		Semester: II
Credits: 2 Theory: 0 Practical: 2		Subject: Zoology
Course Code: MSZC-NP-121P		TITLE: Structure and functions of vertebrates Lab
Course Objectives: CO1: To understand the Identification and structure of Ascidians. CO2: To provide knowledge about Identification and structure of representatives from amphibians and reptiles. CO3: To study identification and general characters of Aves. CO4: To know about identification and structure of representatives from mammals. CO5: To identify bones of vertebrates.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: P: 2 (In Hours/Week)=8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No	List of Experiments	No. of Lectures Allotted
1.	Class-Ascidaceae: <i>Herdmania, Botryllus, Pyrosoma, Doliolum, Salpa, Oikopleura</i>	10
2.	Class-Pisces: <i>Rhinobatus, Chimaera, Acipensor, Amia, Notopterus, Notopterus, Echeneis, Diodon, Triacanthus, Trichurius</i>	10
3.	Class Amphibia: <i>Ichythophis, Ambyostoma, Rhacophorus, Rana</i>	7
4.	Class- Reptilia: <i>Chelone, Chameleon, Draco, Naja, Bungarus, Viper, Alligator</i>	7
5.	Class – Aves: Koel, Indian tailor bird,Fowl, Peacock, Emu, Ostrich, Penguin	7
6.	Class- Mammalia: <i>Loris, Indian Otter, Bat, Pangolin, Ornithorhyncus, Kangaroo, WhaleRhesus monkey, Lion</i>	7
7.	Osteology Osteology: Bones of frog, varanus, fowl, rabbit (Skull, Vertebrae, Pectoral & pelvic girdle, Limb bones)	6
8.	DISSECTION: <i>Channa punctata</i> (Demonstration Only) - Afferent, Efferent Blood vessel, Cranial nerves. Rat/ Mice - Digestive System, Reproductive system. (Through models and virtual lab)	6

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D.		Year: I
Class: M.Sc. Zoology		Semester: II
Credits: 4 Theory: 4 Practical: 0		Subject: Zoology
Course Code: MSZC-NP-122		Title: Molecular Biology
Course Objectives: CO1: To provide knowledge about Nucleic Acids and DNA model to the course learners. CO2: To impart understanding of key events of molecular biology comprising of mechanism of DNA Replication, Transcription and Translation in Prokaryotes and Eukaryotes. CO3: To provide adequate knowledge about Post Transcriptional Modifications and Processing of Eukaryotic RNA to the course learners. CO4: To impart detailed explanation of Transcriptional Regulation with examples of lac operon and tryptophan operon in prokaryotic as well as eukaryotic organisms. CO5: To develop comprehensive understanding regarding DNA Repair Mechanisms in the course learners.		
Nature of Paper: Core/DSE/SEC/GE/AECC: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P: 2 (In Hours/Week) 8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Genetic material: Nucleic acids as genetic material, Structure of DNA and RNA; DNA replication: Enzymes involved in replication, Recombination and Repair of DNA: DNA repair and recombination, DNA Mismatch Repair, Double Strand Break Repair, Recombination repair, SOS repair.	12
II	Transcription: Transcription machinery of prokaryotes, various transcription enzymes and cofactors, sigma factors, Transcription machinery of eukaryotes, various forms of RNA polymerase and cofactors, promoters, enhancers, silencers, activators, effect of chromatin structure, regulation of transcription. Post-transcriptional processes: RNA processing, splicing, capping and polyadenylation,	12
III	Gene regulation and expression: regulation of gene transcription in prokaryotes (operon model, negative and positive regulation of lac operon and trp operon), transcriptional switch in bacteriophage, regulation of transcription in eukaryotes, post transcriptional gene silencing and regulation of gene expression.	12
IV	Translation: The genetic code, Mechanisms of translation in prokaryotes, Mechanisms of translation in eukaryotes, initiation complex, ribosomes and	12

	t RNA, factors, elongation and termination, Post-translational processes	
V	Polymerase Chain Reaction- Concept of PCR, Various kinds of PCR, Applications of PCR.	12

Reference / Text Books:

- Benjamin Lewin. Genes XII.2017. Benjamin-Cummings Pub Co. London.
- Harvey Lodish. 2016. Molecular cell biology. 8th Edition. W. H. Freeman. America.
- David. P. Clark. 2010. Molecular Biology. Academic Press. USA.
- Brown. T.A.2017. Genomes. 4thEdn. Wiley-Liss (New York).
- Larry Snyder, Wendy Champness. 2013. Molecular Genetics of Bacteria. 4th Edn. American
- Sandy B. Primrose, Richard M. Twyman, Robert W. Old, 2016. Principles of Gene Manipulation
- Volker A. Erdmann. 2015. RNA and DNA Diagnostics. Springer International Publishing. Switzerland.
- Suming Huang. Michael. D. Litt. C. Ann Blakey. 2016. Epigenetic Gene Expression and Regulation. Academic Press London

If the course is available as Generic Elective then the students of following departments may opt it.

1. NO

Evaluation/Assessment Methodology

Max. Marks:100	
1. Sessional Examination	16
2. Assignments	5
3. Presentations /Seminar /Attendance	4
4. ESE	75
Total:	100

Prerequisites for the course:

Course Learning Outcomes:

CLO1: Student will be able to explain structure of DNA and RNA, Recombination and Repair of DNA.

CLO2: Student will be able to describe key events of transcription, regulation of transcription and Post-transcriptional processes.

CLO3: Student will be able to explain about, post transcriptional gene silencing and regulation of gene expression

CLO4: Student will be able to explain mechanisms of translation in prokaryotes

CLO5: Student will be able to describe DNA Repair Mechanisms in the course learners.

CLO6: Student will be able to explain various kinds of PCR and applications of PCR.

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D. Class: M.Sc. Zoology		Year: I Semester: II
Credits: 2 Theory: 0 Practical: 2		Subject: Zoology
Course Code:MSZC-NP-122P		TITLE: Molecular Biology Lab
Course Objectives: CO1: To understand the Preparation of Stock solutions CO2: To understand the procedure of Isolation of genomic DNA from plant sample by CTAB method. CO3: To study about the procedure of Agarose Gel electrophoresis of genomic DNA CO4: To understand the various steps of Protein isolation and purification CO5: To provide knowledge of SDS-PAGE gel electrophoresis.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)=8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No	List of Experiments	No. of Lectures Allotted
1.	Preparation of Stock solutions	6
2.	Isolation of genomic DNA from plant sample by CTAB method.	6
3.	Quantitative and qualitative analysis of DNA by UV-spectrophotometer	6
4.	Agarose Gel electrophoresis of genomic DNA	6
5.	Protein isolation and purification	6
6.	SDS-PAGE gel electrophoresis	6
7	Amplification of DNA by polymerase chain reaction	6
8	Plasmid DNA isolation	6
9.	Preparation of competent cell and transformation	6
10.	Preparation of competent cell and transformation Selection of recombinant clone	6

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: Master of Science in Zoology Certificate/Diploma/ Degree/PG/Ph.D.		Year: I
Class: M.Sc. Zoology		Semester: II
Credits: 4 Theory: 4 Practical: 0		Subject: Zoology
Course Code: MSZDSE-NPR-123a		Title: Environmental Science and Wildlife Management
Course Objectives: CO1: To provide knowledge about Environment and its biotic, abiotic factors, Characteristics of Population and Community. CO2: To impart knowledge about Natural resources and their Management. CO3: To understand Radiation and Environment, Wild Life Conservation and Biodiversity hotspots CO4: To impart knowledge about Global environment, Hydrosphere, Lithosphere, Atmosphere and Biosphere. CO5: To impart knowledge about Zoogeography of India and world		
Nature of Paper: Core/DSE/SEC/GE/AECC: DSE		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P: 2 (In Hours/Week) 8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Environment: Meaning and definition, Environmental components- Abiotic factors-, Soil, Water, Humidity, Climate and Microclimate, Light, Temperature, pH, Nutrients. Biotic components- Fauna and Flora. Ecology: Introduction of ecology, Definition, brief history, scope and branches of ecology. Biogeochemical cycles(C, O, N, P, S)	12
II	Environmental pollution –air, water, soil, noise and radioactive pollution, global warming and green house effect, Concept of sustainable development. Concept of Solid Waste Management (SWM).	12
III	Principles of conservation: Water conservation- rain water harvesting, Soil conservation, Biological indicators and their role in environmental monitoring.	12
IV	Wildlife: definition, Zoogeography of India and world with reference to reptiles, birds and mammals, reasons for conservation and destruction of wildlife, Indian species at risk: Endangered, vulnerable, rare and extinct species (with examples).	12
V	Wildlife Management: Definition, Zoogeography of India and world with reference to reptiles, birds and mammals, Habitat diversity, Indian wildlife sanctuaries, national parks and biosphere reserves, Wildlife (protection) Act	12

	of 1972. IUCN and Red data book, CITES (Convention on international trade in endangered species) Appendices I & II Conservation, Remote sensing in conservation of forest and wildlife, Radio telemetry in wildlife management	
Reference / Text Books: - Environmental Biotechnology, Basic concepts and application, Thakur I.S., I K International Pvt. Ltd. 2010 - Environmental management; Sandhu, D; India Environment society, New Delhi, 2013. - Environmental Science, Santra S.C., New Central Book Agency Pvt. Ltd., Kolkata., 2001.		
If the course is available as Generic Elective then the students of following departments may opt it.		
1. NO		
Evaluation/Assessment Methodology		
		Max. Marks:100
1. Sessional Examination		16
2. Assignments		5
3. Presentations /Seminar /Attendance		4
4. ESE		75
Total:		100
Prerequisites for the course:		
Course Learning Outcomes: CLO1: Student will be aware about Environment and its biotic and abiotic factors, Global environment, Hydrosphere, Lithosphere, Atmosphere and Biosphere. CLO2: Student will be able to explain Natural resources and their Management and Environmental pollution. CLO3: Student will be able to explain Radiation and Environment, Wild Life Conservation and Biodiversity hotspots. CLO4: Student will be able to describe Zoogeography of India and world with reference to reptiles, birds and mammals. CLO5: Student will be able to explain about Indian wildlife sanctuaries, national parks and biosphere reserves. CLO6: Student will be able to explain different principles of conservation.		

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D. Class: M.Sc. Zoology		Year: I Semester: II
Credits: 2 Theory: 0 Practical: 2	Subject: Zoology	
Course Code: MSZDSE-NPR-123aP	TITLE: Environmental Science and Wildlife Management	
Course Objectives: CO1: To understand the procedure of estimation of total hardness of given water sample. CO2: To understand the procedure of acidity of water. CO3: To understand the step of estimation of total solids. CO4: To understand the procedure of alkalinity of water. CO5: To study community of quadrate.		
Nature of Paper: DSE		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)=8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No	List of Experiments	No. of Lectures Allotted
1.	To determine chloride in the given water sample.	8
2.	Estimation of total hardness of given water sample.	8
3.	To determine the acidity of water.	4
4.	To determine the alkalinity of water.	8
5.	To estimate total solid in water.	8
6.	To determine the dissolved oxygen in given water sample.	8
7.	To determine the BOD of given water sample.	8
8.	Study of community of quadrate.	8

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D. Class: M.Sc. Zoology		Year: I Semester: II
Credits: 4 Theory: 4 Practical: 0	Subject: Zoology	
Course Code: MSZDSE-NPR-123b	Title: Biochemistry and Instrumentation Techniques	
Course Objectives: CO1: To provide students with a solid foundation in the principles of biochemistry, including the structure and function of biomolecules, metabolic pathways, and cellular processes. CO2: To enable students to develop proficiency in using a variety of instrumentation techniques commonly employed in biochemical research, such as spectroscopy, chromatography and electrophoresis. CO3: To introduce students to advanced techniques for the analysis of biomolecules, including DNA sequencing, protein purification, and enzyme kinetics, and provide hands-on experience with these methods. CO4: To help students bridge the gap between theoretical knowledge and practical application by conducting experiments, data analysis, and interpretation of results in the context of biochemistry research. CO5: To foster the ability of students to critically evaluate experimental results, troubleshoot instrument-related issues, and design experiments to answer specific biochemical questions.		
Nature of Paper: Core/DSE/SEC/GE/AECC: DSE		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P: 2 (In Hours/Week)=8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Classification and structure of amino acids based on structure. Introduction, classification of proteins based on solubility, size and shape. Structure of proteins - primary, secondary, tertiary and quaternary	12
II	Carbohydrates: Definition, general properties, classification and configuration of carbohydrates Metabolism, Catabolism of glycogen and glucose, details of glycolysis.	12
III	Lipids: Definition, general properties and classification, Structure and importance of: (a) Simple lipids- fats and wax (b) Compound lipids- phospholipids, glycolipids, aminolipids and sulpholipids(c) Steroids- cholesterol, bile acids, steroid hormones.	12
IV	Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds), Stability of protein	12

V	Hybridoma technology, Embryo sexing, assisted reproductive technologies, Cell culture techniques: culture media, primary and secondary culture, cell line.	12
Suggested Readings - Principles and Practice of Bioanalysis, R F Venn, Taylor and Francis. - Principles and Techniques of Biochemistry and Molecular Biology, (6th edition), K. Wilson and J Walker (editor), Cambridge University Press. - Biochemistry, D. Voet and J.G. Voet, John Wiley & Sons - Principles of Biochemistry, Lehninger, Nelson and Cox. - Principles and Techniques in Biochemistry and Molecular Biology, Edited by Keith Wilson and John Walker, Cambridge University Press.		
If the course is available as Generic Elective then the students of following departments may opt it. 1. NO 2		
Evaluation/Assessment Methodology		
		Max. Marks 100
1. Sessional Examination		16
2. Assignments		5
3. Presentations /Seminar /Attendance		4
4. ESE		75
Total:		100
Prerequisites for the course:		
Course Learning Outcomes: CLO1: At the end of the course, students will be able to explain the fundamental concepts of biochemistry, including molecular structures, biochemical pathways, and their relevance to various biological processes. CLO2: Students will demonstrate proficiency in operating various biochemical instrumentation tools, such as spectrophotometers, chromatographs, and electrophoresis equipment, and will be able to effectively collect and analyze experimental data. CLO3: By the end of the course, students will be able to perform advanced techniques for biomolecular analysis, such as DNA sequencing, protein purification, and enzyme kinetics assays, and interpret the results accurately. CLO4: Students will develop the ability to plan and conduct biochemical experiments independently, troubleshoot experimental challenges, and effectively communicate their findings through written reports and presentations. CLO5: of the course will be capable of critically evaluating experimental data, designing experiments to answer specific research questions, and adapting to new instrumentation and techniques in the field of biochemistry.		

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D. Class: M.Sc. Zoology		Year: I Semester: II
Credits: 2 Theory: 0 Practical: 2	Subject: Zoology	
Course Code: MSZDSE-NPR-123bP	TITLE: Biochemistry and Instrumentation Techniques Lab	
Course Objectives: CO1: To provide students with practical, hands-on experience in using a variety of laboratory instruments and techniques commonly employed in biochemistry research, including spectrophotometry, chromatography, gel electrophoresis, and PCR. CO2: To ensure that students become proficient in the operation and maintenance of laboratory instruments, allowing them to collect accurate and reliable experimental data. CO3: To teach students how to design experiments, execute protocols, and troubleshoot issues that may arise during laboratory work, fostering independence and problem-solving skills. CO4: To enable students to analyze and interpret the data they generate, helping them draw meaningful conclusions and relate their findings to biochemical principles. CO5: To instill a strong understanding of laboratory safety protocols, good laboratory practices, and ethical considerations in scientific research, ensuring the responsible and safe conduct of experiments.		
Nature of Paper: DSE		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)=8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents (Minimum any three from each unit, based on the facilities)	No. of Lectures Allotted
I	Qualitative analysis of Lipid, protein and Carbohydrate samples Colorimetric / Spectrophotometric estimation of: Carbohydrate - Glucose, glycogen, cholesterol etc, Protein, Phospholipids.	15
II	Analysis of enzyme activity, Study of temperature effect on enzyme action.	15
III	Instrumentation and Techniques Microscopes. To study the principle of UV & visible light spectroscopy.	15
IV	Flow cytometry. Isolation of DNA	15
Suggested Readings - Principles and Practice of Bioanalysis, R F Venn, Taylor and Francis. - Principles and Techniques of Biochemistry and Molecular Biology,(6th edition), K .Wilson and J Walker (editor), Cambridge University Press. - Biochemistry, D. Voet and J.G. Voet, John Wiley & Sons - Principles of Biochemistry, Lehninger, Nelson and Cox. - Principles and Techniques in Biochemistry and Molecular Biology, Edited by Keith Wilson and John Walker, Cambridge University Press.		

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D.	Year: I	
Class: M.Sc. Zoology	Semester: II	
Credits: 4	Subject: Zoology	
Theory: 4		
Practical: 0		
Course Code: MSZGE- NPN-124b	Title: Immunology	
Course Objectives: CO1: To provide a comprehensive understanding of the scope, historical background, and biological aspects of immunology. CO2: To examine the essential features of antigens and antibodies, including their structure, classification, and functional roles in the immune response. CO3: To elucidate the different types of immunity, immune responses, and the mechanisms underlying phagocytosis, interferon activity, and the complement CO4: To introduce students to autoimmune diseases, their mechanisms, and the clinical tests used to diagnose these conditions. CO5: To explore the immunological basis of transplantation, including graft types, transplantation reactions, and mechanisms of immunosuppression.		
Nature of Paper: Core/DSE/SEC/GE/AECC: GE		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P: 0 (In Hours/Week) 4 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction: Scope of Immunology, Historical background of Immunology, Biological aspects of Immunology, Self and non-self-recognition, specificity, memory of immune system. Antigens: Essential features of Ag, haptens, Carrier molecule, Antibodies: Nature, Primary structure of immunoglobulins, light chain, heavy chain, variable region, constant region,	12
II	Domain structure of Ig and significance; Classification of Immunoglobulins: Types –IgG, IgM, IgA, IgD and IgE (Origin, structural functions). Theories of Ab formation-Instructive, selective, clonal selection theories and evidences; Immunological memory. Antibody diversity: Mini gene theory, Mutation theory, Germ line theory, Hinge region; Enzymatic fragmentation of Ig.	12
III	Immunity: Types: Active and passive immunity. Cell mediated immunity, humoral immunity, immune response; primary and secondary response. Phagocytosis, mechanism of phagocytosis. Interferon: Types of Interferons. Null cells: Natural Killer cells. Complement system: Nature, components of compliment.	12

IV	Auto immunity: Introduction, Auto recognition, classes of auto immuno diseases. (Hashimoto disease, thyrotoxicosis, Systemic lupus erythematosus, Autoimmune haemolyticanaemia, Rheumatoid arthritis). Agglutination: Direct and Indirect, Widal test, VDRL test.	12
V	Transplantation: Terminology, Auto graft, Isograft, Allograft, Xenograft, Immunological basis of transplantation reactions, GVH reaction, Immuno suppression, General mechanisms of Immune suppression, Immune suppression, Major Histocompatibility Complex: MHC in mice and HLA in man-fine structure and functions only.	12

Reference / Text Books:

1. Essential immunology- Ivan M. Roitt.
2. Introduction to Immunology – John W. Kinball.
3. Immunology – D.M. Weir.
4. Immunology – Janis Kuby.

If the course is available as Generic Elective then the students of following departments may opt it.

1. NO
- 2.

Evaluation/Assessment Methodology

Max. Marks:100	
1. Sessional Examination	16
2. Assignments	5
3. Presentations /Seminar /Attendance	4
4. ESE	75
Total:	100

Prerequisites for the course:

Course Learning Outcomes:

- CLO 1: Students will be able to describe the scope, history, and biological aspects of immunology.
- CLO 2: Students will demonstrate an understanding of the structure and function of
- CLO 3: Students will explain the types of immunity, immune responses, and
- CLO 4: Students will identify various autoimmune diseases and explain their underlying mechanisms and diagnostic tests.
- CLO 5: Students will understand the immunological aspects of transplantation, including different graft types, transplantation reactions, and immunosuppression mechanisms.

IIMTU-NEP IMPLEMENTATION

Year: II /Semester: III

Programme: Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D. Class: M.Sc. Zoology		Year: II Semester: III
Credits: 4 Theory: 4 Practical: 0	Subject: Zoology	
Course Code: MSZC-NP-231	Title: Animal Physiology	
Course Objectives: CO1: To acquire integrated understanding of physiological mechanisms. CO2: To understand physiology of digestive and respiratory system of human beings. CO3: To understand blood composition, types, groups and circulatory system. CO4: To impart knowledge of physiology of excretory system and nervous system of human beings. CO5: To know the physiology of sense organs, muscles and reproductive system.		
Nature of Paper: Core/DSE/SEC/GE/AECC: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P: 2 (In Hours/Week) 8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Blood and circulation: Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis. Cardiovascular System: Anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump and blood pressure.	12
II	Nervous system: Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system. Sense organs: Vision, hearing and tactile response. Digestive system: Digestion, absorption, energy balance, BMR.	12
III	Respiratory system: Physiology of respiration, transport of gases, waste elimination, neural and chemical regulation of respiration. Excretory system: Physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, electrolyte balance, acid-base balance.	12
IV	Thermoregulation: Comfort zone, body temperature-physical, chemical, neural regulation, acclimatization, Stress and adaptation.	12
V	Endocrinology and reproduction: Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, neuroendocrine regulation.	12

Reference / Text Books:

- Verma PS, Tyagi and Agarwal, V.K. 2010 Animal Physiology. S Chand & company (P) Ltd, New Delhi, 2000
- Goel, K.A and Sastry, K.V, 1998 (IV Edition) A text book of Animal Physiology, Rastogi Publication, Meerut 250 002.

If the course is available as Generic Elective then the students of following departments may opt it.
 1.NO

Evaluation/Assessment Methodology

		Max. Marks:100
1. Sessional Examination		16
2. Assignments		5
3. Presentations /Seminar /Attendance		4
4. ESE		75
Total:		100

Prerequisites for the course:

Course Learning Outcomes:

- CLO1: Student will be able to explain various components of blood, cardiovascular system and their functions.
- CLO2: Student will be able to explain nervous system and digestive system.
- CLO3: Student will be able to explain the physiology of respiration and excretion.
- CLO4: Student will be able to explain process of thermoregulation, stress and adaptation.
- CLO5: Student will be able to explain endocrine system with special emphasis on hormonal functions.
- CLO6: Student will be able to distinguish between the endocrine, exocrine and mixed glands.

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: III

Programme:Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D.		Year: II
Class: M.Sc. Zoology		Semester: III
Credits: 2		Subject: Zoology
Theory: 0		
Practical: 2		
Course Code:MSZC-NP-231P		TITLE: Animal Physiology lab
Course Objectives: CO1: To understand procedure of total RBC and WBC count of your own blood. CO2: To find out haemoglobin percentage of your own blood. CO3: To understand the blood group and Rh+ and Rh-blood groups. CO4: To impart knowledge about the process of coagulation of blood. CO5: To study histological structure (liver, heart, pancreas, kidney)		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No	List of Experiments	No. of Lectures Allotted
1.	Enumerate the total RBC count of your own blood.	6
2.	Enumerate the total WBC count of your own blood.	6
3.	Find out the hemoglobin percentage of your own blood.	6
4.	To examine the given sample of human blood and identify blood group.	6
5.	Determination of Rh+ and Rh- blood groups	6
6.	To demonstrate coagulation of blood	6
7	To determine bleeding time of blood.	6
8	To determine clotting time of blood.	6
9.	To determine the blood pressure.	6
10.	To study Histological structure (liver, heart, pancreas, kidney)	6

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: III

Programme: Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D. Class: M.Sc. Zoology		Year: II Semester: III
Credits: 4 Theory: 4 Practical: 0	Subject: Zoology	
Course Code:MSZC-NP-232	Title: Animal Behavior	
Course Objectives: CO1: To understand fundamental concepts of animal behavior. CO2: To impart knowledge about perception of the environment CO3: To understand concept and types of learning. CO4: To understand pattern of nervous system in animals. CO5: To understand significance of social behavior.		
Nature of Paper: Core/DSE/SEC/GE/AECC: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P: 2 (In Hours/Week) 8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Concept of Animal behavior: Mile-Stones in the history of animal behaviour and scope. Stereotyped behaviour: Taxes, reflexes and instinct. Individual behavioural patterns: Conflict behaviour	12
II	Perception of the environment: Mechanical, Electrical, chemical, olfactory, auditory, visual Biological rhythms and concept of biological clock. Motivation: Introduction, goal oriented behaviour, biological drives– Primary and Secondary drives.	12
III	Concept of learning: law of learning, types of learning – Habitation, trial & error learning, latent learning, Insight, Imprinting and mechanism of learning. Communication: Study of communication, messages and their meanings, the forms of signals, communication in animals as language.	12
IV	Neural and hormonal control of behaviour: Neural structures, general pattern of nervous system in animals, hormones in relation to different behavioural patterns. Pheromones and behavior: Introduction, definition, classification and role of hormones behavioural patterns.	12
V	Social behavior: Social structures, social dominance, domestication, advantages of groupings, development, social organization in insects and primates.	12

Reference / Text Books:

1. Mechanism of Animal Behaviour, Peter Marler and J. Hamilton; John Wiley & Sons, USA, 2001
2. Animal Behaviour, David McFarland, Pitman Publishing Limited, London, UK, 1991
3. Animal Behaviour, John Alcock, Sinauer Associate Inc., USA
4. Concept of animal behaviour, Reena Mathur; Rastogi Publication, 2014.

If the course is available as Generic Elective then the students of following departments may opt it.

1.NO

Evaluation/Assessment Methodology

		Max. Marks:100
1. Sessional Examination		16
2. Assignments		5
3. Presentations /Seminar /Attendance		4
4. ESE		75
Total:		100

Prerequisites for the course:

Course Learning Outcomes:

- CLO1: Students will be able to explain concepts and principles of animal behavior, animal cognition, conservation psychology/biology and animal welfare science.
- CLO2: Student will be able to explain types of perception of the environment.
- CLO3: Student will be able to explain ethical standards in conducting and evaluating psychological and behavioral research.
- CLO4: Student will be able to explain different types of communication in animals.
- CLO5: Student will be able to explain Neural and hormonal control of behavior.
- CLO6: Students will be able to explain social organization in insects and primates.

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: III

Programme: Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D. Class: M.Sc. Zoology		Year: II Semester: III
Credits: 2 Theory: 4 Practical: 0		Subject: Zoology
Course Code: MSZC-NP-232P		TITLE: Animal Behaviour Lab
Course Objectives: CO1: To understand about simple reflex action/autonomic reflex action CO2: To understand conditioned reflex (Pavlovian conditioning). CO3: To understand imprinting and pheromones. CO4: To study effect of water temperature on the opercular movement of the given fish. CO5: To learn about wildlife zones of India.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S. No.	List of Experiments	No. of Lectures Allotted
1.	To study. simple reflex action/autonomic reflex action	8
2.	To study conditioned reflex (Pavlovian conditioning).	8
3.	To study imprinting.	4
4.	To study trail pheromones in Ants.	8
5.	To study habitat selection behaviour in earthworms (Temperature preference).	8
6.	To study habitat selection behaviour in earthworms (Light preference).	8
7.	To prepare charts of wildlife zones of India.	8
8.	To study effect of water temperature on the opercular movement of the given fish.	8

IIMTU-NEP IMPLEMENTATION

Year: II/ Semester: III

Programme: Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D. Class: M.Sc. Zoology		Year: II Semester: III
Credits: 4 Theory: 4 Practical: 0	Subject: Zoology	
Course Code:MSZDSE-NP-233a	Title: FISH BIOLOGY	
Course Objectives: CO1: To understand basis of classification of fishes. CO2: To learn general characters of Cyclostomes,Elasmobranchii, Actinopterygi and Crossopterygi.. CO3: To learn about types of locomotionand migration in fishes. CO4: To learn about types and modifications of fins and scales. CO5: To understand biological significance of endoskeleton and musculature.		
Nature of Paper: Core/DSE/SEC/GE/AECC: DSE		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P: 2 (In Hours/Week)8 Theory - 1 Hr. = 1 Credit Practical-2 Hrs.=1Credit (2Hrs./Week= 2Credits)		
Unit	Contents	No. of Lectures Allotted
I	Classification of fishes – Origin, affinities, general characters & important examples of Cyclostomata, Elasmobranchii, Actinopterygii, Crosspterygii and Dipnoi. Distribution of fishes-In marine and fresh water habitats, fresh water fish fauna of India, Marine fish fauna of India.	12
II	Migration in fishes- Types and pattern of migration, courses of migration. Locomotion in fishes - muscles, red and white muscle types, organization of myonemes, types of swimming and hydromechanics of propulsion, significance of swim bladder in swimming.	12
III	Body form and its diversity-Types of fins, origin of paired fins, modifications and functions of fins. Integument and exoskeleton-Types of scales.	12
IV	Biological significance of endoskeleton and musculature- Vertebral column, types of jaw suspension in fishes, structure arrangement and homology of Weberianossicles. Coloration in fishes-Chromatophores, types of chromatophores, morphological, physiological and biological significance of coloration in fishes.	12
V	Electric organs in fishes - Types of electric fishes, origin, structure and function of electric organs, location of electric organs, evolution of electro-	12

	receptors and electric organs. Luminescent organs in fishes - Location, structure and control of luminescent organs, physiological and biological significance of luminescence.	
Reference / Text Books: 1. Biology of Fishes by Quentin Bone and Richard H. Moore, 2008 2. The Biology of Fishes by M. Harry Kyle., 2007 3. Fish Biology and fisheries: S S Khanna., 2015		
If the course is available as Generic Elective then the students of following departments may opt it. 1. NO		
Evaluation/Assessment Methodology		
		Max. Marks:100
1. Sessional Examination		16
2. Assignments		5
3. Presentations /Seminar /Attendance		4
4. ESE		75
Total:		100
Prerequisites for the course:		
Course Learning Outcomes: CLO1: Student will be able to explain general characters and classification of fishes. CLO2: Student will be able to recognize life functions of fishes CLO3: Student will be able to explain ecological role of different classes. CLO4: Student will be able to describe diversity from cyclostomes to bony fishes. CLO5: Student will be able to explain the structure and functions of electric organs of various fishes. CLO6: Student will be able to describe physiological and biological significance of luminescence.		

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: III

Programme: Master of Science in Zoology		Year: II
Certificate/Diploma/Degree//PG/Ph.D.		
Class: M.Sc. Zoology		Semester: III
Credits: 2	Subject: Zoology	
Theory: 0		
Practical: 2		
Course Code: MSZDSE-233aP	TITLE: Fish Biology Lab	
Course Objectives:		
CO1: To understand taxonomic identification of local fish fauna.		
CO2: To understand various steps of mounting.		
CO3: To gain knowledge about Calculation of HIS, VIS and Condition factor of a given fish sample.		
CO4: To learn about morphology of fishes.		
CO5: To learn about anatomy of fishes.		
Nature of Paper: DSE		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4		
T:		
P: 4(In Hours/Week)		
Theory - 1 Hr. = 1 Credit		
Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No	List of Experiments	No. of Lectures Allotted
1.	Taxonomic Identification of Local fish Fauna	12
2.	Minor Dissection: (Through models and virtual labs) Accessory Respiratory Organs of: <i>Clarias Heterropneustes</i> Internal ear of <i>Channapunctate</i>	13
3.	Mounting: (Study through slides) Placoid Scales Cycloid Scales Cteniod Scales	12
4.	Calculation of HIS, VIS and Condition factor of a given fish sample.	12
5.	Field Visit/ Education visit of Students	12

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: IV

Programme: Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D.		Year: II
Class: M.Sc. Zoology		Semester: IV
Credits: 4		Subject: Zoology
Theory: 4		
Practical: 0		
Course Code: MSZC-NP-241F		Title: FISH PHYSIOLOGY
Course Objectives: CO1: To learn about taxonomy and biology of fishes as well as various aquaculture techniques. CO2: To impart knowledge about different types of fish shapes in relation to their environment CO3: To understand fish migration and factors affecting it CO4: To understand fish reproduction. CO5: To understand process of digestion and respiration in fishes.		
Nature of Paper: Core/DSE/SEC/GE/AECC: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P: 2 (In Hours/Week) 4 Theory - 1 Hr. = 1 Credit Practical-2 Hrs.=1Credit (2Hrs./Week=2Credits)		
Unit	Contents	No. of Lectures Allotted
I	Food, digestion and nutrition –Food, feeding habits, alimentary canal in fishes, physiology of digestion. Blood Vascular system- Heart and circulatory vessels, Blood, tissue fluids and blood forming organs, structure of the heart.	12
II	Respiratory System- Morphology of the gill epithelia, Structure and function of gill, gaseous exchange at the gill surface. Air breathing in fishes - Causes, adaptation for air breathing, accessory respiratory organs, morphology & function of pseudo branch.	12
III	Excretion- Structure and function of the kidney, osmoregulatory and excretory organs, excretory products. Nervous system & sense organs-Nervous system, Spinal cord, spinal nerves, autonomic nervous system, CNS and sense organs in fishes Reproduction & development –Types of reproduction, Reproductive system, reproductive cycles and breeding, parental care and development	12
IV	Endocrine glands in fishes - Pituitary, thyroid, gonads, adrenal, corpuscles of stannious, pancreas.	12
V	Adaptations in fishes - Deep sea adaptations, cave adaptations, hill stream fishes, freezing avoidance. Fish venoms - Poisonous fishes, venom apparatus, toxicology of fish venoms	12

Reference / Text Books:

1. Biology of Fishes by Quentin Bone and Richard H. Moore, 2008
2. The Biology of Fishes by M. Harry Kyle., 2007
3. Fish Biology and fisheries: S S Khanna. 2015

If the course is available as Generic Elective then the students of following departments may opt it.

1.NO

Evaluation/Assessment Methodology

Max. Marks:100

1. Sessional Examination	16
2. Assignments	5
3. Presentations /Seminar /Attendance	4
4. ESE	75
Total:	100

Prerequisites for the course:

Course Learning Outcomes:

- CLO1: Student will be able to explain diverse physiological systems in aquatic fauna.
 CLO2: Student will be able to discuss various fish body systems in fishes and their roles.
 CLO3: Student will be able to explain breeding and reproductive systems of male and female fishes.
 CLO4: Student will be able to explain fish nervous system and their importance.
 CLO5: Student will be able to explain process of digestion and respiration in fishes.
 CLO6: Student will be able to explain various physiological systems and their mechanisms in fishes.

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: IV

Programme: Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D. Class: M.Sc. Zoology		Year: II Semester: IV
Credits: 2 Theory: 0 Practical: 2	Subject: Zoology	
Course Code: MSZC-NP 241FP	TITLE: Fish Physiology Lab	
Course Objectives: CO1: To learn about Fish Osteology. CO2: To impart knowledge about opercular movement of fish. CO3: To learn about Aquarium maintenance CO4: To gain knowledge about water sample analysis. CO5: To study the physiological color change in the given fish by injecting the given hormone.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No.	List of Experiments	No. of Lectures Allotted
1.	Fish Osteology	10
2.	Observation of opercular movement of a selected fish	10
3.	Aquarium maintenance	10
4.	Water Sample Analysis	10
5.	To study the physiological color change in the given fish (<i>H. fossilis</i>) by injecting the given hormone (Adrenaline).	10
6.	Field Visit/ Education visit of Students	10

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: IV

Programme: Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D. Class: M.Sc. Zoology		Year: II Semester: IV
Credits: 4 Theory: 4 Practical: 0	Subject: Zoology	
Course Code:MSZC-NP-242F	Title: Fish Culture and Fisheries Science	
Course Objectives: CO1: To understand the techniques involved in aquaculture practices. CO2: To get a detailed information about aquaculture. CO3: To provide basic idea about the importance of live feed in culture systems. CO4: To impart knowledge about riverine and reservoir fisheries. CO5: To provide knowledge about various methods of fishing.		
Nature of Paper: Core/DSE/SEC/GE/AECC: core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P: 4 (In Hours/Week) 4 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction - Indian fisheries and World fisheries. Fish Culture- Fresh water fish culture in India, culture of Indian major carps (Rohu,Catla&Mrigal) exotic carps (Common carp, Grass carp, Silver carp), tilapia, Culture of air breathing fishes (<i>Heteropneustis</i> , <i>Clarias</i> , <i>Channa</i> & <i>Anabas</i>).	12
II	Riverine fisheries- Ecology and fisheries of the major river systems of India, Production and potential of riverine fisheries. Reservoir fisheries- Ecology of lakes and reservoirs, development, exploitation and management of reservoir fisheries.	12
III	Cold water fisheries - Ecology of high altitude streams, lakes and reservoirs, important cold water fisheries. Marine Capture fisheries - Capture fisheries of Sardines, Mackerel; Bombay duck, Ribbon fish, Pomfret, Tuna and Sole. Culture of pearl oyster & bivalves, present status & potential of mariculture in India. Crustacean fisheries - Prawn fisheries, lobster fisheries and crab fisheries, development and exploitation of crustacean fishery resources.	12
IV	Ecology and Productivity of fresh water pond, lake and river. Methods of fishing - Fishing effort, crafts and gears used in India for fishing. Recent advances in fishing methods-electrical fishing, light fishing, fish finders (echosounder and sonar) and their uses.	12

V	Environment & Fish - Environmental factors in relation to life of fishes, pollution of aquatic ecosystems, effects of water pollution on fishes, EEZ, Indian Antarctic Expedition & relevance to fishing.	12
Reference / Text Books: A text book of fish biology and fisheries by SS Khanna,2015 Ichthyology by Richardson,2018 Fish and Fisheries of India by Jinhgran,2004		
If the course is available as Generic Elective then the students of following departments may opt it. 1.NO		
Evaluation/Assessment Methodology		
		Max. Marks:100
1. Sessional Examination		16
2. Assignments		5
3. Presentations /Seminar /Attendance		4
4. ESE		75
Total:		100
Prerequisites for the course:		
Course Learning Outcomes: CLO1: Student will be aware of all the techniques involved in aquaculture. CLO2: Student will be able to explain aquaculture practices. CLO3: Student will be able to explain types of fishing methods used in aquaculture and fisheries. CLO4: Student will be able to explain pollution of aquatic ecosystems CLO5: Student will be able to explain fresh water fish culture in India. CLO6: Student will be able to explain ecology and fisheries of the major river systems of India		

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: IV

Programme: Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D. Class: M.Sc. Zoology		Year: II Semester: IV
Credits: 2 Theory: 0 Practical: 2		Subject: Zoology
Course Code:MSZC-NP-242FP		TITLE: Fish Culture and Fisheries Science Lab
Course Objectives: CO1: To provide knowledge about age determination using hard parts of fish CO2: To understand various types of cultivable freshwater fish species CO3: To gain the knowledge on aquaculture practices. CO4: To understand types of pollution of aquatic ecosystems CO5: To get a detailed information about aquaculture.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No	List of Experiments	No. of Lectures Allotted
1.	Age determination using hard parts of fish (Through virtual lab)	10
2.	To discuss the various types of cultivable freshwater fish species <i>Channamarulius</i> <i>Channapunctata</i> <i>Channa striata</i> <i>Channagachua</i> <i>Nandus nandus</i> <i>Ompok pabda</i> <i>Ailia coila</i> <i>Clarias batrachus</i> <i>Clarias gariepinus</i> <i>Bagarius bagarius</i> <i>Heteropneustes fossilis</i> <i>Sperata aor</i> <i>Mystus cavasius</i> <i>Mystus tengra</i> <i>Sperata seenghala</i> <i>Mystus vittatus</i> <i>Rita rita</i> <i>Wallago attu</i>	50

	<i>Mastacembelusarmatus</i> <i>Macrognathuspancalus</i> <i>Macrognathusaculeatus</i> <i>Notopterusnotopterus</i> <i>Notopteruschitala</i> <i>Labeocalbasu</i> <i>Labeovictoriances</i> <i>Labeorohita</i> <i>Catlacatla</i> <i>Puntiussarana</i> <i>Cirrhinusmrigala</i> <i>Cirrhinusreba</i> <i>Cyprinuscarpio</i> <i>Hypophthalmichthysnobilis</i>	

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: IV

Programme: Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D. Class: M.Sc. Zoology		Year: II Semester: IV
Credits: 4 Theory: 4 Practical: 0	Subject: Zoology	
Course Code:MSZDSE-NP-243AF	Title: Applied Fisheries	
Course Objectives: CO1: To impart knowledge about pisciculture in India and different methods of fish breeding techniques CO2: To provide knowledge about various types of fish diseases, fish processing technologies and quality assurance in fisheries. CO3: To explain the several types of feeds used in the fish nutrition and ornamental fishes. CO4: To provide knowledge about methods used for fish transportation and their role in the field of aquaculture and applied fisheries. CO5: To impart knowledge about Indian fishery Institutes.		
Nature of Paper: Core/DSE/SEC/GE/AECC: DSE		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P: 4 (In Hours/Week) 4 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Pisciculture - Objectives and applications. Fish Breeding & Hatchery Technology – Induced Breeding, Types of Hatchery and their Operation.	12
II	Fish Pathology - Symptoms, Etiology, Prophylaxis and Treatment of common diseases of cultivable fishes. Fish Processing Technology: Methods of Preservation of fish and prawn (chilling, freezing, quick freezing, salting, drying, freeze-drying, smoking, canning), Rigor mortis in fish, fish spoilage - bacterial & chemical. Quality Assurance: Value Added Products (Fish Fingers, Fish Flakes, Soup, Powder), Byproducts (Fish Meal, Fish Oil, Surgical Sutures).	12
III	Fish Genetics & Biotechnology: Genetic Improvement (Inbreeding & Cross Breeding), Transgenic fish & Shellfish. Fish Nutrition & Feed Technology: Feed formulation strategies & Methods, Types of feed & their ingredients, Formulation of feed for larvae, fry, fingerlings, adults & brood stock, formulation of nutritionally balanced & cost effective diets. Ornamental Fishes: Types of ornamental fishes, Aquarium manufacturing and their accessories.	12

IV	Fish Transport & Marketing – Handling & Transportation of Fresh Water Fish, Whole sale and Retail markets, Fishery cooperatives.	12
V	Fishery Education & Management - Objectives & function of Central Institute of Fishery. Education-CIFE, Central Inland Captured Fisheries Research Institute (CICFRI), Central Institute of Freshwater Aquaculture (CIFA), Central Marine Fisheries Research Institute (CMFRI), Fisheries legislation for resource management.	12

Reference / Text Books:

1. A text book of fish biology and fisheries by SS Khanna, 2015
2. Applied Fisheries by Laxmi Prashad, 2013

If the course is available as Generic Elective then the students of following departments may opt it.

1. NO

Evaluation/Assessment Methodology

Max. Marks:100	
1. Sessional Examination	16
2. Assignments	5
3. Presentations /Seminar /Attendance	4
4. ESE	75
Total:	100

Prerequisites for the course:

Course Learning Outcomes:

- CLO1: Student able to explain Pisciculture in India and different methods of fish breeding techniques.
- CLO2: Student identify various types of fish diseases, Fish processing technologies, and quality assurance in fisheries.
- CLO3: Student will be able to solve the problems on fish genetics and their constituent. Also, to explain the several types of feeds used in fish nutrition and ornamental fishes.
- CLO4: Student can develop the methods used for fish transportation and their role in the field of aquaculture and applied fisheries.
- CLO5: Student will be able to explain Indian fishery Institutes and the mandates regarding fish education in India.
- CLO6: Student builds basic understanding of fish and fisheries and its applications.

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: IV

Programme:Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D. Class: M.Sc. Zoology		Year: II Semester: IV
Credits: 2 Theory: 0 Practical: 2	Subject:Zoology	
Course Code:MSZDSE-NP-243aFP	TITLE: Applied Fisheries Lab	
Course Objectives: CO1: To understand techniques of breeding in fishes. CO2: To Learn about various types of by-products in fisheries CO3: To impart knowledge about induced Breeding with Pituitary Gland Extraction from Fish. CO4: To explain the several types of feeds used in the fish nutrition and ornamental fishes CO5: To gain knowledge about different types of nets and gears		
Nature of Paper:DSE		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No	List of Experiments	No. of Lectures Allotted
1.	Induced Breeding with Pituitary Gland Extraction from Fish. (Through virtual lab)	10
2.	To discuss the technique of Breeding in fishes.	10
3.	Comments upon the various types of by-products in fisheries Gelatine • Insulin • Fish Albumin • Fish Protein Concentrate • Shark Fin Rays • Chitin and Chitosan • Squalene • Isinglass • Collagen-Chitosan Membrane for Plastic Surgery and Dentistry • Fish cutlets • Fish finger • Fish Surumi	30
4.	Comment upon the different types of nets and gears	10

School of Life Science & Technology

ACADEMIC HAND BOOK



SCHOOL OF LIFE SCIENCES AND TECHNOLOGY
Post Graduate Program
(MICROBIOLOGY)
Ordinance & Academic Regulations
(Academic Session 2024-25)

PREAMBLE

The biological field of microbiology covers five different types of microorganisms: bacteria, protozoa, algae, fungi, and viruses. It investigates how they interact with their habitats, how these organisms are explored by humans, and how they have a detrimental as well as beneficial effect on living beings. By using microbes as study models, the study has extensions in numerous other conventional and cutting-edge domains of biology. Microbiology has been a branch of science since its inception, and it continues to be a rapidly developing area of active research that can be generally divided into pure and applied science. Since the discovery of microorganisms more than 350 years ago, a vast variety is believed to still be unexplored. Understanding various facets of microbiology has become essential and necessary to society as evident by the utilization of microbes in synthesis plethora of commercially important products and the recent outbreaks of various microbial disasters that shattered the mankind in every aspect. Hence microbiology research is now an essential component of education and the advancement of humanity. Microbiologists are constantly in demand in the fields of education, industry, and research. Microbiology students have equal career options in both industry and academia.

1. DEFINITIONS AND NOMENCLATURE

- a) **“Program”** indicates Degree Program like “Degree Program in Microbiology”
- b) **“Course”** denotes a subject that is studied in a semester, either theoretical or practical.
- c) **“Vice – Chancellor of IIMT-University”** denotes the Head of the University.
- d) **“Registrar”** is the University's chief academic and general administrative officer.
- e) **“Dean”** means the in charge of all academic activities for different programmes and the execution of pertinent regulations pertaining to the academic programme.
- f) **“Controller of Examinations”** signifies the University official in charge of all matters pertaining to university exams, including the release of results, the awarding of grade reports and degrees.
- g) **“Dean – Student Welfare”** is accountable for all activities involving students, such as student discipline, extracurricular and co-curricular pursuits, participation in and attendance at meetings with class representatives, the Student Council, and parent-teacher conferences.
- h) **“HOD”** means the Head of the Department concerned.
- i) **“University”** represents IIMT-University, Meerut.
- j) **“TCH”** means Total Contact Hours – refers to the teaching – learning periods.
- k) **“DEC” means Department Exam Committee.**
- l) **“BOS”** means Board of Studies.
- m) **“ACM”** indicates that the Academic Council will meet with the highest-ranking authority to approve all academic policies.
- n) **“Class Co-ordinator”** is a teacher who oversees the class's students' attendance, academic achievement, and behavior in general.
- o) **“IA”** is Internal Assessment which is evaluated for each student in every course throughout the semester.
- p) **“ESE”** is End Semester Examination administered in the University at the End of the Semester for all the courses.
- q) **“UGC”** is University grant Commission.
- r) **“MHRD”** meaning Ministry of Human Resources and Management, India

2. VISION AND MISSION OF THE SCHOOL

Vision: To become the finest institution and to create social, economical and intellectual well-being of the students through discovery, learning and innovations

Mission: To fulfill the educational needs of the students through imparting value based knowledge and innovative skills in an unbiased manner to meet greater challenges involving food, farming, fiber, feed, families, health, energy, water and environment

3. PROGRAM EDUCATIONAL OBJECTIVES FOR M. SC MICROBIOLOGY

The programme has been created in a way that exposes students to a solid theoretical and practical basis on a variety of microbiology disciplines.

PEO 1: To make the study of microbiology for the sustainable development of human society, the programme includes information on significant microorganisms of agricultural, medical, and industrial importance, biomolecules, tools and techniques, enzymes, immunology, cell biology, molecular biology, and genetic engineering.

PEO 2: To assist the growing demand for competent scientific personnel, with a focus on application, information sharing, and advancement in interdisciplinary fields connected to microbiology and the life sciences.

PEO 3: The practical courses are meant to give the students the laboratory expertise they need in microbiology. In addition to designing and carrying out experiments, students will be able to analyze and understand scientific data.

PEO 4: The programme will equip students with the knowledge and skills necessary for them to pursue further education in the fields of microbiology and related fields, as well as in multidisciplinary fields involving microbiology, biochemistry, biotechnology, and molecular biology. It will also assist in the development of a variety of generic skills important for fostering student entrepreneurship.

PEO 5: The students will learn about a variety of professions that mix microbiology, the environment, business, and medicine.

4. PROGRAM OUTCOME FOR M. SC MICROBIOLOGY

On completion of the course the students will be able to-

PO1: Be capable of providing high-quality clinical investigations by having knowledge and technical expertise related to Microbiology laboratories.

PO2: Handle common laboratory instruments, Perform sophisticated molecular microbiological techniques, maintain/operate laboratory equipment and Conduct standard clinical laboratory techniques while adhering to appropriate quality control standards.

PO3: Acquire problem-solving skills for identifying and addressing pre-, post-, and analytical variables. Thereby compiling and presenting research studies that progress all fields of advanced research using the basics of the research process.

PO4: Work in a wide range of professional and industrial research fields as a team leader or team member to gain real-world experience.

PO5: Foster a questioning mindset toward the growth of inventiveness and the improvement of entrepreneurship abilities.

5. PROGRAM SPECIFIC OUTCOME FOR M. SC MICROBIOLOGY

PSO1: Learners will be able to pick up specific knowledge and skills related to microbiology and apply them.

PSO2: Students will be able to understand the pathogenic as well as beneficial significance of microorganisms and microbial communities to man and nature, and appreciate the diversity of microorganisms and microbial communities inhabiting a multitude of settings.

PSO3: states that students will learn and be able to use good laboratory procedures in a Microbiological lab, and be able to describe the theoretical underpinnings and practical abilities of the tools/technologies typically employed to investigate this topic.

PSO4: Students will learn the basic theories and concepts underlying the diverse branches of agricultural and environmental microbiology.

PSO5: Students will gain acquaintance with and understanding of the ideas in microbiology as they relate to diverse fields, including biochemistry, microbial physiology, molecular biology, and genetics.

PSO6: states that students must demonstrate sufficient proficiency in the use of instruments, technological advancements, and microbiology-related procedures, as well as the use of logic and theory testing in the organisation and administration of exams.

PSO7: Students will have the knowledge and skills necessary to use microbiology to identify problems involving microorganisms, discuss these with colleagues, and take corrective action.

PSO8: Students will be able to explain the processes through which microorganisms acquire energy, carry out their metabolism, reproduce, survive, and interact with their surroundings, hosts, and host populations.

PSO9: Students will have a wide range of career options, including positions in higher education institutions teaching biological and medical science, environmental groups, public health, and the food, dairy, pharmaceutical, and biotechnology industries.

PSO10: Students in the M.Sc. Microbiology Program will develop their ability to reason scientifically as they explore a wide range of modern topics, including virology, microbial physiology, biochemistry, immunology, cell biology, genetics, molecular biology and microbial genetics, as well as the significance of environmental microbiology.

PSO11: Students will gain knowledge of the different biotechnological uses of microorganisms as well as the materials produced by microbes that are pertinent to industry.

They will gain knowledge of the unique function bacteria play in genetic modification techniques.

PSO12: Students will gain knowledge of proper lab procedures in a microbiological lab and be able to explain the theoretical underpinnings and practical applications of the equipment and technologies frequently employed in this field. Students can become proficient in the quantitative abilities required to study biological issues.

PSO13: Students will gain knowledge of experimental techniques, the development and testing of hypotheses, and the planning and carrying out of experiments. Students can improve both their capacity for critical thought and for reading and interpreting scientific texts. Students can develop strong oral and writing communication skills through the effective presentation of experimental results and workshops.

PO14: Use skill sets to comprehend the justifications for the numerous regulatory/legal organisations that control industry R&D.

PSO15: The courses will prepare students to pursue Ph.D.-level study in microbiology and related fields.

6. **ADMISSION**

- The UGC/NEP/AICTE and Ministry of Education (MOE), Government of India, have released guidelines on which the admission policy and method shall be decided.
- The number of seats must be in conformity with the university's regulations.
- Seats are also available for non-resident Indians and foreigners who meet the university's requirements for admission.

7. **ELIGIBILITY IN ALL YEAR AS NEP (ENTRY & EXIT)**

A Candidate who after having secured the B. Sc. degree in Microbiology / Biotechnology / CBZ / Agriculture / Life Sciences / BMLT with at least 40% Marks from a recognized University shall be eligible for admission to the course. The admission to the course will be on the basis of the merit and according to the guidelines from the university and Government of Uttar Pradesh. After the term-end examination at the end of each semester, the student will be provisionally admitted to the next semester. Each semester will be followed by a break not exceeding 15 days.

8. **CURRICULUM**

For the purpose of awarding degrees, the curriculum for M. Sc Microbiology programs is structured to have a minimum of credits + NCC (Non-credit Audit Courses) as specified in the evaluation scheme approved by the University's Board of Studies and spread out across six semesters of study.

Under CBCS, the degree program will consist of the following categories of courses:

- a) Core course
- b) Skill Enchantment Course – SEC
- c) Generic Elective Course – GEC
- d) Discipline Specific Elective - DSE
- e) Ability Enhancement Compulsory Courses – AECC

- NPTEL and Spoken courses are added as per program under Skill Enhancement Courses.
- NCC is added in each semester as per availability of seats
- Sport is integrated in the curriculum as a non-credit compulsory course.
- Generic Elective Courses are also added in the curriculum.

9. MEDIUM OF INSTRUCTION

All classes, exams, seminar presentations, and project reports are conducted in English.

10. CHOICE BASE CREDIT SYSTEM (CBCS)/LOCF/OBE

The university follows a flexible Choice based Credit System. Degree program will consist of the different groups of courses including Core course, Skill Enchantment Course, Generic Elective Course, Discipline Specific Elective, and Ability Enhancement Compulsory Courses. The student has the choice of how many credits to take each semester, subject to the minimum and maximum requirements of the curriculum.

11. REGISTRATION FOR COURSE IN A SEMESTER

In the beginning of the semester the candidate will choose the subjects of his choice and will register for the current semester within the 3 days of commencement of the semester

12. ATTENDANCE

Regular students are not allowed to take the semester exam unless they have consistently attended at least 75% of the total number of classes offered across all topics. However, the institution may allow a 10% reduction in attendance in each subject for any of the following reasons.

- a) Participation in NCC/ NSS Camps.
- b) Participation in University/ Inter-university/ State-level Games.
- c) Participation in other extra-curricular activities at University/ Inter-university/ State level.
- d) Prolonged Illness.

13.1 Condonation of Medical cases

For medical circumstances, it is required that the Dean (Students Welfare) get a thorough medical history, records, and prior information from the parent or legal guardian. The attendance sub-committee will evaluate these instances based on their merit and make recommendations to the Vice-Chancellor. If the Vice-Chancellor finds it appropriate and meritorious, he or she may then excuse absence based on the attendance subcommittee. The condonation cannot, however, be greater than 10%. For the duration of the programme, a student may receive such a pardon just twice.

13.2 Additional Condonation

In rare and real instances, additional condonation may be taken into consideration, including authorised leave for Participation in NCC/ NSS Camps.

- a) Participation in University/ Inter-university/ State-level Games.
- b) Participation in other extra-curricular activities at University/ Inter-university/ State level.
- c) Prolonged Illness

For such select NCC / Sports Camps prior permission for leave shall be obtained by the respective faculty coordinator / Director of sports from the designated authority, before deputing the students.

13. ASSESSMENT PROCEDURE

Two components of evaluation are required for the graduate course, namely

Internal Assessment: “IA”: This evaluation will take place according to the academic schedule during the semester.

External Assessment/End Semester assessment “ES”: In accordance with the academic calendar, this assessment will take place at the end of the semester.

14.1 Theory Assessment:

Each Core paper shall be of 100 marks, out of which internal and end semester assessments will carry 25 marks and 75 marks respectively. While the Ability Enhancement Courses will be of 50 marks out of which internal and external assessments will carry 15 marks and 35 marks respectively. Skill Enhancement Courses will carry the weight age of 50 marks.

INTERNAL AND EXTERNAL ASSESSMENT FOR THEORY			
Internal Assessment	Marks	External Assessment	Marks
Sessional	15	End Semester Final Examination	75
Assignment	5	-	-
Attendance	5	-	-
Total	25		75

14.2 Practical Assessment

INTERNAL AND EXTERNAL ASSESSMENT FOR PRACTICAL			
Internal Assessment	Marks	External Assessment	Marks
Lab Performance	6	Major Experiment	6
Quiz	6	Minor Experiment	4
Charts/ Model	8	Spotting	10
-	-	Viva	6
-	-	Record	4
Total	20	Total	30

14. RESEARCH PROJECT/SEMESTER PROJECT ASSESSMENT CRITERIA

Students will have to do a Research project during IV semester. Only Internal assessment of 40% and External assessment of 60% will be done. The project can be done under any external faculty too (outside the university) maintaining their attendance with the prior permission of the Dean of the said school.

For the assessment of the project work, student has to deliver a presentation regarding his work and give viva voce in front of the external examiner appointed by the University. The student shall submit the project report (4 copies) in the format prescribed by the University.

15. INTERNSHIP – RESEARCH / INDUSTRIAL INTERNSHIP

A student may do an internship during summer and winter break

16. FOR NON – CREDIT COURSES / AUDIT COURSES

The university has provided USR (University Social Responsibility) course and sports as non-credit/Audit course.

17. CREDIT WEIGHTAGE

Credits are the weightage, assigned to the courses based on the following general pattern:

One Hour: 1 credits (Theory)

Two Hour: 1 Credit (Practical)

18. MAXIMUM DURATION OF PROGRAM/PROMOTION POLICY

M.Sc. Microbiology will be a full time two year program to be covered in four semesters each of six months duration. The yearly structure of the program would be as given below:

I Year – I and II Sem.

II Year – III and IV Sem

M.Sc Microbiology Degree Programs will have the curriculum and syllabi (for 2 years) as approved by the respective Board of Studies and Academic Council of the University based on CBCS and NEP 2020.

A student may proceed through the curriculum more slowly than usual, but in no case longer than N+2 years. A student who completes their degree programme in the extra time will not be ranked by their university.

A student will be promoted if he/she fulfills the criteria of minimum percentage of marks to pass the examination in each Semester which will be as given below:

- 40 percent Marks in each written paper with internal and external assessment separately;
- 50% Marks in aggregate of each semester examination.
- A candidate will advance to the next higher semester if he or she receives at least a passing grade on 50% of the semester's compulsory papers; otherwise, the applicant will be judged to have failed the semester and will need to reapply and take all currently required exams.

19. MAXIMUM GAPS BETWEEN SEMESTER/YEAR

The Vice Chancellor may grant a student permission to withdraw from the full programme for a maximum of two semesters due to illness, a start-up business, or other good cause as suggested by the committee made up of the department head, school dean, and dean of student welfare.

20. CREDIT SYSTEM & GRADING CGPA/SGPA

The IIMT-University adopted the UGC directives for implementation of the choice-based credit system in 2015 to allow students the possibility to complete a programme by earning credits at a pace decided by them. According to their learning needs, interests, and aptitude, the technique allowed students to choose inter- or intra-disciplinary courses. It was viewed as a cafeteria approach and was expected to allow students mobility.

Since the current credit system used in institutions offers very little flexibility, choice, and is less learner-centric, extensive improvements are required. Today's degrees are more self-contained, concentrate on a certain field of study, and heavily rely on the faculty members' department-specific knowledge. Though there are thousands of educational institutions in India, only a small number of them offer the most essential credit system, which gives students a wide range of options and freedom. In these institutions, the curriculum is typically created with the learner in mind and offers a wide range of specialist areas from which students can select courses. The institutions will make an effort to have individual course instructors be in charge of the credit system design as well as the modalities of instruction and evaluation. Students should be allowed to choose courses outside of their primary focus and not be restricted to it. Stronger partnerships between university departments and the outside world are required for this.

CGPA/SGPA and grading will be done by CoE of the University.

21. CLASS / DIVISION

The division the candidate will be documented in the degree. The list of successful candidates after the six semesters of examinations for the Bachelor of Science programme shall be arranged as follows into divisions based on the total marks earned in all semester examinations calculated together.

- **First Division** to students obtaining 60% or more of the aggregate marks.
- **Second Division** to students obtaining 50% or more but less than 60% of the aggregate marks.
- Those who qualify all semester examinations in first attempt obtaining 75% or more marks in the aggregate shall be declared to have qualified with **DISTINCTION**.

Upon passing the semester exam, each successful candidate will be given a copy of their complete score report.

22. TRANSFER OF CREDIT /ACADEMIC CREDIT BANK

- 23.1 The Academic Council, acting on the advice of the newly formed Credit Transfer Committee, may, within the general parameters of these regulations, allow students to transfer a portion of the credit they have earned at other recognised universities in India or overseas.

- 23.2** On a case-by-case basis, the Academic Council may additionally authorise the admission of students who have successfully completed a portion of their coursework at another accredited institution of repute via the multiple entry & exit system.
- 23.3** Students who have completed at least one year of coursework at a university other than the one to which transfer is desired may apply for admission transfer to this institution. Only through a procedure that adheres to the same rules for new admissions may a student be admitted. To achieve credit transfer, all universities must adhere to a standard credit system.
- 23.4** Only once the student has been admitted to the relevant programme and the following requirements have been satisfied may a credit transfer request be made:
- The coursework was finished in a full-time, formal learning mode at a university that has received UGC approval and accreditation.
 - The accreditation grade or rating of the university is not inferior to that of the institution from which the transfer is requested.
 - Under the UGC CBCS system, the courses must adhere to the common minimum syllabus.
 - The courses were completed with a letter grade of "B" or above.
 - The total number of credits that can be transferred does not go over the established cap.

The programme in question must have a comparable credit system, specifically one that is modular or semester-based, the same system of letter and number grades, and a shared definition of "credit" in numerical terms.

When accepting credits, it is important to take the aspect of a course's shelf life into account because it is important to determine whether a particular field's expertise has become outdated or no longer relevant. It is important to take into account how much time has passed between successfully completing specific programme courses and being admitted to the programme to which transfer is desired. It is necessary to specify the maximum amount of credit points that may be taken into account during a credit transfer. While drafting the credit transfer policy, contextual factors such the teaching-learning methodology used, the learning facilities provided, and the use of evaluation modalities may also be taken into account.

23. CHANGE OF DISCIPLINE

The student can change the discipline within 15 days of commencement of the classes that too if the eligibility matches and availability of vacant seats.

24. USE OF TECHNOLOGICAL INTERVENTION

The ubiquity of various access devices, particularly mobile access devices, presents an opportunity for technology to enhance established teaching strategies and transform evaluation and learning processes. In reality, technology has the potential to be a key enabler of lifelong learning. The use of technology in a variety of ways, including synchronous learning, semi-

synchronous learning, blended learning, collaborative learning, the flipped classroom, etc., helps students learn and stay engaged.

MOOCs are a window of opportunity for lifelong learning and are delivered through technology-based platforms, particularly through SWAYAM. Institutions may employ learning management systems (LMS) to integrate the complete teaching, learning, and evaluation process. Institutions may use the learning management system to present academic material in a blended format and to evaluate student learning through theses, assignments, etc. You can submit content in the form of videos, audios, e-learning modules, live class sessions, and other formats using open-source learning management systems like Moodle and Edmodo. To verify the originality of content, it will be strongly advised to use plagiarism detection software.

Universities face many obstacles when conducting exams, including the need for trained staff, the need for error-free question paper distribution, the delay in answer script evaluation, the lack of infrastructure needed to conduct exams on a large scale, the unavailability of faculty members for evaluation, security concerns during paper setting and paper distribution, certificate and answer script tampering, and more.

For a typical examination department of a university, from student registration to convocation through an integrated system, it will be an autonomous entity. In actuality, actions must be taken to put in place a comprehensive examination management system that takes into account the entire life cycle of the examination process. Utilizing technology will eliminate errors and lessen reliance on human intervention. The subsequent processes will be automated:

- Student registration and creation of distinctive PRN.
- Filling up of examination form.
- Generations of seat numbers and admit cards/hall tickets.
- Making a list of paper setters.
- Generating question papers and creating question sets using a question bank system.
- Online release of exam-day question papers using an encryption mechanism.
- Barcode system for answer books (this will eliminate issues related to errors, avoid malpractices etc.)
- Digitalization of the answer papers and on-screen scoring of the answers.
- Monitoring student's performance.
- Submission of marks through online tools.
- Online system for viewing results.
- Online mechanism of verification and revaluation.

- Digitalization of diplomas and transcripts (to avoid tampering and easy retrieval).
- Certificate authentication system.
- Submission of various other applications through online system.

The aforementioned will result in the efficient and transparent operation of the examination system as well as the prompt dissemination of information to pupils

25. STUDENT DISCIPLINE

A student is expected to behave appropriately in accordance with the ethical and socio cultural standards established by the University for Day to Day living. Additionally, students must adhere to the norms and regulations established by the University for Various Activities.

26. STUDENT WELFARE

Any case of student disobedience that is brought to the attention of the Dean (Students Welfare) and the Head of the Department must be sent to a Discipline Committee formed especially for that purpose. The Committee will investigate the claims if they are accurate and choose an appropriate punishment. The committee will also give the Dean of Students Welfare approval to request that the Vice-Chancellor implement the decision. The Vice-Chancellor, to whom the offending student may appeal, shall render the final decision.

27. RAGGING

In our nation, ragging in any form is illegal and is not subject to bail. The state and federal laws in effect today offer severe penalties, including imprisonment for anyone involved in such act. Once a student's involvement in ragging, offending other students or staff, harassing other students or staff in any way, etc., is proven, the student may be expelled from the university in accordance with the specified UGC/Government/Institute procedures. Every senior student at the university has to sign and submit an undertaking in this regard, at the time of registration.

28. POWER OF MODIFY

Despite what has been said above, the academic council has the authority to change any or all of the mentioned regulations as necessary, subject to Board of Studies approval and Vice Chancellor approval in the final instance.

29. EXIT POINT

Student may exit after the completion of fourth semester of the two years' post graduate

30. NC/CREDIT COURSE

USR University Social Responsibility and Sports

Evaluation Scheme

M.Sc. MICROBIOLOGY
Semester-I

S.No.	Course Code	Subject	Course Type	Study Scheme			Evaluation Scheme			Credit
				L	T	P	Internal	External	Total	
1	MMBC-NP-111	Fundamentals of Microbiology & Bacteriology	C-13 Theory	4	0	0	25	75	100	4
2	MBTC-NP-111	Biochemistry and Instrumentation	C-14 Theory	4	0	0	25	75	100	4
3	MBTC-NP-112	Immunology	DSE-7 Theory	4	0	0	25	75	100	4
	MMBDSE-NP-113b	Biosafety & IPR								
4	NHU-N-111/NHU-N-112	English communication/ Environment and Ecology	AECC 5	3	0	0	15	35	50	3
5	GENCC-701	NCC	GenE	2						2
6	NECC-472	University Social Responsibility	USEC	0	0	0	25	0	NC	0
PRACTICALS										
1	MMBC-NP-111P	Fundamentals of Microbiology & Bacteriology Lab	Core13	0	0	2	20	30	50	2
2	MBTC-NP-111P	Biochemistry and Instrumentation Lab	Core 14	0	0	2	20	30	50	2
3	MBTC-NP-112P	Immunology	DSE7	0	0	2	20	30	50	2
	MMBDSE-NP-113bP	Biosafety & IPR								
		Total					150	350	500	
4	SPT-171	Sports	USEC	0	0	0	0	50	NC	0
21 (23 Including NCC)										

M.Sc. MICROBIOLOGY
Semester-II

S.No.	Course Code	Subject	Course Type	Study Scheme			Evaluation Scheme			Credit
				L	T	P	Internal	External	Total	
1	MMBC-NP-121	Mycology and Phycology	C-15 Theory	4	0	0	25	75	100	4
2	MMBC-NP-122	Virology	C-16 Theory	4	0	0	25	75	100	4
3	MBTC-NP-122	Molecular Biology	DSE-8 Theory	4	0	0	25	75	100	4
	MMBDSE-NP-123	Environmental Microbiology								
4	MMBGE-NP-124a	Biostatistics and Bioinformatics	GE-3	4	0	0	25	75	100	4
5	MMBGE-NP-124b	Pharmaceutical Microbiology								
6	GENCC-801	NCC	GenE	2						2
7	NECC-482	University Social Responsibility	USEC	0	0	0	25	0	NC	0
8	NECC-484	MOOCs	SEC4	2	0	0	50	0	50	2
PRACTICALS										
1	MMBC-NP-121P	Mycology and Phycology Lab	Core15	0	0	2	20	30	50	2
2	MMBC-NP-122P	Virology Lab	Core16	0	0	2	20	30	50	2
3	MBTC-NP-122P	Molecular Biology Lab	DSE-8	0	0	2	20	30	50	2
	MMBDSE-NP-123bP	Environmental Microbiology Lab								
		Total					210	390	600	
4	SPT-481	Sports	USEC	0	0	0	50		NC	0
24 (26 Including NCC)										

M.Sc. MICROBIOLOGY Semester-III										
S.No.	Course Code	Subject	Course Type	Study Scheme			Evaluation Scheme			Credit
				L	T	P	Internal	External	Total	
1	MMBC-NP-231	Industrial Microbiology	C-17 Theory	4	0	0	25	75	100	4
2	MMBC-NP-232	Medical Microbiology	C-18 Theory	4	0	0	25	75	100	4
3	MBTDSE-NP-233a	Recombinant DNA Technology	DSE-9 Theory	4	0	0	25	75	100	4
	MMBDSE-NP-233b	Soil & Agriculture Microbiology								
4	MMBGE-NP-234a	Food and Dairy Microbiology	GE-4	4	0	0	25	75	100	4
	MMBGE-NP-234b	Advances in Microbiology								
5	MMB-RP-231	Industrial training/Research Project	Industrial training/ Research Project	0	0	0	25	75	100	4
6	GENCC-901	NCC	GenE							2
7	NECC-592	University Social Responsibility	USEC	0	0	0	25	0	NC	0
PRACTICALS										
1	MMBC-NP-231P	Industrial Microbiology	Core-17	0	0	2	20	30	50	2
2	MMBC-NP-232P	Medical Microbiology	Core- 18	0	0	2	20	30	50	2
3	MBTDSE-NP-233aP	Recombinant DNA Technology	DSE-9	0	0	2	20	30	50	2
	MMBDSE-NP-233bP	Soil & Agriculture Microbiology								
		Total					185	465	650	
4	SPT-591	Sports	USEC	0	0	0	50	0	NC	0
26(28 Including NCC)										

M.Sc. MICROBIOLOGY
Semester-IV

S.No.	Course Code	Subject	Course Type	Study Scheme			Evaluation Scheme			Credit
				L	T	P	Internal	External	Total	
1	MMB-RP-241	Industrial training/Survey/Research Project	Industrial training/ Research project				75	225	300	20
2	GENCC-X01	NCC	GenE	2						2
3	NECC-5X2	University Social Responsibility	USEC				25		NC	2
4	NECC-5X4	MOOCs	SEC5 (2Cr)	2			50		50	
		Total					125	225	350	
22 (24 Including NCC)										

Evaluation Scheme

2024 (I and II Semester)

Department of Microbiology, IIMT University, Meerut
Study & Evaluation Schemes as per NEP-2020
M. Sc. Microbiology I Year/ Certificate Course
I Semester w. e. f. 2024-2025

S.No.	Course Type	Course Code	Subjects	Credit	Study Scheme			Evaluation Scheme		
					L	T	P	Internal	External	Total
1.	C-13 Theory	MMB-NPR-111	Introduction to Microbial World	4	4	0	0	25	75	100
2	C-14 Theory	MMB-NPR-112	Microbial Physiology and Biochemistry	4	4	0	0	25	75	100
3	DSE-7 Theory	MMBD-NPR-113a	Essential Tools in Biological Research	4	4	0	0	25	75	100
		MMBD-NPR-113b	Bioethics, IPR and Entrepreneurship							
4	AECC 5	NHU-N-111	English communication	3	3	0	0	15	35	50
5	GenE	GENCC-701	NCC	2						
6	VAC	VAC-I	(Indian Ethos and Modern Management)	2	0	0	2	20	30	50
7	USEC	NECC-472	University Social Responsibility	0	0	0	0	25	0	NC
PRACTICALS										
1	Core13	MMB-NPR-111P	Introduction to Microbial World Lab	2	0	0	2	20	30	50
2	Core 14	MMB-NPR-112P	Microbial Biochemistry & Microbial Physiology Lab	2	0	0	2	20	30	50
3	DSE7	MMBD-NPR-113aP	Essential Tools in Biological Research lab	2	0	0	2	20	30	50
		MMBD-NPR-113bP	Bioethics, IPR and Entrepreneurship lab							
4	USEC	SPT-471	Sports	0	0	0	0	0	50	NC
			Total					170	380	550

23 (25 Including NCC)

Department of Microbiology, IIMT University, Meerut
Study & Evaluation Schemes as per NEP-2020
M. Sc. Microbiology I Year/ Certificate Course
II Semester w. e. f. 2024-2025

S.No.	Course Type	Course Code	Subjects	Credit	Study Scheme			Evaluation Scheme		
					L	T	P	Internal	External	Total
1.	C-15 Theory	MMB-NPR-121	Medical Microbiology and Immunology	4	4	0	0	25	75	100
2	C-16 Theory	MMB-NPR-122	Applied Virology	4	4	0	0	25	75	100
3	DSE-8 Theory	MMBD-NPR-123	Molecular Microbial Genetics and RDT	4	4	0	0	25	75	100
		MMBDSE-NP-123	Environmental Microbiology							
4	AECC-6		Research and Publication ethics	3	3	0	0	15	35	50
5	GE-3	MMBG-NPR-124a	Microbial Pharmaceuticals and Forensic Research	4	4	0	0	25	75	100
		MMBG-NPR-124b	Mycology, Phycology and Parasitology							
6	Gen E	GENCC-801	NCC	2						
7	USEC	NECC-482	University Social Responsibility	0	0	0	0	25	0	NC
8	SEC4	NECC-484	MOOCs	2	2	0	0	50	0	50
PRACTICALS										
1	Core15	MMB-NPR-121P	Medical Microbiology and Immunology Lab	2	0	0	2	20	30	50
2	Core16	MMB-NPR-122P	Applied Virology Lab	2	0	0	2	20	30	50
3	DSE-8	MMBD-NPR-123aP	Molecular Microbial Genetics and RDT Lab	2	0	0	2	20	30	50
		MMBD-NPR-123b	Environmental Microbiology Lab							
4	USEC	SPT-481	Sports	0	0	0	0	0	50	NC
			Total					225	425	650

27 (29 Including NCC)

Format-1

NEP-2020 IMPLEMENTATION 3 STEPS PLAN (FORMAT-1,2& 3)
CBCS: Statement of Credits distribution

Format -1

College/School: Programme: Duration: UG (6 Sem.), UG (Hons./Research) 8 Sem., PG (4 Sem.)	Credit range: Minimum 120 for UG 160 for UG (Hons.), 80 for PG (Suggested by CBCS-NEP Committee)

COURSE	CREDIT	SEMESTER	CORE (Th 4+P 2) Major	DSE (Th 4+P 2) Minor	AECC (Th 3)	SEC **	GE (Th 4) Interdisciplinary	General Elective (2)	Value Added Course (VAC) (2)	Industrial Training/ Survey / Research Project (4)	Total Credits
Certificate Course in.....	52	Ist	C1-General Microbiology C 2- Bacteriology and Biosystematics	DSE 1- Basic Computer & Bioinformatics/ Biosafety and Intellectual Property Rights	AECC 1 English Communication/Environment Science			NC C	VAC- 1:(Indian Ethos and Modern Management)		25 (Excluding NCC)

		2nd	C3-Microbial Physiology & Metabolism C4- Basic Biochemistry	Control of microorganisms in the environment / Microbial Biotechnology	AECC 1/2- English Communication /Environment & Ecology	SEC 1 - MOOCs	GE1- Interaction with Entrepreneur in Microbial Technology and Startup/ Microbial technology for human welfare	NC C			27 (Excluding NCC)
Entry and Exit point											
Diploma in	54	3 rd	C5- Microbial Pathogenicity and Diseases C6-Virology	Basic Computers, Biostatistics & Bioinformatics / Microbial Entrepreneurship	AECC 3- Human values		GE 2-Food Fermentation Technology/ Microbial quality control in food & pharmaceutical industries	NC C	VAC-2- (Ancient Sanskrit Language)		27 (Excluding NCC)
		4 th	C7-Molecular Biology C8- Environmental Microbiology	Microbiological Methods / Pharmaceutical Microbiology	AECC 4- Professional Skills	SEC 2- MOOCs		NC C		Summer Internship in between 4 th and 5 th Sem. During session break (6-8 weeks) (Credit-4)	23+4= 27

Entry and Exit point

B.Sc.	52	5 th	C9-Microbial Genetics C10-Immunology	Epidemiology / Agricultural Microbiology			GE-3 Research writing	NC C	VAC-3- (Traditional System of Medicine)	Industrial Training/ Survey/Research Project (Credit-4, for 3 years programmes)	28
		6 th	C11-Industrial Microbiology C12-Medical Microbiology	DSE 6- Genetic Engineering & RDT/ Applied Techniques in Microbiology		SEC 3- MOOCs/N PTEL		NC C		Industrial Training/ Survey/Research Project (Credit-4, for 3 years programmes)	24 (Excluding NCC)

Note: For 04 years undergraduate programmes, research projects will be of 6 credits each in last 02 semesters.

*General Elective: Certificate will be provided to the students opted for NCC apart from degree.

** One SEC must be E&I and IPR (Can be through NPTEL or IPR can be from TIFAC, DST)

M.Sc.	101	7 th	C13- Fundamentals of Microbiology and Bacteriology C14- Biochemistry & Instrumentation	DSE 7- Essential Tools in Biological Research /Biosafety and IPR	AECC 5- English Communication/			NC C	VAC-1: (Indian Ethos and Modern Management)		23 (Excluding NCC)

		8 th	C15- Immunology and Medical Microbiology C16- Virology	DSE 8- Molecular Biology/ Environmental Microbiology		SEC 4- MOOCs	Pharmaceutical and Forensic Microbiology / Mycology and Parasitology	NC C	VAC-2- (Ancient Sanskrit Language)	Seminar/Industrial Training/Research (Credits-4)	30 (Excluding NCC)
		9 th	C17- Industrial Microbiology C18- Molecular Diagnosis, Drug Designing and Vaccines	DSE 9- Recombinant DNA Technology/S oil & Agriculture Microbiology			GE-4 Food and Dairy Microbiology /Advances in Microbiology	NC C	VAC-3- (Traditional System of Medicine)	Seminar/Industrial Training/Research (Credits-4)	28 (Excluding NCC)
		10 th				SEC 5- MOOCs		NC C		Research Project (Credits - 16)	20 (Excluding NCC)

Format-2

NEP-2020 IMPLEMENTATION 3 STEPS PLAN

Format-2

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
CERTIFICATE COURSES –(48 Credits)	FIRST YEAR	SEMESTER -I	i) C1- General Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C1- General Microbiology	Unit=6/Period=60	N/A	N/A
			ii) C2-Bacteriology and Biosystematics (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C2-Bacteriology and Biosystematics	Unit=6/Period=60	N/A	N/A
			iii) AECC-1/2- English communication/Environment & Ecology (Th.3 Cr)	3	3	45	iii) AECC-1/2- English communication/Environment & Ecology	Unit=5/Period=45	N/A	N/A
			iv) DSE 1- Basic Computer & Bioinformatics/ Biosafety and Intellectual Property Rights(Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iv) DSE 1- Basic Computer & Bioinformatics/ Biosafety and Intellectual Property Rights	Unit=5/Period=60	N/A	N/A

SEMESTER - II	i) C3-Microbial Physiology and Metabolism (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C3-Microbial Physiology and Metabolism	Unit=6/Period=60	N/A	N/A
	ii) C4- Basic Biochemistry (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C4- Basic Biochemistry	Unit=6/Period=60	N/A	N/A
	iii) AECC-1/2- English Communication/ Environment & Ecology (Th.3 Cr)	3	3	45	iii) AECC-1/2- English Communication/Environment & Ecology	Unit=5/Period=45	N/A	N/A
	iv) SEC-1 MOOCs (Th.2 Cr)	2	2	30	iv) SEC-1 MOOCs	Unit=5/Period=30	N/A	N/A
	v) DSE 2- Plant Pathology & Disease Management/Microbial Biotechnology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	v) DSE 2- Plant Pathology & Disease Management/ Microbial Biotechnology	Unit=5/Period=60	N/A	N/A
	vi) GE1-Interaction with Entrepreneur in Microbial Technology & Startup/Microbial world and Microbial diversity (Th.4 Cr)	4	4	60	vi) GE1--Interaction with Entrepreneur in Microbial Technology & Startup/Microbial world and Microbial diversity	Unit=5/Period=60	10+2 Bio	B.Sc. Biotech/Agri

Programme Outcome:

PO 1: Apply the knowledge acquired and comprehension of the principles of Microbiology as they relate to a variety of disciplines, including Medicine, Industry, the Environment, Genetics, Agriculture, Food, and others.

PO 2: Use skills learned during the programme with fluency that will allow students to pursue higher education, find employment in a variety of industries, and build their entrepreneurship capabilities.

PO 3: Exhibit essential practical abilities when dealing with microbes for research and application both in and out of the lab, including the application of sound microbiological principles.

PO 4: Clearly and concisely express scientific ideas, experimental findings, and analytical

Programme Specific Outcome:

PSO1: Students will be able to pick up specific knowledge and abilities related to microbiology and apply them.

PSO2: Students will be able to recognize the range of microbes and microbial communities that live in a variety of habitats and comprehend both their pathogenic and beneficial roles in the environment and in human health.

PSO3: Students will learn and be able to demonstrate mastery in acceptable laboratory procedures in a microbiological laboratory, as well as the theoretical underpinnings and practical abilities of the equipment and technologies typically used to investigate this discipline.

arguments related to the field of microbiology

PO 5: Correlate the subject to society and explain the benefit of Microbiology in development and welfare of the mankind

PO 6: Keep themselves skilled and advanced in the subject as the course includes more practical, which helps the students get hands on experience about the subjects taught

PSO4: The fundamentals of agricultural and environmental microbiology and associated concepts will be taught to the students.

PSO5: Students who complete the certificate programme will be able to apply for technical jobs at public and private research facilities.

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
DIPLOMA COURSE (96 Credits) --	SECOND YEAR	SEMESTER -III	i) C5- Mycology and Phycology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C5- Mycology and Phycology	Unit=6/Period=60	N/A	N/A
			ii) C6-Virology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C6-Virology	Unit=7/Period=60	N/A	N/A
			iii) AECC-3- Human Values (Th.3 Cr)	3	3	45	iii) AECC-3- Human values	Unit=5/Period=45	N/A	N/A
			iv) DSE-3- Biophysics and Biostatistics /Microbial products: Biofertilizers & Biopesticides (Th.4 Cr.+ P-2Cr.)	4+2	8	60+60	iv) DSE-3- Biophysics and Biostatistics/ Microbial products: Biofertilizers & Biopesticides	Unit=6/5Period=60	N/A	N/A
			vi) GE-2 Food Fermentation Technology/Microbial Quality control in food & pharmaceutical industries (Th.4)	4	4	60	vi) GE-2 Food Fermentation Technology/Microbial quality control in food & pharmaceutical industries	Unit=6/5Period=60	10+2 Bio	B.Sc. Biotech./HM/ Agri

SEMESTER - IV	i) C 7- Molecular Biology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	C 7- Molecular Biology	Unit=6/Period=60	N/A	N/A
	ii) C8-Environmental Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C8-Environmental Microbiology	Unit=5/Period=60	N/A	N/A
	iii) AECC-4-Professional skill (Th.3 Cr)	3	3	45	iii) AECC-4-Professional skill	Unit=5/Period=45	N/A	N/A
	iv) SEC-2MOOCs (Th.2 Cr)	2	2	30	iv) SEC-2 MOOCs	Unit=5/Period=30	N/A	N/A
	v) DSE-4 -Advanced Instrumentation: Principles and Applications/ Pharmaceutical Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	v) DSE-4 -Advanced Instrumentation: Principles and Applications/ Pharmaceutical Microbiology	Unit=5/5Period=60	N/A	N/A

Programme Outcome:

PO 1: Apply the knowledge acquired and comprehension of the principles of Microbiology as they relate to a variety of disciplines, including Medicine, Industry, the Environment, Genetics, Agriculture, Food, and others.

PO 2: Use skills learned during the programme with fluency that will allow students to pursue higher education, find employment in a variety of industries, and build their entrepreneurship capabilities.

PO 3: Exhibit essential practical abilities when dealing with microbes for research and application both in and out of the lab, including the application of sound microbiological principles.

PO4: Clearly and concisely express scientific ideas, experimental findings, and analytical arguments related to the field of microbiology

PO5: Correlate the subject to society and explain the benefit of Microbiology in development and welfare of the mankind

PO6: Keep themselves skilled and advanced in the subject as the course includes more

Programme Specific Outcome:

PSO1: Students will gain acquaintance with and understanding of the ideas of microbiology as they relate to diverse fields, including biochemistry, microbial physiology, molecular biology, and genetics.

PSO2: Students will demonstrate adequate proficiency in the use of tools, technological advancements, and microbiology-related procedures. They will also use theory testing and logical reasoning to plan and administer exams.

PSO3: Students will have the knowledge and skills necessary to use microbiology to identify problems involving microorganisms, discuss these with colleagues, and take corrective action.

PSO4: Students will be able to explain the processes, through which microorganisms acquire energy, carry out their metabolism, reproduce, survive, and interact with their surroundings, hosts, and host populations.

PSO5: The biological and medical sciences, environmental groups, public health, pharmaceutical, the food, dairy, and biotechnology industries are just a few of the career

practical, which helps the students get hands on experience about the subjects taught

options available to students after completing this programme.

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
UNDER GRADUATE DEGREE (142 Credits)	THIRD YEAR	SEMESTER - V	i) C9—Clinical and Diagnostic Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C9-- Clinical and Diagnostic Microbiology	Unit=5/Period=60	N/A	N/A
			ii) C10-Immunology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C10-Immunology	Unit=6/Period=60	N/A	N/A
			iii) DSE-5- Food and dairy Microbiology/ Microbes in Sustainable agriculture (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iii) DSE-5- - Food and dairy Microbiology/ Microbes in Sustainable agriculture	Unit=6/5Period=60	N/A	N/A
			*Research project/ Industry Training/ Internship Survey	4	4	60				
		SEMESTER - VI	i) C 11- Industrial Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C 11- Industrial Microbiology	Unit=5/Period=60	N/A	N/A
			ii) C 12-Medical Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C 12-Medical Microbiology	Unit=5/Period=60	N/A	N/A
			iii) SEC-3MOOCs (Th.2 Cr)	2	2	30	iii) SEC-3 MOOCs	Unit=5/Period=30	N/A	N/A
			iv) DSE-6 Genetic Engineering & RDT/ Advanced Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iv) DSE-6 Genetic Engineering & RDT/ Advanced Microbiology	Unit=5/5Period=60	N/A	N/A
			*Research project/ Industry Training/ Internship Survey	4	4	60				

*Research Topic may be selected from any one of 02 core papers.

Programme Outcome:

PO1: Apply the knowledge acquired and comprehension of the principles of Microbiology as they relate to a variety of disciplines, including Medicine, Industry, the Environment, Genetics, Agriculture, Food, and others.

PO2: Use skills learned during the programme with fluency that will allow students to pursue higher education, find employment in a variety of industries, and build their entrepreneurship capabilities.

PO3: Exhibit essential practical abilities when dealing with microbes for research and application both in and out of the lab, including the application of sound microbiological principles.

PO4: Clearly and concisely express scientific ideas, experimental findings, and analytical arguments related to the field of microbiology

PO5: Correlate the subject to society and explain the benefit of Microbiology in development and welfare of the mankind

PO6: Keep themselves skilled and advanced in the subject as the course includes more practical, which helps the students get hands on experience about the subjects taught

Note: Correlation between CO/PO/PSO3 are to be established by bloom taxonomy:

Programme Specific Outcome:

PSO1: Students enrolled in the B.Sc. Microbiology Program will develop their ability to reason scientifically as they research a wide range of modern topics, including Virology Bacteriology, Biochemistry, Immunology, Microbial Physiology, Cell Biology, Molecular Biology, Genetics and Microbial Genetics, as well as the significance of environmental microbiology.

PSO2: Students will gain knowledge of the numerous biotechnological uses of microorganisms as well as the compounds produced by microbes that are significant to industry. They will discover the unique function bacteria have in genetic modification techniques.

PSO3: Students will gain knowledge of proper lab procedures in a microbiological lab and be able to describe the theoretical underpinnings and practical applications of the equipment and technologies frequently employed in this field. Students can become proficient in the quantitative abilities required to study biological issues.

PSO4: Students will gain knowledge of experimental techniques, the development and testing of hypotheses, and the planning and carrying out of experiments. Students can improve both their capacity for critical thought and for reading and interpreting scientific texts. Students can develop strong oral and writing communication skills by presenting experimental results persuasively and by participating in workshops.

PSO5: The degree programmes will prepare students for advanced study in microbiology and related fields that lead to postgraduate and doctoral degrees.

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)

POST GRADUATE DEGREE (R) (187 Credits)	FOURTH YEAR	SEMESTER - VII	i) C13-Fundamental of Microbiology and Bacteriology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C13- Fundamental of Microbiology and Bacteriology	Unit=5/Period=60	N/A	N/A
			ii) C14-Biochemistry and Instrumentation (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C14- Biochemistry and Instrumentation	Unit=5/Period=60	N/A	N/A
			iii) DSE7-Immunology/Biosafety & IPR (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iii) DSE7- Immunology/Biosafety & IPR	Unit=5/Period=60	N/A	N/A
			iv) AECC 5- English Communication/Environment and Ecology (Th.3 Cr)	3	3	45	iv) AECC 5- English Communication/Environment and Ecology	Unit=5/Period=45	N/A	N/A
		SEMESTER - VIII	i) C15- Mycology and Phycology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C15- Mycology and Phycology	Unit=5/Period=60	N/A	N/A
			ii) C16-Virology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C16-Virology	Unit=5/Period=60	N/A	N/A
			iii) DSE8-Molecular Biology/Environmental Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iii) DSE8- Molecular Biology/Environmental Microbiology	Unit=5/Period=60	N/A	N/A
			iv) GE 3- Biostatistics and Bioinformatics/ Pharmaceutical Microbiology (Th.4)	4	4	60	iv) GE 3- Biostatistics and Bioinformatics/ Pharmaceutical Microbiology	Unit=5/Period=60	10+2 Bio	B.Sc. Biotech./ Agri.
			v) SEC 4- MOOCs (Th.2)	2	2	30	v) SEC 4- MOOCs	Unit=5/Period=30	N/A	N/A

***Dissertation report will be evaluated by external & internal examiners & Research topic may be selected from the main core paper**

Programme Outcome:

PO1: Be capable of providing high-quality clinical investigations by having knowledge and technical expertise related to Microbiology laboratories.
PO2: Handle common laboratory instruments, Perform sophisticated molecular microbiological techniques, maintain/operate laboratory equipment and Conduct standard clinical laboratory techniques while adhering to appropriate quality control standards.
PO3: Acquire problem-solving skills for identifying and addressing pre-, post-, and analytical variables. Thereby compiling and presenting research studies that progress all fields of advanced research using the basics of the research process.
PO4: Work in a wide range of professional and industrial research fields as a team leader

Programme Specific Outcome:

PSO1: Learners will be able to pick up specific knowledge and skills related to microbiology and apply them.
PSO2: Students will be able to understand the pathogenic as well as beneficial significance of microorganisms and microbial communities to man and nature, and appreciate the diversity of microorganisms and microbial communities inhabiting a multitude of settings.
PSO3: states that students will learn and be able to use good laboratory procedures in a Microbiological lab, and be able to describe the theoretical underpinnings and practical abilities of the tools/technologies typically employed to investigate this topic.
PSO4: Students will learn the basic theories and concepts underlying the diverse branches

or team member to gain real-world experience.

PO5: Foster a questioning mindset toward the growth of inventiveness and the improvement of entrepreneurship abilities.

of agricultural and environmental microbiology.

PSO5: Students will gain acquaintance with and understanding of the ideas in microbiology as they relate to diverse fields, including biochemistry, microbial physiology, molecular biology, and genetics.

PSO6: states that students must demonstrate sufficient proficiency in the use of instruments, technological advancements, and microbiology-related procedures, as well as the use of logic and theory testing in the organisation and administration of exams.

PSO7: Students will have the knowledge and skills necessary to use microbiology to identify problems involving microorganisms, discuss these with colleagues, and take corrective action.

PSO 8: Students will be able to explain the processes through which microorganisms acquire energy, carry out their metabolism, reproduce, survive, and interact with their surroundings, hosts, and host populations.

PSO9: Students will have a wide range of career options, including positions in higher education institutions teaching biological and medical science, environmental groups, public health, and the food, dairy, pharmaceutical, and biotechnology industries.

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
POST GRADUATE DEGREE (235 Credits)	FIFTH YEAR	SEMESTER -IX	i) C17-Industrial Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C17- Industrial Microbiology	Unit=6/Period=60	N/A	N/A
			ii) C18-Medical Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C18-Medical Microbiology	Unit=6/Period=60	N/A	N/A
			iii) DSE9-Recombinant DNA Technology/ Soil & Agriculture Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iii) DSE 9-Recombinant DNA Technology/ Soil & Agriculture Microbiology	Unit=5 Period=60	N/A	N/A
			iv) GE 4- Food and Dairy Microbiology/Advances in Microbiology (Th.4)	4	4	60	iv) GE 4- Food and Dairy Microbiology/Advances in Microbiology	Unit=6/5Period=60	B.Sc. Bio	M.Sc. Biotech
			*Research project/ Industry Training/ Internship Survey	4	4	60				
		SEMESTER -X	SEC 5 - MOOCs (Th.2)	2	2	30	SEC 5 MOOCs	Unit=5/Period=30		

			*Research project/ Industry Training/ Internship Survey	20						
*Research topic is to be selected from main core paper.										

Programme Outcome:

PO1: Be capable of providing high-quality clinical investigations by having knowledge and technical expertise related to Microbiology laboratories.

PO2: Handle common laboratory instruments, Perform sophisticated molecular microbiological techniques, maintain/operate laboratory equipment and Conduct standard clinical laboratory techniques while adhering to appropriate quality control standards.

PO3: Acquire problem-solving skills for identifying and addressing pre-, post-, and analytical variables. Thereby compiling and presenting research studies that progress all fields of advanced research using the basics of the research process.

PO4: Work in a wide range of professional and industrial research fields as a team leader or team member to gain real-world experience.

PO5: Foster a questioning mindset toward the growth of inventiveness and the improvement of entrepreneurship abilities.

Programme Specific Outcome:

PSO1: Students in the M.Sc. Microbiology Program will develop their ability to reason scientifically as they explore a wide range of modern topics, including virology, microbial physiology, biochemistry, immunology, cell biology, genetics, molecular biology and microbial genetics, as well as the significance of environmental microbiology.

PSO2: Students will gain knowledge of the different biotechnological uses of microorganisms as well as the materials produced by microbes that are pertinent to industry. They will gain knowledge of the unique function bacteria play in genetic modification techniques.

PSO3: Students will gain knowledge of proper lab procedures in a microbiological lab and be able to explain the theoretical underpinnings and practical applications of the equipment and technologies frequently employed in this field. Students can become proficient in the quantitative abilities required to study biological issues.

PSO4: Students will gain knowledge of experimental techniques, the development and testing of hypotheses, and the planning and carrying out of experiments. Students can improve both their capacity for critical thought and for reading and interpreting scientific texts. Students can develop strong oral and writing communication skills through the effective presentation of experimental results and workshops.

PSO5: Use skill sets to comprehend the justifications for the numerous regulatory/legal organisations that control industry R&D.

PSO6: The courses will prepare students to pursue Ph.D.-level study in microbiology and related fields.

Format-3

CORE-13

MMBC-NP-111: FUNDAMENTALS OF MICROBIOLOGY AND BACTERIOLOGY

Programme: Certificate/Diploma/Degree/PG Class: M.Sc. Microbiology	Year: I Semester: I	
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code: MMBC-NP-111	Title: FUNDAMENTALS OF MICROBIOLOGY AND BACTERIOLOGY	
Course Objectives: CO1: This course's major goal is to introduce students to the world of microbes. CO2: Students will understand diversity, classification, structure, evolution & cultivation of bacteria. CO3: To introduce students about the various methods of sterilization, prevention and control of bacteria. CO4: They will additionally learn how important bacteria are to both everyday life and the survival of every kind on Earth. CO5: To orient students about nutritional requirement and growth of bacteria. CO6: To learn the structure and function of different parts of Bacteria and Archaeobacteria		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Emergence of Microbiology as a Discipline Acharya Shushrut, Joseph Lister, Golden age of Microbiology, Support and contributions of Joseph Lister, Louis Pasteur, Antonie Von Leeuwenhoek, Robert Koch, E. Jenner, Ivanovski, Beijerinck; Mile stones or landmarks in Microbiology; Controversy of Spontaneous generation; Current theories on the origin of life and microbial evolution.	12
II	Taxonomy & Classification Haeckel's classification, Whittaker's classification, Carl Woese and Cavalier Smith's concepts of classification; Including 16S rDNA sequencing, current microbial categorization trends, Numerical taxonomy and Molecular taxonomy; Bergey's Manual of Determinative Bacteriology.	12
III	Bacterial morphology and fine structure Size, shape and arrangement of bacteria; Gram's negative, Gram's positive bacterial cell wall, synthesis of peptidoglycan; L forms,	12

	Structure and function of bacterial capsule, plasma membrane, flagella, fimbriae, pili, endospores gas vesicles, nucleoid, and cytoplasmic inclusions, carboxysomes, magnetosomes. General characters and classification of Archaeobacteria.	
IV	Cultivation of Bacteria Nutritional requirements and Nutritional types of bacteria (Phototrophs, chaemotrophs, autotrophs, heterotrophs and obligate parasite), Culture media; types of media (simple, complex, synthetic, selective, differential, enriched and transport media), preparation of culture media, cultivation of Aerobic bacteria and Anaerobic bacteria, Bacterial Growth curve, generation time, factors affecting the growth, batch culture and continuous culture.	12
V	Sterilization and Disinfection: Importance of sterilization, microorganism growth control using physical and chemical sterilization, dry heat sterilization, moist heat sterilization, incineration, etc. Pure culture techniques, methods for isolation of bacteria; preservation and maintenance of bacterial cultures.	12

Reference / Text Books:

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.
3. Cappuccino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGrawHill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. Matron Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw, Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

If the course is available as Generic Elective, then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology	
	Max. Marks:100
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	

Course Learning Outcomes:

By the end of this course, the students will be able to:

CLO1: Will be able to explain the history, scope and golden era of microbiology.

CLO2: Will in a position to clarify the taxonomy and classification of microorganism.

CLO3: Would be able to elaborate the morphology and fine structure of bacteria. Has acquired knowledge of various cell appendages and cytoplasmic inclusions.

CLO4: Would be able to defend the growth curve and cultivation of bacteria.

CLO5: Will acquire the knowledge of different methods of sterilization, prevention and control of bacteria.

CLO6: Will gain the details about various types of culture media and culture methods.

PRACTICALS

MMBC-NP-111P: FUNDAMENTALS OF MICROBIOLOGY AND BACTERIOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

1. To learn appropriate Laboratories Practices and Biosafety in Microbiology.
2. To learn the fundamentals and uses of essential equipment used in the microbiology lab, such as the autoclave, incubator, BOD incubator, hot air oven, light microscope, and pH meter.
3. To prepare various types of culture media for the growth of bacteria.
4. To sterilize the culture media using Autoclave and sterility testing.
5. To sterilize glass wares using Hot air oven and sterility testing.
6. To sterilize heat sensitive materials using membrane filters.
7. To demonstrate the presence of microflora present in the environment by exposing NAM plate to air
8. Demonstration of effectiveness of disinfectants.
9. To perform Gram's staining
10. Identification of bacteria based on morphological, biochemical and molecular characterization.

CORE-14
MBTC-NP-111: BIOCHEMISTRY AND INSTRUMENTATION

Programme: Certificate/Diploma/Degree/PG		Year: I
Class: M.Sc. Microbiology		Semester: I
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code: MBTC-NP111-	Title: BIOCHEMISTRY AND INSTRUMENTATION	
Course Objectives: CO1: The main goal of this essay is to give students a thorough understanding of the fundamental characteristics of various biomolecules, such as carbohydrates, lipids, proteins, and nucleic acids. CO2: The learners will learn the principles of thermodynamics and bioenergetics and CO3: The learners will learn how to apply bioenergetics to biological systems. CO4: The learners will learn the basic composition of various biomolecules. CO5: The learners will learn the structure and biological function of various biomolecules CO6: The learners will learn the classification and function of enzymes.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Concept of Bioenergetics Thermodynamics' first and second laws. Entropy, Gibb's Free Energy, and their mathematical relationships standard equilibrium constant and free energy change Coupled reactions, the additive nature of free energy change, and rich in energy substances like ATP.	10
II	Carbohydrate Aldoses, ketoses, and other monosaccharides Monosaccharides, epimers, mutarotation, and anomers of glucose all exhibit stereoisomerism. Haworth projection formulas for glucose, chair and boat forms of glucose, sugar derivatives, glucosamine, galactosamine, muramic acid, and furanose and pyranose forms of glucose and fructose Disaccharides: reducing and non-reducing sugars, maltose, lactose, and sucrose Haworth projections, Storage polysaccharides include starch and glycogen. structural polysaccharides, including chitin, cellulose, and peptidoglycan.	10

III	Protein Structures that are primary, secondary, tertiary, and quaternary. Amino acid titration curve and its significance, Amino acids are categorized as proteins' building blocks. Typical protein amino acid structure and notation in biochemistry Ninhydrin response. The definition of zwitterion and the generic amino acid formula. Hydrolysis, cystine, and hydroxyproline are naturally occurring modifications of the amino acids found in proteins. Gramicidin, beta-alanine, D-alanine, and D-glutamic acid are non-protein amino acids.	10
IV	Enzymes Enzyme structure, Enzyme classification, metal cofactors, the prosthetic group TPP, the coenzyme NAD, and the apoenzyme and cofactors Active site, transition state complex, and activation energy make up the enzymes' mechanism of action. Both the lock and key and the induced fit hypotheses. significance of the allosteric mechanism notion of V_{max} and K_m , enzyme unit, specific activity, and turnover number, and hyperbolic, double reciprocal graphs of enzyme activity. temperature and pH effects on enzyme activity. Competitive and non-competitive enzyme inhibition.	10
V	Lipids Lipids used in storage and structure. Triacylglycerols, Essential Fatty Acids, Storage Lipids, and Structure and Function of Fatty Acids. Saponification. lipids used in structure Phosphoglycerides: Components, Basic Structure, Uses, and Characteristics. Phosphatidylethanolamine and phosphatidylcholine molecule structures Sphingolipids are the ceramide and sphingosine's structural building blocks. Sphingomyelins, cerebroside, and gangliosides deserve special consideration. Lipid micelles, monolayers, and bilayers are introduced. Cell signals, cofactors, and prostaglandins all have lipid roles.	10
VI	Nucleic acids and vitamins Nucleoside and nucleotide structures, as well as purines and pyrimidines. The production of nucleotides. The basic structure of genomes rich in A+T and G+C. Structure of DNA and RNA types and purposes. Concept, varieties, and function of vitamins in metabolism.	10

Reference / Text Books:

1. Nelson D.L. and Cox M., Lehninger Principles of Biochemistry (2017), Seventh edition, Macmillan Learning, USA
2. Berg J.M., Stryer L., Tymoczko J.L., Gatto G. J., Biochemistry, (2015) Eighth edition, Macmillan Learning, USA
3. Upadhyay A., Biophysical Chemistry (2009), Himalaya Publishing House, India.
4. Wilson K. and Walker J., Principle and techniques of Biochemistry and Molecular Biology (2010), Cambridge University Press, UK.

5. Voet D., Voet J., Pratt C.W., Fundamentals of Biochemistry: Life at the molecular level, (2016) Fifth Edition, Wiley Publishers, USA.	
If the course is available as Generic Elective then the students of following departments may opt it. NO	
Evaluation/Assessment Methodology	
Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes: CLO1. will be able to recall the principles of thermodynamics applied to biological systems and will be able to calculate free energy changes accompanying metabolic reactions. CLO2. will be able to demonstrate the structures of carbohydrates and their key properties and their importance as functional components such as energy generation and as storage food molecules for bacterial cells. CLO3. will be able to determine about the structure and multifarious function of protein and amino acids are formation of polypeptides. CLO4. Will be able to categorize the basic concepts of enzyme biochemistry including enzyme kinetics, and will become aware of different variants of enzymes found in living cells and will be able to calculate enzyme activity and other quantitative and qualitative parameters of enzyme kinetics. CLO5. Will be able to appraise the properties of storage and membrane lipids and also will be acquainted with different types of lipid aggregates and their applications. CLO6. Will be able to formulate the structures and types of nucleic acid and also acquainted with different types of vitamins and their role in metabolic activities	
PRACTICALS	
MBTC-NP-111P: BIOCHEMISTRY AND INSTRUMENTATION LAB	
Marks: 50	Duration: 60 hours (2 credits)
1. Water characteristics, the idea of pH and buffers, creating buffers, and numerical problems to clarify concepts. 2. The use of pipettes and micropipettes and accuracy checks. 3. To create the desired Normality and Molarity in the solutions. 4. Numerical issues with equilibrium constant and standard free energy change calculations. 5. Coupled reactions with a standard free energy change. 6. Tests for carbs, reducing sugars, and non-reducing sugars that are qualitative or quantitative. 7. Lipids and protein qualitative and quantitative assays. 8. Model-based study of protein secondary and tertiary structures. 9. Calculation of the Vmax and Km values in the study of enzyme kinetics. 10. Research how heavy metals, pH, and temperature affect enzyme activity.	

DSE-7a
MBTC-NP-112: IMMUNOLOGY

Programme: Certificate/Diploma/Degree/PG		Year: I
Class: M.Sc. Microbiology		Semester: I
Credits: 6	Subject: MICROBIOLOGY	
Theory: 4		
Practical: 2		
Course Code: MBTC-NP-112		Title: IMMUNOLOGY
Course Objectives: CO1: Gain in-depth knowledge of the cells, tissues, and organs comprising the immune system, and comprehend their roles in defending the host against microorganisms. CO2: Understand the mechanisms employed by the immune system to recognize and eliminate pathogens, and grasp the process of immune response and the development of immunity. CO3: Recognize the intricate relationship between the immune system, pathogens, and the acquisition of immunity. CO4: Acquire knowledge of various immunological techniques used in research and diagnostics, and understand their applications. CO5: Explore common immunological disorders, their underlying mechanisms, and their impact on human health. CO6: Stay updated with recent advancements and breakthroughs in the field of Immunology, enabling students to critically evaluate and interpret scientific literature related to immunological research. CO7: By successfully completing the course, students will have developed a strong foundation in Immunology, enabling them to comprehend the intricacies of the host immune system, its interactions with pathogens, and the advancements in immunological techniques and disorders.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	History and Basic Concepts of Immunology: Basic concepts of immunology, History and development in immunology, Contributions of Various Scientists in the field on Immunology, Non-Specific (Innate Immunity) and Specific Immunity (Adaptive Immunity), Phagocytosis and Inflammation, Introduction to Immunological Tolerance:	10
II	Immune cells and organs: Structure, Functions, and Properties of Immune Cells: Explore the characteristics, roles, and properties of immune cells, including stem cells, lymphoid lineage cells (T cells, B cells, NK cells), and myeloid lineage cells (macrophages, neutrophils, eosinophils, basophils, mast cells, dendritic cells). Central and Peripheral	10

	Immune Organs: Understand the structure and functions of central immune organs (such as the bone marrow and thymus) and peripheral immune organs (such as lymph nodes, spleen, and mucosa-associated lymphoid tissue).	
III	Antigens and antibodies: Antigenicity and Immunogenicity: Differentiate between antigenicity and immunogenicity and understand the factors that influence an antigen's ability to induce an immune response. Properties of an Antigen: Study the characteristics and properties of antigens, including haptens, epitopes (T and B cell epitopes), and adjuvants. Antibodies: Explore the structure, types, functions, and properties of antibodies. Learn about antigenic determinants on antibodies (isotypic, allotypic, idiotypic) and concepts such as monoclonal and chimeric antibodies. Understand antibody diversity and its significance.	10
IV	Major Histocompatibility Complex: Organization of MHC Locus: Examine the organization of the Major Histocompatibility Complex (MHC) locus in mice and humans. Structure and Functions of MHC I and MHC II Molecules: Understand the structure and functions of MHC I and MHC II molecules and their roles in antigen presentation. Antigen Processing and Presentation: Learn about the cytosolic and endocytic pathways of antigen processing and the mechanisms of antigen presentation to T cells and B cells.	10
V	Complement System: Components of Complement System: Study the components involved in the complement system, a series of proteins that contribute to immune defense. Classical, Alternative, and Lectin Pathways of Complement Activation: Explore the three pathways (classical, alternative, and lectin) that lead to complement activation. Biological Consequences of Complement Activation: Understand the biological consequences of complement activation and its role in immune responses. Learn about the complement fixation test.	10
VI	Immunological Techniques and Disorders: Immunological Techniques: Introduce various immunological techniques such as precipitation, agglutination, immunodiffusion, immune electrophoresis, ELISA, western blotting, immunofluorescence, and flow cytometry, explaining their principles and applications. Immunological Disorders: Explore different types of immunological disorders, including autoimmune diseases (types and mechanisms), hypersensitivity reactions, and immunodeficiency disorders.	10

Reference / Text Books:

1. Janeway's Immunobiology by Kenneth Murphy. Garland Publishing, 9th Edition (March, 2016)
2. How the Immune System Works by Lauren M. Sompayrac Publication: Wiley-Blackwell; 5th Edition (September 2015)
3. Kuby Immunology by Thomas J. Kindt, Barbara A. Osborne, Richard Goldsby. Publisher: W. H. Freeman; 6th edition edition (October 2006)
4. Immunology: A Short Course by Richard Coico, Geoffrey Sunshine Publication: John Wiley & amp; Sons, (Jan-2015)
5. Textbook of Immunology by Arvind Kumar Publication: The Energy and Resources Institute

- (TERI), 01-Jan-2013 Chang, J.H., Jiang, Y., Pillarisetty, V.G., 2016. Role of immune cells in pancreatic cancer from bench to clinical application: An updated review. *Medicine* 95(49), e5541.
6. Liu, J., Cao, X., 2015. Regulatory dendritic cells in autoimmunity: A comprehensive review. *Journal of Autoimmunity* 63, 1-12.
 7. Ng, S., Galipeau, J., 2015. Concise review: engineering the fusion of cytokines for the modulation of immune cellular responses in cancer and autoimmune disorders. *Stem Cells Transl Med* 4(1), 66-73.
 8. Spagnolo, P., Rossi, G., Cavazza, A., Bonifazi, M., Paladini, I., Bonella, F., Sverzellati, N., Costabel, U., 2015. Hypersensitivity Pneumonitis: A Comprehensive Review. *J Investig Allergol Clin Immunol* 25(4), 237-250; quiz follow 250.
 9. Stenken, J.A., Poschenrieder, A.J., 2015. Bioanalytical chemistry of cytokines--a review. *Analytica Chimica Acta* 853, 95-115.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology	
	Max. Marks:100
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

Upon successful completion of the course, the student:

CLO1: will be able to gain familiarity with the historical development of immunology and comprehend the immune system's role in protecting against infections through various defense mechanisms.

CLO2: will be able to acquire knowledge of the characteristics and functions of immune cells, as well as the organization of immune organs, enhancing understanding of the immune system's structure and functionality.

CLO3 will be able to determine the factors that determine antigenicity and become familiar with the types, properties, and functions of antibodies generated against antigens. Gain insights into the production and application of monoclonal antibodies.

CLO4: Will be able to categorize the cell surface proteins involved in generating acquired immune responses and their significance in discriminating self from non-self molecules. Gain an understanding of antigen processing and presentation pathways.

CLO5: Will be able to appraise the recruitment and enhancing effects of the complement system, including how it complements the abilities of antibodies and phagocytic cells.

CLO6: Will be able to formulate the knowledge of the generation and mechanisms of action in humoral and cell-mediated immunity. Acquire proficiency in various immunological techniques. Gain insight into immunodeficiency disorders, including autoimmunity and hypersensitivity reactions.

PRACTICALS MBTC-NP-112P: IMMUNOLOGY LAB	
Marks: 50	Duration: 60 hours (2 credits)
1. Identify human blood groups through agglutination techniques. 2. Conduct Total Leukocyte Count (TLC) analysis on a provided blood sample. 3. Perform Differential Leukocyte Count (DLC) analysis on a given blood sample. 4. Demonstrate the separation of serum from a blood sample. 5. Conduct immunodiffusion using the double diffusion method (Ouchterlony method). 6. Perform DOT ELISA (Enzyme-Linked Immunosorbent Assay). 7. Conduct Immunoelectrophoresis analysis.	

DSE-7b
MMBDSE-NP-113: BIOSAFETY & IPR

Programme: Certificate/Diploma/Degree/PG		Year: I
Class: M.Sc. Microbiology		Semester: I
Credits: 6 Theory: 4 Practical: 2		Subject: MICROBIOLOGY
Course Code: MMBDSE-NP-113		Title: BIOSAFETY & IPR
Course Objectives: CO1: To learn the fundamentals of how a laboratory operates while performing all necessary safety precautions, handling live cultures, disposing of hazardous waste, and maintaining the equipment that requires safety audit. CO2: To study about biosafety regulations CO3: To examine and Control the Risks Associated with GMOs. CO4: The objective of this course is to give students a basic understanding of intellectual property rights so they can make significant contributions to the nation's economy through innovations and companies. CO5: To learn the patent filing procedure and the IPR Acts are covered in all of the course material. CO6: The course is intended to increase awareness of the need to preserve intellectual property.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	BIOSAFETY: GUIDELINES AND INTRODUCTION Concept of Biosafety and biosecurity, Biosafety concerns, Types of biological safety cabinets Primary Biohazard Containment; Specific Microorganism Biosafety Levels. Biosafety Recommendations: GMOs/LMOs - Issues and Challenges; National and International Biosafety policies and laws; Role of Institutional Biosafety Committees (IBSC), Review Committee on Genetic Manipulation (RCGM), Genetic Engineering Appraisal Committee (GEAC), State Biotechnology Coordination Committee (SBCC), District Level Committee (DLC) for GMO application in the field of Food, Dairy and Agriculture.	12
II	RISK MANAGEMENT AND GUIDELINES Genetically modified organisms (GMO) environmental release, risk analysis, risk assessment, risk communication, and risk management; Overview of International Agreements: Cartagena Protocol, GRAS organisms,	12

	Utilization of Animals in Testing and Research and alternative of animals in research, human and animal cloning, and its ethical implications, Human Volunteer Drug Testing by Public and Non-Governmental Organizations (NGOs), participation in biosafety and biodiversity protection, Regulations from Radiological Safety Division (RSD), Atomic Energy Regulatory Board (AERB) for employing radioisotopes in laboratories, Discarding of hazardous waste material, methods of disinfection.	
III	INTRODUCTION TO INTELLECTUAL PROPERTY History and an introduction to intellectual property; Trademarks, copyright, Patent, Trade secrets, Industrial Design and Rights, Traditional Knowledge, Geographical Indications; IPR (intellectual property rights) and IPP (intellectual property protection), The World Intellectual Property Rights Organization (WIPO), Ethics, the advantages and disadvantages of protecting intellectual property, the necessity of IPR, patentability and non-patentability, patenting life, and legal protection of biotechnological ideas.	12
IV	PATENT ISSUANCE, PATENTING AUTHORITIES, AND TREATIES Patent applications might be of the following types: Ordinary, Patent Cooperation Treaty (PCT) , Conventional, Divisional, and Patent of Addition; a Guide to Patent Filing Methods; Patent Licencing and Agreement; Patent Infringement- Meaning, Scope, Litigation, Case Studies; Rights and Duties of Patent Owner. GATT, TRIPS, WIPO, the Budapest Treaty on the international recognition of the deposit of microorganisms, the UPOV and Brene conventions, the Patent Co-operation Treaty (PCT), and the Indian Patent Act of 1970 and its most recent revisions are among the agreements and treaties. Patent of living microorganisms.	12
V	MICROBIOLOGY/BIOTECHNOLOGY PATENTING Microbiology and IPR-Rationale of Patents in innovation and Research, Microbiological Patents, Patentable subject matter, novelty, invention in microbiological research, industrial applicability, enablement requirement, patent specifications, and fundamental elements of licence agreement, System Categories of Biotechnological/microbiological Patents, Patenting in the New Genomic, Proteomic, and Biotechnology Era; Examples of Patents Granted by the USPTO; and Microbiology Patent Concerns. Microbiology/Biotechnology patenting: European, US, Australian, and Indian scenarios; non-patentable and patentable intellectual property; Indian Patent Act.	12

Reference / Text Books:

1. Private Power, Public Law: The Globalization of Intellectual Property Rights by Susan K. Sell Cambridge University Press, 2000
2. Essentials of Intellectual Property: Law, Economics, and Strategy by Alexander I. Poltorak; Paul J. Lerner Wiley, 2011 (2nd edition)
3. M K Sateesh Bioethics and Biosafety. Kindle Edition
4. Diane O. Fleming, Debra L. Hunt Biological Safety: Principles and Practices, 4th Edition. ASM 2006
5. Shomini Parashar, Deepa Goel IPR, Biosafety and Bioethics Pearson India 2013.

If the course is available as Generic Elective, then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology	
Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3)Assignments	04
4)Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes: After completing this course, the students will have: CLO1: Complete understanding of working in a microbiology lab while adhering to all safety precautions, handling live bacteria, disposing of infectious waste, and taking care of equipment that needs to be safety audited. CLO2: Will be able to develop a complete understanding of the biosafety standards and laws that are followed on a national and international level. CLO3: Will have gained knowledge of IPR concepts and its protection. CLO4: Will possess knowledge of the IP protection provided by patents, copyrights, and related rights. CLO5: In addition to specific microbiological examples, students will have acquired the fundamentals of IP protection through the use of trademarks, geographic indications, industrial designs, and new plant varieties. CLO6: will be able to explain about agreements, treaties, and laws relating to the protection of intellectual property.	
PRACTICALS MMBDSE-NP-113P: BIOSAFETY & IPR LAB	
Marks: 50	Duration: 60 hours (2 credits)
- To study safety precautions and good laboratory in a microbiological lab. - Introduction, use, and safety instructions for typical laboratory tools for studying microorganisms: Laminar air flow hood, clinical centrifuge, hot air oven, autoclave, colorimeter, and incubator. - To investigate the components and layout of a BSL II and BSL III laboratory. - To file requests for IBSC (biosafety committee) approval. - To draft and file initial patent applications. - To analyze the steps in the patenting process.	

CORE-15
MMBC-NP-121: MYCOLOGY AND PHYCOLOGY

Programme: Certificate/Diploma/Degree/PG		Year: I
Class: M.Sc. Microbiology		Semester: II
Credits: 6 Theory: 4 Practical: 2		Subject: MICROBIOLOGY
Course Code: MMBC-NP-121		Title: MYCOLOGY AND PHYCOLOGY
Course Objectives: CO1: The primary goal of this course is to provide students with a thorough understanding of fungi, algae, and cyanobacteria. CO2: To understand the reproduction and life cycle of various classes of fungi. CO3: To understand the reproduction and life cycle of various classes of algae and cyanobacteria. CO4: To give students in depth knowledge of biotechnological applications of various groups of algae and fungi. CO5: To understand the role of algae as pollution indicator. CO6: To study the industrial application of fungi and algae.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Mycology: The diversity and importance of mycology. Somatic structure, asexual and sexual reproduction in fungi, and distinguishing characteristics, Fungus classification. Ainsworth's classification system, Heterothallism, heterokaryosis, parasexual cycle, and dimorphism in fungi, Distinguishing characteristics of major fungal groups: Zygomycota, Ascomycota, Basidiomycota, Deuteromycota, and Oomycota.	12
II	Life Cycle of Fungi: Study of the several classes representing the following genera with regard to occurrence, somatic structure, life cycle, and economic importance: Acrasiomycetes (Dictyostelium), Myxomycetes (Endosporus and exosporus), Chytridiomycetes (Neocallimastix), Oomycetes (Phytophthora), Zygomycetes (Rhizopus), Ascomycotina (Hemiascomycetes-Saccharomyces, Plectomycetes-Penicillium Pyrenomycetes – Xylaria, Discomycetes - Peziza), Basidiomycotina (Hymenomycetes Agaricus, Teliomycetes - Puccinia), Deuteromycetes	12

	(Alternaria) Lichens: ascolichens, basidiolichens, deuterolichens, Mycorrhiza: ecto-, endo-, ectendo-, VAM.	
III	Fungal biotechnology: Industrial uses for fungi in fungal biotechnology mechanism for fungus fermentation, Alcoholic beverages (beer, wine), fermented foods (bread, mushrooms), important antibiotics produced by moulds (commercial manufacture of penicillin), and fungi as plant pathogen biocontrol agents Fungi as symbionts of insects, fungi's attack on other microorganisms, and fungi's potential use in agriculture, the environment, industry, and food. Fungi's role in the biodegradation of wood, paper, and textiles. Myxotoxins and fungal quorum sensing.	12
IV	Introduction of Algae: Algae distribution, general characteristics of algae, classification of algae, criteria for algal classification, Cell structure of algae, thallus structure, features, flagella, chloroplast, pyrenoid, pigments and their importance in classification, Nutrition, and reproduction; Cyanobacteria distribution, classification, thallus structure, and nutrition. A brief overview of the algae kingdoms Chlorophyta, Bacillariophyta, Phaeophyta, Rhodophyta, Algae Ecology and Algal Biotechnology,	12
V	Applied Phycology: The economic importance of algae in the production of algal pigments, biofuels, hydrogen, and important bioactive molecules, as well as their roles as eutrophication agents, bioremediation agents, global warming agents, and environmental sustainability agents. Algal biofertilizers and their role in soil fertility, Algae as food and medicine, Diatomaceous earth, Biological importance of phytoplanktons and water blooms Industrial applications and significance of algal and cyanobacteria.	12
Reference / Text Books: 1. Aneja, K.R. & Mehrotra, R.S. (2011). Fungal Diversity & Biotechnology. New Age International Publishers, New Delhi. 2. Alexopoulos, C. J., Mims, C.W. and Blackwell, M. (1996). Introductory Mycology. 4th edition John Wiley & Sons, USA. 3. Mehrotra, R.S. and Aneja, K.R. (2010). Introduction to Mycology. Wiley Eastern Ltd. New Delhi. 4. Moore –Lancker, E. (1996). Fundamentals of the Fungi. Prentice Hall. 5. Prescott, G.W. 1984. Algae: A review, Bishan Singh, Mahendra Pal Singh. Dehradun. 6. Kumar, H.D. Introductory Phycology. 2nd Ed. Affiliated East-West Press, New. 7. Vashishta, B.R and sinha, A.K., 2011. Fungi. 1st Edition. Published by S. Chand and Company Ltd. New Delhi. 8. Pelezar, J.M., chan E.C.S and Kreig, R.N. 2008. Microbiology. 13th Tata Mc. Graw Hill Publishing Company Ltd, New Delhi.		
If the course is available as Generic Elective, then the students of following departments may opt it. NO		

Evaluation/Assessment Methodology	
	Max. Marks:100
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3)Assignments	04
4)Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes: CLO1: Students will develop the knowledge about the introduction of general properties of Fungi. CLO2: Will be able to explain reproduction and life cycle of various classes of fungi. CLO3: Will be able to explain reproduction and life cycle of various classes of algae and cyanobacteria. CLO4: Has acquired knowledge of industrial application and biotechnology of Fungi. CLO5: Can isolate the bioactive molecules from algal and cyanobacterial groups. CLO6: Can be able to develop the algal strains for the bioremediations process.	
PRACTICALS MMBC-NP-121P: MYCOLOGY AND PHYCOLOGY LAB	
Marks: 50	Duration: 60 hours (2 credits)
Experiments List: - To prepare examine the lactophenol cotton blue slide of the fungus - To prepare and examine Cellotape preparation for the fungus. - To calculate and measure conidia/spores of fungus - To isolate microflora from soil samples. - To enumerate and count fungal aerospores. - To prepare the slide for the identification of Yeast Candida albicans and Saccharomyces cerevisiae. - To isolate and identify Algae and cyanobacteria.	

CORE-16
MMBC-NP-122: VIROLOGY

Programme: Certificate/Diploma/Degree/PG	Year: I	
Class: M.Sc. Microbiology	Semester: II	
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code: MMBC-NP-122	Title: VIROLOGY	
Course Objectives: CO1: The primary goal of this course is to familiarize students with the fundamentals of virus structure, genome organisation, and host cell replication techniques. CO2: The students will learn the nomenclature and classification of viruses. CO3: The students will learn how to cultivate different DNA and RNA viruses. CO4: The learner will discover how different DNA and RNA viruses evolve, spread, and cause disease, as well as how to stop them. CO5: The students will learn the morphology, pathogenesis, prevention and control of different DNA and RNA Viruses CO6: Different plant viruses are described in the course as well.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	General properties of Viruses History and principles of virology, Nomenclature, taxonomy and classification of viruses, Structure and morphology of viruses, Arrangements of capsids, Components of genomes, Replication of viruses, Isolation, purification and cultivation of viruses, Introduction, history, morphology and life cycle of Bacteriophages, bacteriophage typing,	12
II	Pathogenesis of Viral Infection Introduction to viral infection, stages and mechanisms of viral infections, viral pathogenesis at the cellular level, host response to viral infections, clinical manifestations of viral diseases, Epidemiology	12
III	Morphology, Replication, Pathogenesis, Prevention and Control of DNA Viruses: Small DNA viruses: Parvoviruses and Papova viruses, Large DNA viruses: Herpesviruses (Herpes Simplex Virus I, Herpes Simplex Viruses II, Varicella Zoster virus, Epstein Barr virus), Adenovirus, Hepatitis viruses and Pox viruses.	12

IV	Morphology, Replication, Pathogenesis, Prevention and Control of RNA Viruses: Positive strand RNA Viruses: Picornaviruses (Polio), Flaviviruses- West Nile virus, Dengue virus, Coronaviruses- SARS and Swine flu. Negative strand RNA viruses: Orthomyxoviruses (Influenza), Paramyxoviruses (Mumps and Measles), Rhabdoviruses, (Rabies), Double strand RNA (dsRNA) viruses- Reoviruses, Retroviruses: structure, classification, life cycle; reverse transcription, Retroviruses: HIV viral pathogenesis and AIDS.	12
V	Plant virology Significance of plant virology and modern classification of plant viruses and viroids according to ICTV; and cryptograms of various plant viruses and virus groups.	12

Reference / Text Books:

1. Flint SJ, Enquist LW, Krug RM, Racaniello VR, and Skalka AM (2008), Principles of Virology 3rd edition, ASM Press Publication.
2. Fields B, Knipe D and Howley P (1989), Fields Virology 5th Edition, Lippincott Williams and Wilkins Publisher.
3. White DO and Fenner FJ (1986). Medical Virology 4th edition, Academic Press Inc.
4. Vinod Singh; Text Book of Virology, Ibdc Publishers.
5. Biswas SB & Biswas A (2006). An introduction to viruses, 4th edition, Vikas Publishing house Pvt Ltd, India.
6. Virology: 1994. 3rd ed. Frankel Conrat et al, Prentice Hall.
7. Introduction to Modern Virology. 2001. 5th ed. Dimmock et al., Blackwell Scientific Publ.
8. Basic Virology, 1999. By Wagnier and M. Hewlett, Blackwell Science Publ.

If the course is available as Generic Elective, then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

CLO1: Will develop the knowledge about the history, structure, classification, nomenclature, and cultivation of virus.

CLO2: Will be familiar to the study of the virus infection mechanism and have acquired the knowledge of some human DNA viruses and RNA viruses.

CLO3: Will acquired the knowledge about the details of bacteriophages.

CLO4: Have acquired knowledge of morphology, pathogenesis, prevention and control of diseases caused by various DNA viruses.

CLO5: Have acquired knowledge of morphology, pathogenesis transmission and prevention of

diseases caused by different RNA viruses.

CLO6: Will acquired the knowledge of Plant viruses.

PRACTICALS
MMBC-NP-122P: VIROLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

List of Experiments

1. Introduction to Virology laboratory safety guidelines & aseptic techniques.
2. Collection, transport and storage of specimens.
3. Isolation of viruses.
4. Rapid culture methods.
5. To detect Viral antigen by Immunofluorescence assay
6. To detect Viral antigen by Immunochromato graphic assay (One step hepatitis B surface antigen (HBsAg) test)
7. To detect Hepatitis B surface antigen
8. (HBsAg) by ELISA.
9. Antibody Detection Methods: IC Rapid Anti-HCV Test.
10. Nucleic Acid Extraction for Polymerase Chain Reaction (PCR)

DSE-8a
MBTC-NP-122: MOLECULAR BIOLOGY

Programme: Certificate/Diploma/Degree/PG		Year: I
Class: M.Sc. Microbiology		Semester: II
Credits: 6 Theory: 4 Practical: 2		Subject: MICROBIOLOGY
Course Code: MBTC-NP-122		Title: MOLECULAR BIOLOGY
Course Objectives: CO1: The main goal of this work is to create a comprehensive knowledge of how prokaryotic genome organization and expression relate to their ability to survive and reproduce. CO2: Students will master the fundamentals of molecular biology, which will serve as the foundation for later courses. CO3: The learners will learn the overview of genome organization. CO4: The learners will learn replication techniques. CO5: The learners will learn these processes' transcription, translation, and post mechanism. CO6: The learners will learn the mechanism to regulate gene expression.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Overview of the genome organization DNA types, genetic material types, and DNA structure: highlights of the double helix. RNA Organization. Cot curves, denaturation, and renaturation. DNA topology: topoisomerases, connecting numbers. DNA organization in viruses, eukaryotes, and prokaryotes.	10
II	DNA Replication in Prokaryotes and Eukaryotes: Semi-conservative and semi-discontinuous replication, bidirectional replication, and unidirectional replication. replication of DNA mechanism, Chromosome replication is completed. DNA replication techniques. Eukaryotic and prokaryotic replication are different.	10
III	Transcription in Prokaryotes and Eukaryotes: Concept of a transcription unit, promoter: its composition and function. Prokaryotes and eukaryotes both undergo general transcription; eukaryotes also undergo post-transcriptional modification. Prokaryotic and eukaryotic RNA Polymerases, RNA Interference, and tRNA and rRNA processing.	10
IV	Post-Transcriptional Processing:	10

	RNA splicing, the idea of introns and exons, the spliceosome system, the idea of alternative splicing, polyadenylation, and capping of gene splitting. rRNA processing. The importance of RNA interference. microRNAs: their importance and role.	
V	Translation in prokaryotes and eukaryotes: tRNA structure, ribosome structure Prokaryotic and eukaryotic translational mechanisms, gene sequences, Wobble hypothesis, accuracy of the translation.	10
VI	Regulation of gene expression in prokaryotes and eukaryotes: Mechanisms for controlling transcription, regulating gene expression, DNA methylation-based gene regulation, and histone acetylation-based gene regulation Translation control systems, inducible operons, and repressible operons.	10

Reference / Text Books:

1. Lewin's Genes XII by Krebs J.E., Goldstein E.S., Kilpatrick S.T., Jones and Bartlett Publishers (2017).
2. Molecular Biology of the Gene by Watson J.D., Baker T.A., Bell S.P., Gann A., Levine M., Lodish R., Pearson Education (2013).
3. Molecular Cell Biology by Lodish H.F., Berk A. , Kaiser C.A., Krieger M., Bretscher A., Ploegh H. , Amon A., Martin K.C., 8th edition, Macmillan Publishers (2016).
4. Cell and Molecular Biology: Concepts and Experiments by Gerald Karp. 8th Edition, John Wiley & Sons Inc, (2016).

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

CLO1: Will be able to recall the differences between prokaryotic and eukaryotic genome organisation, as well as the prokaryotic cellular structure and functional components of cells.
CLO2: Will be able to demonstrate the mechanisms through which chromosomal and extra chromosomal genes and sequences replicate, transmit, and act.
CLO3: Will be able to determine and classify multiple levels of genetic regulatory systems.
CLO4: Will be able to categorize split genes, introns, exons, spliceosomes and alternative splicing besides learning about other processing events like polyadenylation and capping. Will become familiar with RNA interference and its significance, siRNA and miRNA
CLO5: Will be able to appraise internal and external signals affecting microbial diversity, control gene expression, and influence microbial communities and their habitats.

CLO6: Will be able to formulate mechanisms that control how genes are expressed.

PRACTICALS

MBTC-NP-122P: MOLECULAR BIOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

List of Experiments-

1. Study of various DNA and RNA types utilizing micrographs and models or schematics.
2. Study of DNA replication in a semi-conservative manner using micrographs or schematics.
3. Agarose gel electrophoresis study of genomic DNA isolated from E. coli.
4. Utilization of diphenylamine reagent to estimate DNA.
5. Protein separation utilizing polyacrylamide gel electrophoresis (SDS-PAGE) and Coomassie dye visualization.
6. Examine how bacterial cells are affected by physical (UV) and chemical (HNO₂) mutagens.
7. Examine the bacterial survival curve following exposure to ultraviolet (UV) radiation.
8. Bacterial transformation demonstration, and calculation of the efficiency of the transformation.

DSE-8b

MMBDSE-NP-123: ENVIRONMENTAL MICROBIOLOGY

Programme: Certificate/Diploma/Degree/PG Class: M.Sc. Microbiology		Year: I
Credits: 6 Theory: 4 Practical: 2		Semester: II
Course Code: MMBDSE-NP-123		Subject: MICROBIOLOGY
Course Objectives: CO1: To understand the diversity of microorganisms present in various ecosystems. CO2: The focus of the students' knowledge will be on how microorganisms interact with each other, with higher plants and animals, and with humans. CO3: Students will learn the details related to Microbial bioremediation. CO4: The students will learn about different techniques used in environment microbiology. CO5: Additionally, the students will learn about a variety of environmental problems and be inspired to develop novel, long-lasting solutions. CO6: To learn various techniques related to liquid and solid waste management.		Title: ENVIRONMENTAL MICROBIOLOGY
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	History and development of environmental microbiology Historical highlights, Introduction of air, water and soil microbiology, Existence, diversity, adaptations and potential applications of extremophiles (alkalophiles, acidophiles, halophiles, psychrophiles, thermophiles, methanogens, methylotrophs, oligotrophs, barophiles, organic solvent and radiation tolerants, metallophiles), Concept of metagenomics.	12
II	Microbial interactions and Biogeochemical cycling Microbes in nutrient cycling with particular reference to the carbon, phosphorous, sulphur, and nitrogen cycles; Microbial degradation of lignocellulosic compounds, keratin, and chitin, as well as Xenobiotics; Interaction between Microbes: Mutualism, synergism, commensalism, competition, amensalism, parasitism, and predation; Plants and microbes Interactions (associated with roots and aerial plant surfaces): Rhizobium Symbiosis, Anabaena-Azolla Symbiosis, Mycorrhizal Associations, Actinorhizal Associations; Animal and microbes interactions: Termite gut microflora, nematophagus fungus, and symbiotic luminous bacteria.	12

III	Microbial bioremediation Cleanup of areas contaminated by heavy metals, oil spills and chlorinated solvents; Microbial degradation & decomposition of pesticides, hydrocarbons; Effluent's biological treatment of pulp, sugar and paper industry; The recovery of metals and minerals from ores, Biodeterioration of heritage buildings and cultural artefacts; microbiological deterioration of paint, paper, textiles, wood, and metal corrosion. Principal methods for their protection.	12
IV	Techniques in environment microbiology Understanding microbial diversity in the environment through culture-dependent techniques and their limitations, as well as through culture-independent molecular techniques (DNA heterogeneity by reannealing denatured environmental DNA, ARDRA, analysis of FAME profiles, determining metabolic capability using BIOLOG microtiter plates, using DNA probes and PCR primers, G+C analysis, slot-blot hybridization of community DNA, and fluorescent in situ hybridization of intact cells).	12
V	Liquid and solid waste management Solid waste: Types, sources and methods of solid waste disposal. Liquid waste management: Composition, strength and types of sewage treatment (primary, secondary and tertiary). Guidelines for tolerated levels of faecal contamination. Decontamination of potable water supplies. Biological and chemical indicators of water safety and quality determination. Microbial assessment for quality of water.	12

Reference / Text Books:

1. Microbiology by Chan ECS, Pelczar Michael J, Krieg NR, by Tata McGraw-Hill Education Pvt. Ltd, 7th Edition, (2009).
2. A textbook of microbiology by R.C. Dubey and D.K. Maheshwari, S Chand Publishing; Fourth edition (2016).
3. Modern concept of microbiology by H D Kumar & Swati Kumar.
4. Foundation in Microbiology by Talaro K P, Chess B, McGraw-Hill Education, 9th edition (2014).
5. Prescott's Microbiology, McGraw-Hill Education; 10th edition (2016).

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	

Course Learning Outcomes:

By the end of this course, the students-

CLO1: Will become familiar with natural habitats of varied microbial populations

CLO2: Will be familiar with the idea of metagenomics as well as soil, air, and water microbiology.

CLO3: With the aid of many instances, will be able to identify the interactions between microorganisms and higher plants and animals.

CLO4: Will learn in-depth information about various solid waste management strategies, with a focus on the benefits and drawbacks of each approach.

CLO5: will learn about the sewage's composition, strength, and treatments. will have gained knowledge of water treatment and safety.

CLO6: Will gain knowledge of a variety of environmental microbiology techniques, such as ARDRA, FAME profile analysis, assessing metabolic capacity using BIOLOG microtiter plates, and utilising DNA.

PRACTICALS

MMBDSE-NP-123P: ENVIRONMENTAL MICROBIOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

List of Experiments-

1. To perform MPN test for determination of water quality
2. To determine BOD for given water sample
3. To determine COD for given water sample
4. IMViC Tests for identification of Enterobacteriaceae members
5. To isolate bacteria from soil by SPC.
6. To isolate fungi from air by settle plate technique
7. To determine efficacy of given disinfectant using Phenol coefficient method.
8. To study fungal spores by cello tape method.
9. To isolate algae from soil sample
10. To isolate microorganism's rhizosphere and phyllosphere.

GE-3a

MMBGE-NP-124a: BIOSTATISTICS AND BIOINFORMATICS

Programme: Certificate/Diploma/ Degree/PG		Year: I
Class: M.Sc. Microbiology		Semester: II
Credits: 4 Theory: 4 Practical: 0		Subject: MICROBIOLOGY
Course Code: MMBGE-NP-124a		Title: BIostatistics and Bioinformatics
Course Objectives: CO1: The main goal of this course is to understand the fundamental ideas of statistics CO2: To analyze biological data with the help of statistics. CO3: To equip students with the skills necessary to manage biological data and get useful results from analyses. CO4: A good understanding of the many ideas in bioinformatics, which includes molecular biology, genetics, genomics, transcriptomics, and proteomics, as well as their uses in research and development, is the course's main goal. CO5: This will make it possible for learners to later pursue multidisciplinary studies. CO6: To equip students with basic concepts of sequence similarity and sequence alignment.		
Nature of Paper: Core/DSE/SEC/GE/AECC [GE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 P: 0 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Data collection, classification, and tabulation Using bar and histogram graphs, frequency polygons, and frequency curves. Standard deviation, mean, median, and mode. Random experiments, sample space, probability theory, and conditional probability are all terms used in this discipline. An overview of discrete and continuous random variables, discrete and continuous probability density functions, and function for distribution.	12
II	Probability discrete and continuous distributions: Principles of least squares, relationship between two variables, scatter diagrams; Karl Pearson's coefficient of correlation, Rank correlation, Tied ranks; Exponential distribution, binomial distribution, Poisson distribution, and normal distribution.	12
III	Sampling parameters: Sample size, sampling errors, parametric vs. non-parametric statistics, sampling distributions, and standard error; difference between sample and population, hypothesis testing; significance level and degree of freedom, p-value interpretation and importance. Small sample test based on t-test and F test; large sample test based on normal distribution.	12

	Chi-square test and its applications, Confidence interval and distribution-free tests.	
IV	Objectives and Scope of Bioinformatics: An introduction to biological databases and sequencing file formats. Data transfer method (FTP, SFTP, SCP), benefits of encrypted data transfer, Nucleotide sequence, genome, protein sequence and structure, gene expression, metabolic pathways, general human genetics, and cancer genes are all included in biological databases. File formats such as Genbank and FASTA. Submission and retrieval of data from the PDB, EMBL, and NCBI.	12
V	Sequence alignments, phylogenetic analyses, and genomics fundamental ideas in pairwise and multiple sequence alignment, local and global sequence alignment, BLAST, and sequence similarity. representation of phylogeny, rooted and unrooted phylogenetic trees, and molecular clocks. Viral, prokaryotic (E. coli), and eukaryotic (human) genomic diversity. Techniques in transcriptomics and genomics: Gene prediction techniques, microarray, metagenomics, and drug design are some examples.	12

Reference / Text Books:

1. Bancroft, H. (1962). Introduction to Biostatistics. P.B. Hoebar, USA.
2. Daniel, W.W., and Cross, C.L. (2013). Biostatistics: A Foundation for Analysis in the Health Sciences. Wiley and Sons, USA.
3. Goon, A.M., Gupta, M. K. and Dasgupta, B. (2002). Fundamentals of Statistics Volumes I and II. 8th edition. The World Press, India.
4. Khan, I.A and Khanum, A. (2004). Fundamentals of Biostatistics. 2nd edition. Ukaaz, India.
5. Baker, L. (editor). (2018). Bioinformatics: Tools and Techniques. 1st edition. Callisto Reference.
6. Ghosh, Z. and Mallick, V. (2015). Bioinformatics- Principles and Applications. 1st edition. Oxford University Press, India.
7. Kaushik, A.C., Kumar, A., Bharadwaj, S., Chaudhary, R. (2018). Bioinformatics Techniques for Drug Discovery: Applications for Complex Diseases. 1st edition. Springer International. 2018.

If the course is available as Generic Elective, then the students of following departments may opt it.

YES

M.Sc. Biotechnology

M.Sc. Zoology

Evaluation/Assessment Methodology	
	Max. Marks:100
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3)Assignments	04
4)Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75

TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes: After successfully completing the course, the student will have an in-depth comprehension of: CLO1: Students will be able to collect, classify and tabulate data using bar and histogram graphs. CLO2: Acquiring knowledge of various probability discrete and continuous distributions and applying them to accurate models. CLO3: Students will attain fundamental ideas in hypothesis testing, such as how to frame the null and alternative hypotheses. CLO4: Students will be able to explain single-sample and two-sample hypotheses using the classical and p-value approaches, respectively and will be familiar to applications of the chi square, t, and F distributions. CLO5: Will be familiar with the field of bioinformatics and how it relates to molecular biology, genetics, and genomics; the advantages of various data transfer methods, including encrypted data transfer; and a thorough understanding of primary, secondary, and composite databases. CLO6: Will acquire the knowledge of Sequence alignments, phylogenetic analyses, and genomics	

GE-3b

MMBGE –NP- I24b: PHARMACEUTICAL MICROBIOLOGY

Programme: Certificate/Diploma/ Degree/PG/ Class: M.Sc. Microbiology		Year: I Semester: II
Credits: 4 Theory: 4 Practical: 0		Subject: MICROBIOLOGY
Course Code: MMBGE –NP- I24b		Title: PHARMACEUTICAL MICROBIOLOGY
Course Objectives: CO1: To study the discovery and development of drugs, chemotherapeutic agents and their effects. CO2: The goal of this course is to provide advanced information on the genesis and mechanisms of antibiotic resistance. CO3: To study various sterilization techniques used to control spoilage of pharma products and their preservation. CO4: To learn about the discovery and development of anti-infective drugs. CO5: To analyze Pharmaceutical Industry Quality Assurance and Validation. CO6: To understand the Sources and Regulations of Biopharmaceuticals		
Nature of Paper: Core/DSE/SEC/GE/AECC [GE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 P: 0 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Discovery and Development of Drugs: Paul Ehrlich's contributions and postulates about drug discovery and development Discovery of Drug- Purification and characterization of bioactive compounds from natural sources, conventional process bioprospecting (Medicinal Chemistry), extraction and purification principles, Rational Drug Design- Tools (High Throughput Screening, Combinatorial Synthesis, Pharmacogenomics) and the SAR (Structure Activity Relationship) Principle. Drug development -Preclinical development: Toxicity testing (acute, subacute, and chronic toxicity); Clinical development: Clinical trials' (Aims, Objectives, Conduct).	12
II	Anti-infective drug development: Therapeutic ratio, Minimum inhibitory concentration (MIC) and Minimum bactericidal concentration (MBC) Testing for Susceptibility: Utilization of liquid and solid medium, Susceptibility testing influencing factors, CLSI recommendations, Agar dilution technique, gradient plate techniques, E-test, Kirby Bauer, and Stokes method;	12

	Susceptibility testing for anti-bacterial, anti-mycobacterial, anti-fungal, anti-protozoan, anti-viral, and other substances susceptibility	
III	Anti-infective drug discovery: Drug targets in bacteria with examples of existing medications: synthesis of cell walls, plasma membrane function, protein synthesis, nucleic acid synthesis, and metabolism, Techniques for measuring the growth/inhibition and metabolic changes in the microbial population in response to anti-infectives, in order to assess their effectiveness and develop understanding of how they work: Direct counts include counting chambers, calibrated smears, and proportionate counts, other methods include turbidometry and nephelometry, electrical resistance and impedance, micro calorimetry, flow cytometry, and radiometric techniques, Radiolabeling methods, Techniques used in laboratories to evaluate the antagonistic, synergistic, and additive effects of antimicrobial combinations.	12
IV	Pharmaceutical Industry Quality Assurance and Validation: Good Manufacturing Practices (GMP) and Good Laboratory procedures in the pharmaceutical sector (GLP); Pharmaceutical quality assurance and management with ISO, WHO, and US certification; Security and safety in the microbiological lab- Testing for pyrogenicity, mutagenicity and carcinogenicity, teratogenicity, adverse drug reactions, and in vivo and in vitro drug interactions.	12
V	Biopharmaceuticals: Sources and Regulations FDA and Pharmacopoeia (IP, UK, US) regulatory authorities and their roles; Drug formulation- Carrier and delivery methods, targeted drug delivery, and sustained release; Studies on pharmacokinetics, ADME, and bioavailability Biopharmaceutical sources include: E. coli, which provides recombinant therapeutic proteins; Recombinant protein expression in animal cell culture systems, yeast- and fungi-based production techniques, transgenic animals, and transgenic plants are only a few examples.	12
Reference / Text Books: 1. A Textbook of Pharmaceutical Microbiology Paperback (2018) by Pulak Mujumder, Sameer Rajan Sahoo Everest Publishing. 2. A Textbook of Pharmaceutical Microbiology (2015) Mehra Prahlad Singh IK International Publishing. 3. Pharmaceutical Microbiology (2015) by Sheth Z. PCBS Publisher 4. A.V.S.S. Samba Murty. A Textbook of Plant Pathology. IK International Publishing House 2009. 5. Nidhi Goel. Pharmaceutical Microbiology: A Textbook. Alpha Science Intl Ltd .2012 6. Prahlad Singh Mehra. A Textbook of Pharmaceutical Microbiology. IK International Publication.		
If the course is available as Generic Elective, then the students of following departments may opt it. yes M.Sc. Biotechnology		
Evaluation/Assessment Methodology		

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes: CLO1: Students will be able to explain about various chemotherapeutic agents. CLO2: Will be able to develop the understanding and mechanism of antibiotic resistance. CLO3: Will be able to understand the sterilization and microbial spoilage of pharma products. CLO4: Will be able to apply various methods of preservation and Pharmaceutical Industry Quality Assurance and Validation. CLO5: Will be able to gain knowledge about bacteriostatic and bactericidal properties of different disinfectants. CLO6: Will be able to analyze anti-infective drug discovery and will acquire the knowledge about Good Laboratory Practises (GLP) and Good Manufacturing Practises (GMP).	

CORE-17
MMBC-NP-231: INDUSTRIAL MICROBIOLOGY

Programme: Certificate/Diploma/Degree/PG. Class: M.Sc. Microbiology		Year: II Semester: III
Credits: 6 Theory: 4 Practical: 2		Subject: MICROBIOLOGY
Course Code: MMBC-NP-231		Title: INDUSTRIAL MICROBIOLOGY
Course Objectives: CO1: This course's main goal is to familiarise students with the numerous facets of industrial microbiology, and various fermentation processes. CO2: Students will learn the design and use of various types of fermenters. CO3: Students will learn about the various recovery techniques and mass-scale cultivating of microbes for the synthesis of various biomolecules and metabolites of industrial importance. CO4: Enzyme immobilisation and its uses will also be covered with the students. CO5: Students will be developed the knowledge about the production of various microbial and industrial products. CO6: Students will be familiar with the production of antibiotics, steroids, enzymes, biofuel and mushroom cultivation.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	An overview to industrial microbiology and fermentation processes An overview to industrial fermentation processes and microbiology A brief account of history and advancements of industrial microbiology, Numerous fermenting techniques: Fermentations in the stationary and submerged solid- and liquid-states, fed-batch, continuous, and batch fermentations, Crude and synthetic media, corn steep liquor, molasses, sulphite waste liquor, whey, yeast extract, General characteristics and sources, methods of isolation, purification and maintenance of industrially important microbes, Primary and secondary screening of industrially important strains, Improvement of strains through mutation, genetic recombination and genetic engineering,	10
II	Types of bio-reactors and Fermentation Technology Microbial growth kinetics in batch and continuous, and fed-batch fermentation processes, Designing and principles of a stirred aerobic bioreactor, Photobioreactor, Fluidized Bed, Packed Bed, Membrane	10

	Bioreactor, and Airlift. ingredients in fermentation medium. Both submerged and solid-state fermentation have benefits and drawbacks, Monitoring and management of the fermentation's important factors, including pH, temperature, dissolved oxygen, foaming, and aeration. Down-stream processing: disruption of cells by chemical, physical and biological techniques, centrifugation, filtering, solvent-solvent extraction, precipitation, lyophilization, and spray drying.	
III	Production of steroids and antibiotics Microbial transformations with emphasis on steroid and alkaloid, primary metabolites and secondary metabolites. Production of antibiotics for commercial use, with emphasis on penicillin, streptomycin, and related derivatives.	10
IV	Microbial production of Industrial products Microbial production of Wine, champagne, distilled spirits, and malt beverages, the production of organic acids used in industry, such as acetic, lactic, citric, and gluconic acids. Commercial production of essential vitamins (vitamin B12, riboflavin, and vitamin A) and amino acids like: tryptophan, lysine, and glutamic acid.	10
V	Enzyme immobilization and Bioprocess Engineering Enzyme immobilization (entrapment, adsorption, cross linking & covalent bonding) and their industrial applications; Fermented foods and food spoilage: Bread, vinegar, fermented vegetables, fermented dairy products, Bioprocess Engineering: Different steps for large-scale protein purification, Physiological aspects, single cell proteins SCP made from waste and renewable resources.	10
VI	Production of enzymes and biofuel Production of industrial enzymes: Pectinases, Cellulases, Xylanases, Proteases, Amylases, and their uses. biofuel production from waste (ethanol and methane), mushroom cultivation, microbiology of petroleum.	10
Reference / Text Books: 1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited 2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA 3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell 4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company 5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited. 6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi. 7. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.		
If the course is available as Generic Elective then the students of following departments may opt it. NO		
Evaluation/Assessment Methodology		
Max. Marks:100		

1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3)Assignments	04
4)Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes: CLO1: Will comprehend the history and significance of industrial microbiology and be knowledgeable about various fermentation processes that take place in both liquid and solid-state substrate media. CLO2: Will learn how to isolate, screen, preserve, and maintain industrially significant microbial strains, as well as the various substrate types that are employed in fermentation operations. CLO3: Will research the construction, use, and applications of various fermenters on a laboratory, pilot plant, and industrial scale. CLO4: Will be familiar with the fundamentals of methods for extracting and removing impurities from industrial goods made by microbial fermentation processes. CLO5: The concepts of large-scale microbial production and recovery of industrial products will have been thoroughly learned. CLO6: Will comprehend the techniques for immobilising enzymes, their benefits and disadvantages, and their industrial uses.	
PRACTICALS	
MMBC-NP-231P: INDUSTRIAL MICROBIOLOGY LAB	
Marks: 50	Duration: 60 hours (2 credits)
1. To learn about different parts of a fermenter/bioreactor 2. To study various types of fermenters 3. To produce microbial products and their qualitative and quantitative estimation, for e.g. 4. Production of Enzymes: Amylase and Protease 5. Production of Amino acid: Glutamic acid 6. Production of Organic acid: Citric acid 7. Production of Alcohol: Ethanol 8. Production of Antibiotics 9. A visit of an industrial fermenter and other downstream processing activities at any educational institute or Industry.	

CORE-18
MMBC-NP-232: MEDICAL MICROBIOLOGY

Programme: Certificate/Diploma/Degree/PG.		Year: II
Class: M.Sc. Microbiology		Semester: III
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code: MMBC-NP-232	Title: MEDICAL MICROBIOLOGY	
Course Objectives: CO1: The major objective of this course is to familiarize and acquaint the students with the key facets of medical microbiology. CO2: Students will gain knowledge about the classification of different types human diseases and modes of their transmission. CO3: To study the human microbiome and its significance. CO4: To study the diseases related to the various pathogenic bacteria, their virulence, pathogenesis and diagnostic methods. CO5: To study the procedures used in clinical Microbiology CO6: Brief outline of the practical aspects of antimicrobial chemotherapy.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Host-Pathogen Interaction: Classification of diseases -Communicable and non-communicable infectious diseases, Sporadic disease, Outbreak, Endemic diseases, Hyperendemic diseases, Epidemic diseases, Pandemic diseases, Acute diseases, Chronic diseases, Latent diseases, Local infections, Systemic infections, Primary infections, Secondary infections, Classification of Pathogens- Pathogens, Opportunistic pathogens, Commensals. Modes of disease transmission- transmission through contact, transmission through vehicle, transmission through vector Phages of disease development- Incubation period, Prodromal period, Period of illness, Period of decline, Period of convalescence Development of disease-Portal of entry, Adherence at the site of infection, Virulence factors and escape from host defense.	10
II	Normal Flora of human and Microbiome: Human Microbiome, Significance of normal microflora, Development of microbial flora, Factors determining the composition of normal flora in human body, Normal microbiota of the human skin, oral and upper respiratory tract flora, gastrointestinal tract flora, urogenital flora,	10

	Common host infections caused by normal flora, Natural interaction between the host pathogens and microbial flora, The terms "infection," "invasion," "pathogen," "pathogenicity," "virulence," "virulence factors", "toxicity," carriers and types of carriers, sepsis, and septic shock.	
III	Systematic Bacteriology: The following bacteria's salient features, morphology, cultural characteristics, antigenic structure, pathogenesis, transmission, clinical significance, and laboratory diagnosis of infection caused by-Gram's Positive Bacteria: Staphylococcus, Streptococcus, and Pneumococcus, Clostridium, Corynebacterium, Bacillus Gram's negative bacteria such as Neisseria, E. coli, Salmonella, Shigella, Vibrio, Pseudomonas, Yersinia, Haemophilus, Acid fast bacteria: Atypical Mycobacterium: Mycobacterium lepra and Mycobacterium tuberculosis Others: Actinomycetes, Spirochaetes, Mycoplasma.	10
IV	Clinical Microbiology: Sampling for surveillance, Testing for O.T. Sterility, Analysing the bacteria in food, milk, air, and water, Processing of clinical samples for detection of pathogens, Managing biomedical waste and hospital infections, Quality control in Microbiology, Laboratory monitoring of antimicrobial therapy, Collection of samples for bacteriological investigations, Culture methods and procedures for the organisms found in CSF, blood cultures, sputum, pus, urine, faeces, urinary tract infections, endocarditis, and bone and joint illnesses.	10
V	Laboratory Approach to Common Clinical Syndromes: Pyrexia of unknown origin (PUO), Skin and soft tissue infections, Tuberculosis, Leprosy, Meningitis and Encephalitis, Eye infections, Food-borne illness, Respiratory tract infections, Sexually transmitted diseases, Dental infections, Blood transfusion and associated infections, Prevention of Hospital-acquired and blood-borne infections.	10
VI	General features and mode of action of antimicrobial agents: Antibacterial agents: Five mechanisms of action, each with a specific example: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine, Antibiotic resistance, MDR, XDR, MRSA, NDM-1.	10
Reference / Text Books: 1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication. 2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication. 3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier. 4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education. 5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of		

Microorganisms. 14th edition. Pearson International Edition.	
If the course is available as Generic Elective, then the students of following departments may opt it. NO	
Evaluation/Assessment Methodology	
Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes: CLO1: Will have an understanding of the relevance of the body's normal microflora and its diversity. The vocabulary and scientific nomenclature used to describe illness aetiology and the pathogenic characteristics of microbial disease agents will also have been familiarised by the student. CLO2: Will have acquired in-depth knowledge of the range of illnesses brought on by bacterial pathogens, as well as knowledge of how diseases progress and the symptoms that go along with them. will gain knowledge about the epidemiological features, transmission mechanisms, and measures for prevention and control. CLO3: Will learn about the range of illnesses brought on by infections. will also comprehend the progression of sickness and the signs and symptoms associated with illnesses affecting various organ systems. CLO4: Will comprehend the classification of diseases and host pathogens interaction. CLO5: Will gain knowledge of the most recent methods for disease diagnostics. CLO6: Will have gained knowledge of the fundamentals of handling clinical specimens and methodologies for applying immunological and molecular biology-based techniques to aid in the detection and diagnosis of diseases. will also comprehend the idea of antimicrobial resistance as well as the various antimicrobial agents' modes of action.	
PRACTICALS	
MMBC-NP-232P: MEDICAL MICROBIOLOGY LAB	
Marks: 50	Duration: 60 hours (2 credits)
- To study the bacterial flora of skin by swab method. - To isolate and identify the microbial flora from human teeth. - To isolate and identify the bacteria from normal urine sample. - To perform catalase test for the identification of bacteria. - To differentiate Staphylococcus and Streptococcus on the basis of morphological and biochemical characteristics. - To perform IMViC test. - To perform sugar fermentation test for the detection of fermentation of various sugars. - To study composition and use of important differential media for identification of bacteria: EMB, Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS. - To perform antibacterial sensitivity by Kirby-Bauer method. - Determination of minimal inhibitory concentration (MIC) of an antibiotic.	

DSE-9a

MBTDSE--NP-233a: RECOMBINANT DNA TECHNOLOGY

Programme: Certificate/Diploma/ Degree/PG Class: M.Sc. Microbiology		Year: II Semester: III
Credits: 6 Theory: 4 Practical: 2		Subject: MICROBIOLOGY
Course Code: MBTDSE-NP-233a		Title: RECOMBINANT DNA TECHNOLOGY
Course Objectives: CO1: The students will be able to develop an understanding about the scope and importance of genetic engineering and biotechnology. CO2: The students will become familiar with recent development in tools and techniques having importance in genetic engineering. CO3: The student will gain knowledge about the manipulation of genes and recombinant proteins for therapeutic and agricultural use. CO4: The students will develop a broad spectrum in terms of system biology, biotechnology and bioengineering. CO5: The students will gain knowledge about the widespread application of RDT including gene therapy. CO6: The students will learn the various methods for the delivery and analysis of DNA.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to genetic engineering Milestones in biotechnology and genetic engineering. Contributions of eminent scientist such as Arber, Alwine, Alec Jeffrey, Burnett, Boyer and Cohen, Bolivar and Rodriguez, Craig Venter, Clark, Messing, Kary Mullis, Smith and Nathans, Paul Berg, Sanger, Southern.	12
II	Tools of molecular cloning - enzymes and vectors Restriction enzymes and their Types, Nomenclatures, Applications, mode of action and frequency of recognition sequences in a DNA molecule. Other endonucleases: DNase I, S1 nuclease. Cloning vectors and types including, baculovirus-based vectors, Cosmids, Plasmid vectors, Phagemids, BACs, and YACs. Phage vectors, Yeast vectors and mammalian SV40 based expression vectors.	12
III	DNA delivery methods and methods of analysis of DNA, RNA and proteins.	12

	Methods of gene delivery: chemical method, electroporation methods, biolistics (gene gun), liposome and viral-mediated delivery, microinjections and Agrobacterium - mediated delivery. Analysis of DNA and RNA by agarose gel electrophoresis, Southern and Northern Blotting and microarray technique. Analysis of protein by SDS-PAGE and western blotting technique. Analysis of Electrophoretic mobility shift assay, DNA Foot printing and Phage display.	
IV	DNA amplification and DNA sequencing: PCR: Introduction and types (RT-PCR and Real-Time PCR). Primer and its designing; Primer walking.). Method of DNA Sequencing: Sanger's sequencing, automated DNA sequencing, Hierarchical versus whole genome shotgun sequencing. Introduction to next generation sequencing methods.	12
V	Applications of recombinant DNA technology: Gene therapy: concept, strategies and types. Use of gene therapy to manufacture products of human therapeutic interest (Insulin, hGH) and agricultural significance (Flavr Savr Tomato, Bt cotton, stress resistant varieties of plants). Application of RFLP in DNA fingerprinting methods. Significance of mitochondrial DNA in forensics. Designing strategy for development of genetically modified crop.	12
Reference / Text Books: 1. Biotechnology- Expanding Horizons by B.D. Singh (2014), Kalyani Publication 2. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K. 3. Clark DP and Pazdernik NJ. (2009). Biotechnology-Appling the Genetic Revolution. Elsevier Academic Press, USA. 4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K. 5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual.3rd edition. Cold Spring Harbor Laboratory Press.		
If the course is available as Generic Elective then the students of following departments may opt it. NO		
Evaluation/Assessment Methodology		
		Max. Marks:100
1) Class tasks/ Sessional Examination		16
2) Presentations /Seminar		-
3) Assignments		04
4) Research Project Report		-
Seminar On Research Project Report		-
5) ESE/Attendance		05
INTERNAL MARKS		25
EXTERNAL MARKS		75
TOTAL		100
Prerequisites for the course:		
Course Learning Outcomes: CLO1: The students will be able to define the contributions of various scientists in the field of genetic engineering.		

CLO2: The students will be able to differentiate between different kinds of enzymes used in Genetic engineering and cloning vectors.
CLO3: The students will be able to determine DNA amplification and sequencing methods.
CLO4: The students will be able to classify gene delivery methods and techniques used for the analysis of DNA, RNA and protein.
CLO5: The students will be able to justify the application of RDT.
CLO6: Students will be able to formulate recent developments in recombinant DNA technology.

PRACTICALS

MBTDSE-NP-233aP: RECOMBINANT DNA TECHNOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

1. To perform Agarose gel electrophoresis.
2. Analysis of DNA after ligation of DNA fragments by agarose gel electrophoresis.
3. To study agarose gel electrophoresis profile: graphical determination of molecular weight of DNA fragments.
4. To demonstrate interpretation of sequencing gel electropherogram.
5. To demonstrate amplification of DNA by PCR and primer designing.
7. To demonstrate procedure of Southern Blotting.

DSE-9b

MMBDSE--NP-233b: SOIL & AGRICULTURE MICROBIOLOGY

Programme: Certificate/Diploma/Degree/PG/ Class: M.Sc. Microbiology		Year: II Semester: III	
Credits: 6 Theory: 4 Practical: 2		Subject: MICROBIOLOGY	
Course Code:MMBDSE-NP-233b		Title: SOIL & AGRICULTURE MICROBIOLOGY	
Course Objectives: CO1: This course of microbiology soil and agriculture is designed with the objective to provide general introduction of microbes present in soil and in-depth information on soil microbial diversity. CO2: To learn about the plant microbe’s interaction in detail. CO3: To understand the changes or transformation of the host by pathogens. CO4: To analyses the plant pathogens and their invasion into the host. CO5: To study the bio-fertilizers, bioinoculants and biopesticides. CO6: Students will learn about the role of microorganisms in biogeochemical cycling of elements like C, N, P and trace elements and soil fertility.			
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]			
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits			
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)			
Unit	Contents	No. of Lectures Allotted	
I	Soil as a habitat for Microorganisms: Distribution of Numerous species of microbes, including bacteria, fungus, protozoa, algae, and viruses, throughout the soil, Effects of environmental factors and climate change on the abundance of soil microbiota, Methods used in the microbiological studies of soil.	12	
II	Plant Microbes Interaction: Commensalism, Mutualism, Parasitism, Amensalism, and Synergism Rhizosphere microorganisms and phyllosphere microorganisms, Rhizosphere effect and the factors that affect rhizosphere microbes, Nitrogen fixation and nodulation, Plant growth promoting rhizobacteria (PGPR) and Vesicular Arbuscular Mycorrhiza (VAM)	12	
III	Microbiological Transitions: The carbon cycle, Biodegradation of cellulose, hemicelluloses, and lignin in soil organic matter. Humic compounds in soil: their origin, composition, structure, and application in agriculture and the environment. The essential role of microorganisms in cycle of Nitrogen, Phosphorus, Sulphur, Iron, and Manganese in soil and plant system, The effect of biogeochemical cycles on the environment.	12	

IV	Plant Pathology: Pathogen identification and invasion of pathogen into host cells. Changes in the behaviour of host cells by pathogens, Disease initiation mechanisms: enzymes, phytotoxins, growth regulators. Role of R and r genes in the development of disease; participation of elicitors. Molecular processes involved in disease diagnosis. Mechanisms of resistance in plants, Resistance genes, systemic resistance, phytoalexins, PR proteins, and signalling mechanisms, using transgenic methods to protect crops.	12
V	Biofertilizes and Bioinoculants: Definition and status of biofertilizer, types of biofertilizers. Nitrogenous and phosphatic biofertilizers - Rhizobium, Azotobacter, Azospirillum, Frankia, Vesicular Arbuscular Mycorrhiza and PSB/PSF Technologies for the production of biofertilizers. Methods of inoculation on seed and in soil. Quality control of biofertilizers. Production of bioinoculants- Azotobacter, α & β rhizobia, Azospirillum, Cyanobacteria, phosphate solubilising microorganisms, Azolla. Mycorrhiza, Biopesticides – types and applications.	12
Reference / Text Books: 1. Subba Rao. 2000. Soil Microbiology. 4th Ed. Oxford & IBH 2. Subba Rao. Biofertilizers in Agriculture. Oxford & IBH 3. Subba Rao. Recent Advances in Biological Nitrogen Fixation. Oxford & IBH. 4. Rangaswamy and Bagyraj. Agricultural Microbiology. 5. Alexendra and Bold. 1999. Introduction to Mycology. Academic Press. 6. Sundara Rajan S. Practical Manual of Fungi. Anmol Publication. 7. Saminathan M.S. Biotechnology in Agriculture. McMillan. 8. Steinhaus. 1963. Insect Pathology. Vol I & II. Academic Press, New York. 9. Burges H D & Hussey N W. 1971. Microbial Control of Insect and Mites. Academic Press, New York. 10. Burges HD. 1970-1980. Microbial Control of Pests and Plant Diseases.		
If the course is available as Generic Elective, then the students of following departments may opt it. NO		
Evaluation/Assessment Methodology		
		Max. Marks:100
1) Class tasks/ Sessional Examination		16
2) Presentations /Seminar		-
3) Assignments		04
4) Research Project Report		-
Seminar On Research Project Report		-
5) ESE/Attendance		05
INTERNAL MARKS		25
EXTERNAL MARKS		75
TOTAL		100
Prerequisites for the course:		

Course Learning Outcomes:

CLO1: Will gain knowledge about the distribution of various microbes in the soil and their importance.

CLO2: Will attain in depth knowledge of the role of microorganisms in plant growth particularly in rhizosphere and phyllosphere and plant microbes interaction.

CLO3: Will develop an understanding of the microbiology and physiology of C and N cycle specifically degradation of native and organic matter and biological nitrogen fixation.

CLO4: Will gain knowledge of microbial transformation of elements as Phosphorus, Iron and Manganese.

CLO5 Get insight of the types, production process, application methods and quality control of microbial biofertilizers.

CLO 6: Will be able to explain the relation between the microbes, soil and environment.

PRACTICALS

MMBDSE-NP-233bP: SOIL & AGRICULTURE MICROBIOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

List of practicals-

1. To isolate and identify the bacteria from soil samples.
2. To isolate and identify the fungus from soil samples.
3. To determine the moisture and organic matter content from manures samples.
2. Estimation of N, P, K, and S from manure samples.
3. Determination of N from urea fertilizers.
4. Determination of NH₄- N, NO₃-N from nitrogenous fertilizers.
5. Determination of P from phosphatic fertilisers.
6. Determination of K from potassic fertilisers.
7. Determination of S from sulphur fertilisers.
8. Estimation of available N, P, K, S and micro nutrient (Fe, Mn, Zn, Cu) from soil samples.

GE-4a

MMBGE-NP-234a: FOOD AND DAIRY MICROBIOLOGY

Programme: Certificate/Diploma/Degree/PG		Year: II
Class: M.Sc. Microbiology		Semester: III
Credits: 4 Theory: 4 Practical: 0		Subject: MICROBIOLOGY
Course Code: MMBGE-NP-234a		Title: FOOD AND DAIRY MICROBIOLOGY
Course Objectives: CO1: To study the advancements in the field of food and dairy microbiology CO2: To familiarize students with the role of microorganisms in association with foods, with prominence on both their beneficial and harmful activities and their applications in the food and dairy industry. CO3: To understand various methods of food preservations. CO4: To learn about various microbiological fermented dairy products. CO5: To apply the role of probiotics in food and dairy products and to study various probiotic foods CO6: To learn different methods of food sanitation and appropriate food sanitation practices.		
Nature of Paper: Core/DSE/SEC/GE/AECC [GE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 P: (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Advancement of Food microbiology The evolution of food microbiology as a science, scope and applications of food microbiology, Food as substrate for microorganisms, internal and external factors affecting the growth of microbes in food products, significant microorganisms present in food products like bacteria, yeast and molds and the source of microorganisms (air, soil, water, plants and animals).	10
II	Intoxication and foodborne infections: Bacterial food borne infections caused by Brucella sp., Bacillus sp., Clostridium sp., Escherichia coli, Listeria monocytogenes; Botulism; Staphylococcal food poisoning; The various kinds of mycotoxins include aflatoxins, ochratoxins, fumosins, trichothecenes, zealenone, and ergot alkaloids, Food-borne disease outbreaks, laboratory testing methodologies used for the detection of foodborne infections, preventive actions against food borne infections, An overview of food borne infections caused by viruses, protozoa, algae, fungus.	10
III	Food preservation: Principles and procedures of food preservation; Physical Methods-	12

	(Temperature, irradiation, Drying, Canning); Chemical methods- (Organic acids, Food additives). Food Preservatives of Classes I and II, Bio preservation using lactic acid bacteria, bacteriocins as food preservatives, Food packaging: types, characteristics, and advantages of packaging materials.	
IV	Microbiology of Dairy Products The sources of microbes in dairy products and varieties of microorganisms encountered in dairy products. Microbiological testing of milk and dairy products (phosphatase, reductase, direct microscopic count, and standard plate count). Pasteurisation of milk and dehydration. Dairy products produced using microbes, such as cheese, yoghurt, and butter, buttermilk, acidophilus milk, kefir, kumis.	12
V	Probiotics and fermented Dairy products: History and introduction of probiotics and fermented dairy products, Classification of fermented dairy products, Scope of fermented dairy products, Microbiology of yoghurt and related products. Microbiology of acidophilus products, curd, lassi, cultured butter milk, shrikhand, kefir, koumiss, yakult, villi, bifidus milk products, kishk, and milk-based products containing probiotic cultures. Factors affecting the quality and stability of fermented milks in storage, Methods for its production, assessment, and quality assurance.	12
VI	Food and sanitation: Appropriate sanitation practises, cleanliness and sanitation in manufacturing and retail trading, and food control agencies and their rules and regulations, Hazard analysis and critical control points (HACCP), Good Manufacturing Practises (GMP), cleanliness in the workplace including standards for employee health, waste management, and quality control. Indian food technology trends and developments in recent years. Food quality and control FSSAI standard, ISO certification.	4

Reference / Text Books:

1. Adams, M.R. and Moss, M.O. (2000). Food Microbiology. 2nd edition. New Age International Publishers, India.
2. Banwart, G.J. (2004). Basic Food Microbiology. 2nd edition. CBS Publishers and Distributors, India.
3. Davidson, P.M., Sofors, J.N. and Branen, A.L. (2005). Antimicrobials in Foods. 3rd edition. CRC Press, UK.
4. Dillon, V.M. and Board, R.G. (1994). Natural Antimicrobial Systems and Food Preservation. CAB International, UK.
5. Frazier, W.C., Westhoff, D.C. and Vanitha, N.M. (2013). Food Microbiology. 5th edition. Tata McGraw-Hill Publishing Company Ltd, India.
6. Gould, G.W. (1995). New Methods of Food Preservation. Blackie Academic and Professional, UK.
7. Jay, J.M., Loessner, M.J. and Golden, D.A. (2006). Modern Food Microbiology. 7th edition. CBS Publishers and Distributors, India.
8. Lund, B.M., Baird- Parker, A.C and Gould, G.W. (editors). (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2. Springer, USA.
9. Tortora, G.J., Funke, B.R., and Case, C.L. (2016). Microbiology: An Introduction. 12th

edition. Pearson Education, USA.	
If the course is available as Generic Elective, then the students of following departments may opt it. Yes M.Sc. Biotechnology	
Evaluation/Assessment Methodology	
	Max. Marks:100
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes: On successful completion of the course, the student: CLO1: Will be aware of the parameters affecting microbial growth in foods and possible sources of contamination of foods. CLO2: Will gain understanding about the microbial spoilage of dairy and food products. CLO3: Will attain a comprehensive knowledge of methods used for food preservation including physical and chemical. CLO4: Will be familiar with microbial production of fermented dairy and non-dairy food products. Will also be able to understand the health benefits of prebiotics, probiotics and synbiotics. CLO5: Will be acquainted with some food-borne diseases and will be able to explain methods for detection of food borne pathogens. CLO6: Will be able to recognize the concept of quality control of food.	

GE-4b

MMBGE-NP-234b: ADVANCES IN MICROBIOLOGY

Programme: Certificate/Diploma/Degree/PG		Year: II
Class: M.Sc. Microbiology		Semester: III
Credits: 4		Subject: MICROBIOLOGY
Theory: 4		
Practical: 0		
Course Code: MMBGE-NP-234b		Title: ADVANCES IN MICROBIOLOGY
Course Objectives:		
CO1: The main objective of this paper is to introduce students to new advancements in technology in microbiology, such as the CRISPR/Cas system, metagenomics, and system biology,		
CO2: To equip them with the skills necessary to define and analyse significant problems or issues that have arisen in the field of study.		
CO3: Additionally, it will create a framework within which students can combine in-depth knowledge to produce scientific hypotheses and build theoretical and practical abilities in experiment design and execution.		
CO4: Students who are interested in nanoscale physical and biological processes and their applications in biotechnology can also gain perspective from this.		
CO5: To study the advances in Nanotechnology		
CO6: To gain knowledge about the nutraceuticals, biosensors and bioplastics		
Nature of Paper: Core/DSE/SEC/GE/AECC [GE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4		
T: 0		
P: (In Hours/Week)- 4 Hours/week		
Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Nanotechnology Definition of nanoparticles, types, characterization and properties. pplications - drug delivery systems, bioremediation, antifouling, degradation of xenobiotics and fiber retting.	12
II	Metagenomics and Microbiome Introduction, history and development of Metagenomics, Metadata annotations in large-scale data mining, Metagenome sequencing – whole-genome shotgun metagenomics, Application of metabolomics and proteomics to metagenomics, Limitations of assembly algorithms, Human microbiome - Gut microbiome, Oral microbiome, Skin microbiome, Other human biomes, Cross-talk between infectious disease and host microbiome, Viromes and human health.	12
III	Nutraceuticals: Probiotics, Prebiotics, Synbiotics, PUFA, Antioxidants, Vitamins, Polyphenols, SCP, Applications. Biosensors: Definition, Components, Basic Characteristics, Elements, Principles, Applications. Detailed study of glucose and BOD sensor. Bioplastics: Definition, Properties, types and composition, synthesis, microorganisms involved in biodegradation, uses, Environmental impact.	12

IV	Introduction to Systems Biology Introduction and basic concepts in biological systems (2 Lectures) 2. Genotype-phenotype mapping, Gene regulation networks, Optimality and robustness, Next generation sequencing (NGS) and its applications, Microarrays (gene expression arrays/CGH arrays), Metabolic networks and flux analysis, Introduction to synthetic biology.	12
V	Mechanism of gene Expression in microbes Microbiomes and the significance of VBNC (viable but not cultivable) bacteria in microbial communities. The usage of genetically engineered organisms. modern techniques for fluorescence-based microbe identification, mass spectrometry, and PCR. CRISPR-Cas technology.	12

Reference / Text Books:

1. Benjamin Lewin, Gene VII, Oxford University Press, (2000).
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Molecular biology of the Cell, 4th Edition. Garland publishing Inc, (2002).
3. Darnell, Lodish and Baltimore, Molecular Cell Biology, Scientific American Publishing Inc. (2000).
4. Watson, Baker. T.A, Bell. S.P, Gann.A. Levine.M .Losick. R, Molecular Biology of Gene, 5th Edition.The Benjamin/Cummings Pub.Co.Inc. (2003).
5. David Frifielder, Stanely R.Maloy, Molecular biology and Microbial genetics. 2ndEdition, Jonesand Barlett Publishers. (1994).
6. Brown T.A., Gene Cloning and DNA analysis. 2nd Edition, ASM press. (2004).
7. Sandy Primrose. Principles of Gene Manipulation and Genomics. 7th Ed., Blackwell Publishers. (2006).
8. Glick BR and Pasternak JJ, Molecular Biotechnology, 2nd Ed.ASM press. (2003).
9. Uldis N. Streips, Ronald E.Yasbin. Modern Microbial Genetics.2nd Edition Wiley-Liss, Inc. (2002).
10. Russel P J, Essential genetics, Blackwell Science Inc, 2 sub edition, (1987).
11. An Introduction to Systems Biology: Design Principles of Biological Circuits (Chapman & Hall/CRC Mathematical and Computational Biology) by Uri Alon

If the course is available as Generic Elective then the students of following departments may opt it.
yes

M.Sc. Biotechnology

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes

By the conclusion of this course, the students -

CLO1. Will be able to explain general characteristics of nanotechnology.

CLO2. Will gain proper knowledge of the concept and importance of metagenomics.

CLO3. Will developed an initial understanding of recent developments of nutraceutical, biosensors and bio plastics. synthetic biology.

CLO4. Are able to understand system biology and synthetic biology

CLO5. Students able to understand the viable but non-culturable forms of microorganism and CRISPER-Cas system.

CLO6: Will be able to understood current thoughts and advancement in the field of microbiology.

CORE-13

INTRODUCTION TO MICROBIAL WORLD (MMB-NPR-111)

Programme: Certificate/Diploma/Degree/ PG		Year: I
Class: M.Sc. Microbiology		Semester: I
Credits: 6		Subject: MICROBIOLOGY
Theory: 4		
Practical: 2		
Course Code:MMB-NPR-111		Title: INTRODUCTION TO MICROBIAL WORLD
Course Objectives: CO1: This course's major goal is to introduce students to the world of microbes. CO2: Students will understand diversity, classification, structure, evolution & cultivation of microorganisms. CO3: To introduce students about the various methods of sterilization, prevention and control of microbes. CO4: They will additionally learn how important bacteria are to both everyday life and the survival of every kind on Earth. CO5: To orient students about nutritional requirement and growth of microbes. CO6: To learn the various culture media and methods for the cultivation of microbes		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week) 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit - (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Microbiology • Introduction, history and scope of microbiology • Discovery of Microscope and Microbes • Theory of abiogenesis and biogenesis • Koch’s Postulates • River’s Postulates • General characteristics of Prokaryotes and Eukaryotes • Classification of Microbes (Haeckel’s three kingdom classification, Whittaker’s five kingdom classification, three domain concept of Carl Woese, Classification of bacteria according to Bergey's Manual of Determinative Bacteriology)	12
II	Prokaryotic cell structure and function • Structure of a Prokaryotic cell • Size, shape and arrangement of bacteria • Components external to the cell wall (Structure and function of flagella, pili, fimbriae, bacterial capsule and slime layer) • Prokaryotic cell wall: Gram’s negative, Gram’s positive bacterial cell	12

	wall, synthesis of peptidoglycan • Prokaryotic cell membrane and cytoplasmic matrix (structure and function of cell membrane, mesosome, ribosome, cytoplasmic inclusions, prokaryotic genome, bacterial endospore)	
III	Microbial Nutrition and Growth • Nutritional requirements and Nutritional types of bacteria (Phototrophs, chaemotrophs, autotrophs, heterotrophs and obligate parasite) • Culture media; types of media (simple, complex, synthetic, selective, differential, enriched and transport media), • Preparation of culture media, • Cultivation of Aerobic bacteria and Anaerobic bacteria, • Pure culture techniques • Bacterial Growth curve, generation time, factors affecting the growth, • Batch culture and continuous culture.	12
IV	Sterilization and Disinfection: • Importance of sterilization, • Types of sterilization • Physical methods of sterilization (dry heat sterilization, moist heat sterilization, incineration etc. • Chemical methods of sterilization • Sterilization by filtration • Sterilization by Radiation • Preservation and maintenance of bacterial cultures.	12
V	• General features of Fungi, Viruses and Acellular infectious agents • General characteristics, morphology, reproduction of Fungi • General characteristic, morphology and reproduction of viruses • Acellular infectious agents: Viroid, Virusoids, Prions	12
1. Reference / Text Books: 1. Prescott, M.J., Harley, J.P., and Klein D.A. Microbiology. 7th edition WCB Mc Graw Hill, New York, 2. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. Microbiology. 5th edition. McGraw Hill, USA. 3. Srivastava, S. and P.S. Srivastava, P.S. Understanding Bacteria. Springer, Netherlands. 4. Dubey RC and Maheshwari D K . A textbook of Microbiology, S Chand, 4th edition. 5. Black, J.G. and Black, L.J. Microbiology: Principles and Explorations. 10th edition. 6. Aneja K.R., Experiments in Microbiology, plant pathology, Tissue culture and Mushroom cultivation, New Age International, New Delhi. 7. Baveja C.P., Textbook of microbiology APC 6th edition. 8. Stanier R.Y., Ingraham J.L., General Microbiology, Prentice Hall of India Private Limited, New Delhi. 9. Tortora, G.J., Funke, B.R., Case, D., Weber, D. and Bair, W. Microbiology: An Introduction. 13th edition. Pearson Education, USA.		
If the course is available as Generic Elective, then the students of following departments may opt it. YES		
Evaluation/Assessment Methodology		
Max. Marks:100		

1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	4
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	5
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes: By the end of this course, the students will be able to: CLO1: Will be able to explain the history, scope and golden era of microbiology. CLO2: Will in a position to clarify the taxonomy and classification of microorganism. CLO3: Would be able to elaborate the morphology and fine structure of bacteria. Has acquired knowledge of various cell appendages and cytoplasmic inclusions. CLO4: Would be able to defend the growth curve and cultivation of microbes. CLO5: Will acquire the knowledge of different methods of sterilization, prevention and control of microbes. CLO6: Will gain the details about various types of culture media and culture methods	
<u>INTRODUCTION TO MICROBIAL WORLD LAB (MMB-NPR-111P)</u>	
PRACTICALS	
INTRODUCTION TO MICROBIAL WORLD LAB (MMB-NPR-111P)	
Marks: 50	Duration: 60 hours (2 credits)
1. To learn appropriate Laboratories Practices and Biosafety in Microbiology. 2. To learn the fundamentals and uses of essential equipment used in the microbiology lab, such as the autoclave, incubator, BOD incubator, hot air oven, light microscope, and pH meter. 3. To perform Gram's staining 4. To perform Lacto phenol cotton blue staining 5. To demonstrate the presence of microflora present in the environment by exposing NAM plate to air 6. Demonstration of effectiveness of disinfectants. 7. Isolation of bacteria by streak plate method 8. Isolation of bacteria by Pour plate method 9. Demonstration of Spread plate method 10. To perform Catalase Test. 9. To perform Oxidase test	

CORE-14

MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY (MMB-NPR-112)

Programme: Certificate/Diploma/Degree/ PG		Year: I
Class: M.Sc. Microbiology		Semester: I
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code: MMB-NPR-112	Title: MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY	
Course Objectives: CO1: Understand the structure and function of microbial cells. CO2: Comprehend microbial metabolism and bioenergetics. CO3: Gain insights into the physiological and biochemical processes in microbes. CO4: Learn about the genetic regulation and signalling mechanisms in microorganisms. CO5: Develop practical skills in microbial physiology and biochemistry techniques. CO6: To learn the bacterial growth and factors affecting the microbial growth.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Microbial Physiology: • Scope and importance of microbial physiology. • Differences between bacteria, archaea, and eukaryotic microorganisms. • Detailed study of bacterial, archaeal, and fungal cell walls and membranes. • Peptidoglycan structure and synthesis in bacteria. • Pseudopeptidoglycan and unique features of archaeal cell walls. • Fungal cell wall components: chitin, glucans, and mannoproteins. • Structure and function of cytoplasmic membranes. • Membrane lipids and their diversity in different microbes. • Membrane proteins: integral, peripheral, and lipid-anchored proteins.	12
II	Microbial Growth and Reproduction • Growth curve and its phases. • Lag, log, stationary, and death phases. • Mathematical modeling of microbial growth. • Measurement of microbial growth. • Direct methods: microscopic counts, plate counts, and flow cytometry. • Indirect methods: turbidity, dry weight, and biochemical assays.	12

	• Factors affecting microbial growth: temperature, pH, oxygen, and nutrients. • Psychrophiles, mesophiles, thermophiles, and hyperthermophiles. • Acidophiles, neutrophiles, and alkaliphiles. • Obligate aerobes, facultative anaerobes, obligate anaerobes, and microaerophiles. • Synchronous and continuous culture techniques. • Batch culture and chemostat systems. • Applications of continuous cultures in research and industry.	
III	Microbial Nutrition • Nutritional types of microorganisms. • Autotrophs, heterotrophs, lithotrophs, and organotrophs. • Photoautotrophs, photoheterotrophs, chemoautotrophs, and chemoheterotrophs. • Nutrient uptake mechanisms: passive and active transport. • Specific transport systems for sugars, amino acids, and ions. • Culture media and growth conditions for different types of microorganisms. • Defined and complex media. • Selective and differential media. • Enrichment cultures.	12
IV	Microbial Biochemistry: Metabolic Pathways in Microorganisms • Glycolysis, TCA cycle, and oxidative phosphorylation. • Metabolism of Macromolecules • Regulation of Metabolic Pathways. • Role of regulatory proteins and metabolic sensing mechanisms. • Signal transduction pathways and their impact on metabolism. Microbial Genetics and Gene Regulation • Mechanisms (transformation, transduction, conjugation). • Implications for microbial evolution and adaptation.	12
V	Microbial Signaling and Communication: • Overview and Mechanisms: • Definition and importance of quorum sensing in microbial communication. • Auto inducers: Types (AHLs, AI-2, peptides) and biosynthesis. • Detection and response to auto inducers. • Gram-negative bacteria: Acyl-homoserine lactone (AHL) systems • Chemotaxis and flagellar movement regulation. • Light sensing and photo taxis in photosynthetic bacteria.	12

Reference / Text Books:

1. Madigan, M.T., Martinko, J.M., and Parker, J. (2018). **Brock Biology of Microorganisms**. Pearson.
2. Moat, A.G., and Foster, J.W. (2002). **Microbial Physiology**. Wiley-Liss. 3. Stryer, L. (2015). **Biochemistry**. W.H. Freeman.
3. Lehninger, A.L., Nelson, D.L., and Cox, M.M. (2017). **Principles of Biochemistry**. W.H. Freeman.
4. White, D., Drummond, J.T., and Fuqua, C. (2011). **The Physiology and Biochemistry of Prokaryotes**. Oxford University Press.

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

Max. Marks: 100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcome:

- CLO1: Develop a comprehensive understanding of microbial cell structure and function.
 CLO2: Gain detailed knowledge of microbial metabolism and bioenergetics.
 CLO3: Understand the regulatory mechanisms in microbial genetics.
 CLO4: Acquire practical skills in microbial physiology and biochemical techniques.
 CLO5: Apply the knowledge of microbial physiology and biochemistry in various fields like industry, medicine, and environment.
 CLO6: Students will gain the knowledge of microbial growth and factors affecting the microbial growth.

Course Learning Outcome:

- CLO1: Develop a comprehensive understanding of microbial cell structure and function.
 CLO2: Gain detailed knowledge of microbial metabolism and bioenergetics.
 CLO3: Understand the regulatory mechanisms in microbial genetics.
 CLO4: Acquire practical skills in microbial physiology and biochemical techniques.
 CLO5: Apply the knowledge of microbial physiology and biochemistry in various fields like industry, medicine, and environment.
 CLO6: Students will gain the knowledge of microbial growth and factors affecting the microbial growth.

MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY LAB (MMB-NPR-112P)

PRACTICALS

MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY LAB (MMB-NPR-112P)

Marks: 50

Duration: 60 hours (2 credits)

1. Study the components of fungal cell walls, including chitin, glucans, and mannoproteins.
2. Investigate the diversity of membrane lipids in bacteria, archaea, and fungi.
3. Understand the phases of microbial growth (lag, log, stationary, death) and growth curve analysis.

4. Compare direct and indirect methods for measuring microbial growth.
5. Investigate how temperature, pH, oxygen levels, and nutrient availability affect microbial growth.
6. Understand synchronous and continuous culture methods in microbial growth.
7. Explore the concept and mechanisms of quorum sensing in microbial communication.

DSE-7a

ESSENTIAL TOOLS IN BIOLOGICAL RESEARCH (MMBD-NPR-113a)

Programme: Certificate/Diploma/Degree/ PG	Year: I	
Class: M.Sc. Microbiology	Semester: I	
Credits: 6	Subject: MICROBIOLOGY	
Theory: 4		
Practical: 2		
Course Code:MMBD-NPR-113a	Title: ESSENTIAL TOOLS IN BIOLOGICAL RESEARCH	
Course Objectives: CO1: To introduce students to the fundamental techniques involved in the purification and analysis of metabolites and to develop an understanding of various filtration, centrifugation, chromatography, and electrophoresis techniques. CO2: To familiarize students with the principles and applications of microscopy and spectroscopy in the analysis and characterization of biological samples as well as to provide hands-on experience with advanced microscopy techniques and spectroscopic methods. CO3: To equip students with the knowledge required to perform molecular diagnostic techniques and to understand the principles of metabolic pathway engineering. CO4: To provide an overview of automation in microbiology laboratories, including the use of automated systems and processes CO5: To discuss the advantages, prerequisites, and limitations of lab automation in microbiological analysis. CO6: To familiarize the students with advanced instruments and techniques used in Microbiology setup that may help them in seeking appropriate opportunities.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Metabolite Purification and Analytical Techniques: • Introduction to Metabolite Purification (Importance and applications) • Filtration Techniques (Microfiltration, Ultrafiltration, Nano-filtration, Dead end filtration, Tangential flow filtration) • Centrifugation Techniques (Ultra-centrifugation, Differential Centrifugation) • Chromatography Techniques (Introduction to Chromatography, Types of Chromatography, Paper Chromatography, Thin Layer Chromatography, Column Chromatography, Affinity Chromatography, Gel Filtration Chromatography, Ion Exchange Chromatography, High-Performance Liquid Chromatography, Gas Chromatography)	12

	Electrophoresis Techniques (SDS Electrophoresis, Immuno-electrophoresis, SDS-PAGE)	
II	Microscopy and Spectroscopy Microscopy Techniques (Types and roles in biotechnology; Compound Microscope, Phase Contrast Microscope, Fluorescence Microscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), CT-Scan, Digital Microscopy) Spectrophotometry and Spectroscopy (Principles and applications, Lambert-Beer's Law, NMR Spectroscopy, Mass Spectrometry) Autoradiography Radioisotope Techniques X-ray Crystallography	12
III	Molecular Diagnostics and Metabolic Engineering Cytochemistry (Principles and applications, Quantitative chemistry) Molecular Diagnostic Techniques; (Polymerase Chain Reaction, Modifications in PCR, Real-time PCR, Southern Blotting, Northern Blotting, Western Blotting) Metabolic Engineering (Introduction to metabolic engineering, Different nodes of metabolic pathways)	12
IV	Introduction to Automation in Microbiology - Overview of automated systems in microbiology labs - Prerequisites for Automation - Automated Processes in Microbiology (Media Preparation, Specimen Preparation, Plating, Inoculation, Streaking, Incubation, Plate Reading and Interpretation, Antibiotic Sensitivity Testing, Application of Artificial Intelligence in microbial analysis) Advantages and limitations of Lab Automation	12
V	Specific Automated Systems in Microbiology lab - API (Analytical Profile Index) KIT - VITEK® 2 Compact - VIDAS D. ASSURANCE® Gene detection system - MALDI-TOF - Polymerase Chain Reaction (PCR) - Multiplex PCR (mPCR) - Real-Time or Quantitative PCR (qPCR) - Loop-Mediated Isothermal Amplification (LAMP)	12

Reference / Text Books:

1. Nelson D.L. and Cox M., Lehninger Principles of Biochemistry (2017), Seventh edition, Macmillan Learning, USA
2. Berg J.M., Stryer L., Tymoczko J.L., Gatto G. J., Biochemistry, (2015) Eighth edition, Macmillan Learning, USA
3. Upadhyay A., Biophysical Chemistry (2009), Himalaya Publishing House, India
4. Wilson K. and Walker J., Principle and techniques of Biochemistry and Molecular Biology (2010), Cambridge University Press, UK.
5. Voet D., Voet J., Pratt C.W., Fundamentals of Biochemistry: Life at the molecular level, (2016) Fifth Edition, Wiley Publishers, USA

6. E Maheshwari Nanda, Clinical Microbiology & Parasitology, 2016, Jaypee Brothers Medical Publishers (P) Ltd.	
7. James Wallace Jorgenson, Automation In Clinical Microbiology, 2017, CRC Press.	
If the course is available as Generic Elective then the students of following departments may opt it. NO	
Evaluation/Assessment Methodology	
	Max. Marks:100
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes: CLO1: Students will develop the knowledge about students to the fundamental techniques involved in the purification and analysis of metabolites and CLO2: Will be able to explain and perform and analyze the results of various techniques like filtration, centrifugation, chromatography, and electrophoresis techniques. CLO3: Will be able to perform microscopy and spectroscopy in the analysis and characterization of biological samples with hands-on experience provided with advanced microscopy techniques and spectroscopic methods CLO4: Student will be able to perform molecular diagnostic techniques and understand the principles of metabolic pathway engineering. CLO5: Student will be able to handle various automated instruments with precision available in microbiology laboratories CLO6: Will be able to develop new protocols and manage new resource centres involved in outsourcing of services for techniques studied.	
ESSENTIAL TOOLS IN BIOLOGICAL RESEARCH LAB (MMBD-NPR-113aP)	
PRACTICALS	
ESSENTIAL TOOLS IN BIOLOGICAL RESEARCH LAB (MMBD-NPR-113aP)	
Marks: 50	Duration: 60 hours (2 credits)
1. To learn the basic principle and operation of a compound microscope and Prepare and observe slides of various biological under different magnifications. 2. Separation and identification of amino acids by paper chromatography. 3. Determination of MIC of given antibiotics using bacteria and Vitamin assay. 4. Separation and identification of sugars/lipids by TLC. 5. Determine the purity of nucleic acid sample by spectrophotometric analysis 6. To separate proteins based on size using gel filtration chromatography. 7. Separate proteins based on their molecular weight using SDS-PAGE. 8. Separate DNA fragments based on size using agarose gel electrophoresis. 9. Demonstration of PCR in a thermocycler 10. Separate cellular components based on their size and density using differential centrifugation.	

DSE-7b
BIOETHICS, IPR AND ENTREPRENEURSHIP (MMBD-NPR-113b)

Programme: Certificate/Diploma/Degree/PG		Year: I
Class: M.Sc. Microbiology		Semester: I
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code:MMBD-NPR-113b	Title: BIOETHICS, IPR AND ENTREPRENEURSHIP	
Course Objectives: CO1: To learn the fundamentals of how a laboratory operates while performing all necessary safety precautions, handling live cultures, disposing of hazardous waste, and maintaining the equipment that requires safety audit. CO2: To study about biosafety regulations CO3: To examine and Control the Risks Associated with GMOs. CO4: The objective of this course is to give students a basic understanding of intellectual property rights so they can make significant contributions to the nation's economy through innovations and companies. CO5: To learn the patent filing procedure and the IPR Acts are covered in all of the course material. CO6: The course is intended to increase awareness of the bio- entrepreneurship.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	INTRODUCTION TO BIOETHICS • Overview of bioethics • Relevance of bioethics in microbiology • Different paradigms of bioethics • Necessity of bioethics • Ethical issues against the molecular technologies • Animal and Human subject research ethics • Bioethical committees • Ethical issues related to testing of vaccines and antibiotics	12
II	BIOSAFETY AND BIOSECURITY • Concept of Biosafety and biosecurity, • Biosafety concerns, • Types of biological safety cabinets • Primary Biohazard Containment;	12

	• Specific Microorganism Biosafety Levels. • Biosafety Recommendations: GMOs/LMOs – • Issues and Challenges; • National and International Biosafety policies and laws; • Role of Institutional Biosafety Committees (IBSC), • Review Committee on Genetic Manipulation (RCGM), • Genetic Engineering Appraisal Committee (GEAC), • State Biotechnology Coordination Committee (SBCC), • District Level Committee (DLC) for GMO application in the field of Food, Dairy and Agriculture	
III	RISK MANAGEMENT AND GUIDELINES • Genetically modified organisms (GMO) environmental release, • Risk analysis, risk assessment, risk communication, and risk management; • Overview of International Agreements: Cartagena Protocol, • GRAS organisms, • Utilization of Animals in Testing and Research and alternative of animals in research, human and animal cloning, and its ethical implications, • Human Volunteer Drug Testing by Public and Non-Governmental Organizations (NGOs), participation in biosafety and biodiversity protection, • Regulations from Radiological Safety Division (RSD), • Atomic Energy Regulatory Board (AERB) for employing radioisotopes in laboratories, • Discarding of hazardous waste material, methods of disinfection.	12
IV	INTRODUCTION TO INTELLECTUAL PROPERTY • History and an introduction to intellectual property; • Types of IPR (Trademarks, copyright, Patent, Trade secrets, • Industrial Design and Rights, Traditional Knowledge, Geographical Indications) • IPR (intellectual property rights) and IPP (intellectual property protection), • The World Intellectual Property Rights Organization (WIPO), • Ethics, the advantages and disadvantages of protecting intellectual property, the necessity of IPR, patentability and non-patentability, • patenting life, and legal protection of biotechnological ideas. • Microbiology/Biotechnology patenting: European, US, • Australian, and Indian scenarios; non-patentable and patentable intellectual property; • Indian Patent Act	12
V	INTRODUCTION TO BIOENTREPRENEURSHIP • Importance of entrepreneurship in microbiology • Public and corporate organizations (MSME, DBT, BIRAC, • STARTUP and Make in India) that promote entrepreneurship.	12

	• Important characteristics of entrepreneur in microbiology and biotechnology • Concept of business incubators • Regulatory compliance and procedural knowledge (CDSCO, NBA, GLP, GCP, GLP)	

Reference / Text Books:

1. Private Power, Public Law: The Globalization of Intellectual Property Rights by Susan K. Sell Cambridge University Press, 2000.
2. Essentials of Intellectual Property: Law, Economics, and Strategy by Alexander I. Poltorak;
3. Paul J. Lerner Wiley, 2011 (2nd edition)
4. M K Sateesh Bioethics and Biosafety. Kindle Edition
5. Diane O. Fleming, Debra L. Hunt Biological Safety: Principles and Practices, 4th Edition. ASM 2006
6. Shomini Parashar, Deepa Goel IPR, Biosafety and Bioethics Pearson India 2013.

If the course is available as Generic Elective, then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

After completing this course, the students will have:

CLO1: Complete understanding of working in a microbiology lab while adhering to all safety precautions, handling live bacteria, disposing of infectious waste, and taking care of equipment that needs to be safety audited.

CLO2: Will be able to develop a complete understanding of the biosafety standards and laws that are followed on a national and international level.

CLO3: Will have gained knowledge of IPR concepts and its protection.

CLO4: Will possess knowledge of the IP protection provided by patents, copyrights, and related rights.

CLO5: In addition to specific microbiological examples, students will have acquired the fundamentals of IP protection through the use of trademarks, geographic indications, industrial designs, and new plant varieties.

CLO6: will be able to explain about role of entrepreneurship in microbiology.

BIOETHICS, IPR AND ENTREPRENEURSHIP (MMBD-NPR-113bP)

PRACTICALS

BIOETHICS, IPR AND ENTREPRENEURSHIP (MMBD-NPR-113bP)

Marks: 50

Duration: 60 hours (2 credits)

1. To study safety precautions and good laboratory in a microbiological lab.
2. Introduction, use, and safety instructions for typical laboratory tools for studying

microorganisms: Laminar air flow hood, clinical centrifuge, hot air oven, autoclave, colorimeter, and incubator.

3. To investigate the components and layout of a BSL II and BSL III laboratory.
4. To file requests for IBSC (biosafety committee) approval.
5. To draft and file initial patent applications.
6. To analyze the steps in the patenting process.

CORE-15
MEDICAL MICROBIOLOGY AND IMMUNOLOGY (MMB-NPR 121)

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D.		Year: I
Class: M.Sc. Microbiology		Semester: II
Credits: 6 Theory: 4 Practical: 2		Subject: MICROBIOLOGY
Course Code: MMB-NPR-121		Title: MEDICAL MICROBIOLOGY AND IMMUNOLOGY
Course Objectives: CO1: Understand the concepts and significance of normal flora organisms in human health. CO2: Comprehend the various microbial diseases and their impact on different organ systems. CO3: Gain knowledge about the mechanisms and effectiveness of different antimicrobial agents. CO4: Understand the roles and functions of immune cells in the immune response. CO5: Recognize the development and implications of immunological disorders. CO6: To familiarize the students with advancement in medical microbiology to seek appropriate opportunities.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Medical Microbiology: ○ Classification of medically important bacteria; Normal flora of human body and its importance; ● Commensals and Pathogenic microorganisms; Culture and growth of bacteria; ● Morphological, Physiological and Biochemical Tests for the identification of bacteria; Nosocomial infections	8
II	Microbial Pathogenesis: Mechanisms of Pathogenicity ● Virulence Factors and Toxins ○ Types of virulence factors (e.g., adhesins, invasins) ○ Bacterial toxins (exotoxins vs. endotoxins) ○ Mechanisms of action and effects on the host ● Host-Pathogen Interactions ○ Stages of infection and disease progression ○ Strategies used by pathogens to evade host defenses Epidemiology of Infectious Diseases	10

	• Disease Transmission and Reservoirs ○ Modes of transmission (direct vs. indirect) ○ Types of reservoirs (human, animal, environmental) • Outbreak Investigation and Control Measures ○ Steps in outbreak investigation ○ Measures to control and prevent infectious diseases	
III	Bacteriology: • Important human diseases caused by- • Staphylococcus; • Streptococcus; • Corynebacterium; • Clostridium; • Organisms belonging to Enterobacteriaceae- (Escherichia coli, Klebsiella, Salmonella, Shigella and Proteus); • Pseudomonas; • Haemophilus; ○ Mycobacterium;	12
IV	Antimicrobial Agents and Antimicrobial Resistance (AMR): Antibacterial Agents: Modes of Action with Examples: 1. Nucleic Acid Synthesis Inhibitors: Ciprofloxacin 2. Cell Wall Synthesis Inhibitors: Penicillin 3. Cell Membrane Function Inhibitors: Polymyxin B 4. Protein Synthesis Inhibitors: Tetracycline 5. Metabolism Inhibitors: Sulfamethoxazole Antifungal Agents: Structure, Functions, and Mechanism of action of Amphotericin B Antiviral agents: Structure, Functions, and Mechanism of action of Acyclovir Antimicrobial Resistance: MDR, XDR, MRSA, NDM-1.	15
V	Immunology Immune System Overview • Antigens and Antibodies • Characteristics of Antigens ○ Foreignness, molecular size, and heterogeneity • Structure and Function of Antibodies ○ Antibody classes (IgG, IgM, IgA, IgE, IgD) • Cell-Mediated Immune Responses ○ T cell activation and function ○ Cytotoxic T cells and helper T cells • Humoral Immune Responses ○ B cell activation and antibody production ○ Role of plasma cells and memory B cells • Hypersensitivity Reactions ○ Types I-IV hypersensitivity and mechanisms ○ Clinical examples and management • Autoimmune Diseases ○ Mechanisms of autoimmunity	15

○ Examples (e.g., rheumatoid arthritis, systemic lupus erythematosus) ● Immunodeficiency Diseases ○ Primary immunodeficiencies (e.g., SCID) ○ Secondary immunodeficiencies (e.g., HIV/AIDS)	
Reference / Text Books: 1. Kenneth. J. Ryan (2010) Sheris's Medical Microbiology, Mc Graw Hill. 2. Willey J, Sherwood L. and Woolverton C (2014). Prescott's Microbiology, 9th edi McGraw Hill. 3. Greenwood D (2015). Medical Microbiology, 18th Edition, Elsevier. 4. Murray PR, P faller MA, Tenover FC and Yolken RH (2007). Clinical Microbiology. ASM Press.	
If the course is available as Generic Elective then the students of following departments may opt it. NO	
Evaluation/Assessment Methodology	
	Max. Marks:100
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcome: At the conclusion of this course, learners will be able to CLO1: Recognize the critical role of normal microbial flora in maintaining human health. CLO2: Investigate the typical microbiota present in various human organs. CLO3: Gain knowledge about microbial diseases that impact different organ systems. CLO4: Comprehend the mechanisms of action for various classes of antibiotics. CLO5: Appreciate the role of immune cells in developing resistance against microbial infections. CLO6: Acquire information on the significant functions of immune organs.	
MEDICAL MICROBIOLOGY AND IMMUNOLOGY LAB (MMB-NPR-121P)	
PRACTICALS	
MEDICAL MICROBIOLOGY AND IMMUNOLOGY LAB (MMB-NPR-121P)	
Marks: 50	Duration: 60 hours (2 credits)
1. Perform Gram staining and observe bacterial morphology. 2. Prepare and inoculate culture media for bacterial growth. 3. Isolate and identify normal flora from human samples. 4. Observe and differentiate bacterial colony morphology. 5. Conduct simple and differential staining techniques. 6. Perform catalase, coagulase, and oxidase tests for bacterial identification. 7. Conduct antibiotic sensitivity testing using the Kirby-Bauer method. 8. Collect and identify nosocomial pathogens from clinical samples. 9. Isolate and identify Staphylococcus aureus and Streptococcus pyogenes	

CORE-16
APPLIED VIROLOGY (MMB-NPR-122)

Programme: Certificate/Diploma/Degree/PG		Year: I
Class: M.Sc. Microbiology		Semester: II
Credits: 6		Subject: MICROBIOLOGY
Theory: 4		
Practical: 2		
Course Code: MMB-NPR- 122		Title: APPLIED VIROLOG
Course Objectives: CO1: The primary goal of this course is to familiarize students with the fundamentals of virus structure, genome organisation, and host cell replication techniques. CO2: The students will learn the nomenclature and classification of viruses. CO3: The students will learn how to cultivate different DNA and RNA viruses. CO4: The learner will discover how different DNA and RNA viruses evolve, spread, and cause disease, as well as how to stop them. CO5: The students will learn the morphology, pathogenesis, prevention and control of different DNA and RNA Viruses CO6: Different plant viruses are described in the course as well.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	General properties of Viruses - History and principles of virology - Nomenclature, taxonomy and classification of viruses - Structure and morphology of viruses - Arrangements of capsids - Components of genomes - Replication of viruses - Isolation, purification and cultivation of viruses - Introduction, history, morphology and life cycle of Bacteriophages - Bacteriophage typing,	12
II	Pathogenesis of Viral Infection - Introduction to viral infection - Stages and mechanisms of viral infections - Viral pathogenesis at the cellular level - Host response to viral infections	12

	• Clinical manifestations of viral diseases • Epidemiology	
III	Morphology, Replication, Pathogenesis, Prevention and Control of DNA Viruses: • Small DNA viruses: Parvoviruses Papovaviruses, • Large DNA viruses: Herpesviruses (Herpes Simplex Virus I, Herpes Simplex Viruses II, Varicella Zoster virus, Epstein Barr virus), Adenovirus, Hepatitis viruses Pox viruses.	12
IV	Morphology, Replication, Pathogenesis, Prevention and Control of RNA Viruses: • Positive strand RNA Viruses:- Picornaviruses (Polio), Flaviviruses (West Nile virus) Dengue virus Coronaviruses Swine flu. • Negative strand RNA viruses:- Orthomyxoviruses (Influenza) Paramyxoviruses (Mumps and Measles) Rhabdoviruses, (Rabies) • Double strand RNA (dsRNA) viruses Rotavirus Reoviruse Retroviruse Retroviruses: HIV viral pathogenesis and AIDS.	12
V	Plant Virology • General characteristics of Plant viruses • History and morphology of plant viruses • Viroids • Prions • Tobacco Mosaic virus • Cauliflower mosaic virus • Tomato yellow leaf curl virus • • Transmission of plant viruses	12

Reference / Text Books:

1. Flint SJ, Enquist LW, Krug RM, Racaniello VR, and Skalka AM, Principles of Virology 3rd edition, ASM Press Publication.
2. Fields B, Knipe D and Howley P, Fields Virology 5th Edition, Lippincott Williams and Wilkins Publisher.
3. White DO and Fenner FJ . Medical Virology 4th edition, Academic Press Inc.
4. Vinod Singh; Text Book of Virology, Ibdc Publishers.
5. Biswas SB & Biswas A. An introduction to viruses, 4th edition, Vikas Publishing house Pvt Ltd,

India.

6. Virology: . 3rd ed. Frankel Conrat et al, Prentice Hall.
7. Introduction to Modern Virology. 5th ed. Dimmock et al., Blackwell Scientific Publ.
8. Basic Virology.. By Waginer and M. Hewlett, Blackwell Science Publ.

If the course is available as Generic Elective, then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

	Max. Marks:100
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

CLO1: Will develop the knowledge about the history, structure, classification, nomenclature, and cultivation of virus.

CLO2: Will be familiar to the study of the virus infection mechanism and have acquired the knowledge of some human DNA viruses and RNA viruses.

CLO3: Will acquired the knowledge about the details of bacteriophages.

CLO4: Have acquired knowledge of morphology, pathogenesis, prevention and control of diseases caused by various DNA viruses.

CLO5: Have acquired knowledge of morphology, pathogenesis transmission and prevention of diseases caused by different RNA viruses.

CLO6: Will acquired the knowledge of Plant viruses.

APPLIED VIROLOGY LAB (MMB-NPR-122P)

PRACTICALS

APPLIED VIROLOGY LAB (MMB-NPR-122P)

Marks: 50

Duration: 60 hours (2 credits)

List of Experiments

1. Introduction to Virology laboratory safety guidelines & aseptic techniques.
2. Introduction to the instruments used in Virology lab.
3. Collection, transport and storage of specimens.
4. Demonstration of Isolation of viruses.
5. Demonstration of the cultivation of the viruses
6. To detect Viral antigen by Immunofluorescence assay
7. To detect Hepatitis B surface antigen (HBsAg) by ELISA.
8. Isolation of bacteriophage with Ganga water

DSE-8a

MOLECULAR MICROBIAL GENETICS AND RDT (MMBD-NPR-123)

Programme: Certificate/Diploma/Degree/UG(R)/PG/Ph.D.		Year: I
Class: M.Sc. Microbiology		Semester: II
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code: MMBD-NPR-123	Title: MOLECULAR MICROBIAL GENETICS AND RDT	
Course Objectives: CO1: To provide students with a comprehensive understanding of the role of nucleic acids (DNA and RNA) as hereditary material, including their structures, conformations, and functional roles in genetic processes. CO2: To enable students to grasp the complexities of gene regulation and expression in both prokaryotic and eukaryotic organisms, focusing on transcriptional and post-transcriptional mechanisms. CO3: To introduce students to the mechanisms of genetic exchange, such as transformation, conjugation, and transduction, as well as the molecular basis of mutations and DNA repair mechanisms. CO4: To familiarize students with the types and functions of plasmids and transposons, highlighting their roles in genetic engineering and molecular biology. CO5: To equip students with practical knowledge of recombinant DNA technology, including tools and techniques for genetic engineering, and the application of molecular markers in genome analysis. CO6: To sensitize students to the ethical and biosafety issues associated with genetically modified organisms (GMOs) and the applications of genetic engineering in various fields.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Nucleic acid as hereditary material - Nucleic acids as genetic material: Structure of DNA and RNA; conformational analysis of DNA (sugar puckering, torsion angles); melting of DNA, super-helicity. Structural features and types of RNA. - Central Dogma: DNA replication: Arrangement of replicons in a genome, Various modes of replication in prokaryotes and eukaryotes, mechanism of transcription and translation	12

II	Gene regulation and expression: • Regulation of gene transcription in prokaryotes (operon model, negative and positive regulation of lac operon and trp operon), transcriptional switch in bacteriophage. • Regulation of transcription in eukaryotes: Post transcriptional gene silencing and regulation of gene expression • Post-translational processes: Protein modification, folding, chaperones, transportation, the signal hypothesis, protein degradation. • Mechanism of Genetic exchange: Transformation, conjugation and transduction (Mechanism and application in mapping)	12
III	Mutation and Repair mechanisms • Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; • Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of • Mutations Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes • DNA Repair Mechanisms: Rep[air by direct reversal, excision repair, recombinational repair and SOS repair	12
IV	Plasmids and Transposons • Plasmids - Types (F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid) Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids • Transposons: Prokaryotic transposable elements (Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon), Eukaryotic transposable elements - Yeast (Ty retrotransposon), Uses of transposons and transposition	12
V	Recombinant DNA Technology • Tools and Techniques in genetic engineering- DNA modifying enzymes and restriction enzymes for Genetic engineering , V in gene cloning-Plasmid, Cosmid, Phages, Phasmids, Advanced cloning vectors-BAC, YAC, PAC, Transformation and Transfection, cDNA and genomic DNA library • Molecular markers in genome analysis- RFLP, RAPD, AFLP, SSR and SNP analysis (molecular markers linked to disease resistance genes), Application of molecular markers in forensic, disease prognosis, MALDI-TOF. • Applications- Medical diagnosis and DNA fingerprinting, genetically engineered biotherapeutics, vaccines and their manufacturing, Genetically modified organisms, Biosafety and Bioethical consideration associated with GMO's	12

Course Learning Outcomes:

CLO1: Students will be able to describe the structure and conformational analysis of DNA and RNA, including the melting, super-helicity, and structural features of different types of RNA.

CLO2: Students will demonstrate an understanding of the central dogma of molecular biology, explaining DNA replication, transcription, and translation mechanisms in prokaryotic and eukaryotic systems.

CLO3: Students will analyze and explain the regulation of gene expression in prokaryotes and eukaryotes, including operon models, transcriptional switches, and post-transcriptional gene silencing.

CLO4: Students will identify and explain the types and molecular basis of mutations, as well as the various DNA repair mechanisms, including direct reversal, excision repair, and SOS repair.

CLO5: Students will develop the skills to use DNA modifying and restriction enzymes, vectors, and other tools of genetic engineering, and understand the applications of molecular markers in genome analysis.

CLO6: Students will critically evaluate the biosafety and bioethical considerations associated with the use of GMOs and genetically engineered products, understanding their implications in medical, forensic, and environmental contexts.

Reference / Text Books:

1. Lewin's Genes XII by Krebs J.E., Goldstein E.S., Kilpatrick S.T., Jones and Bartlett Publishers (2017).
2. Molecular Biology of the Gene by Watson J.D., Baker T.A., Bell S.P., Gann A., Levine M., Lodish R., Pearson Education (2013).
3. Molecular Cell Biology by Lodish H.F., Berk A., Kaiser C.A., Krieger M., Bretscher A., Ploegh H., Amon A., Martin K.C., 8th edition, Macmillan Publishers (2016).
4. Cell and Molecular Biology: Concepts and Experiments by Gerald Karp. 8th Edition, John Wiley & Sons Inc, (2016).
5. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
6. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
7. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
8. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

Evaluation/Assessment Methodology		Max. Marks:100
1) Class tasks/ Sessional Examination		16
2) Presentations /Seminar		-
3) Assignments		04
4) Research Project Report		-
Seminar On Research Project Report		-
5) ESE/Attendance		05
INTERNAL MARKS		25
EXTERNAL MARKS		75
TOTAL		100

Prerequisites for the course:

MOLECULAR MICROBIAL GENETICS AND RDT LAB (MMBD-NPR-123P)

PRACTICALS
MOLECULAR MICROBIAL GENETICS AND RDT LAB
(MMBD-NPR-123P)

Marks: 50

Duration: 60 hours (2 credits)

1. Isolation of E. coli Bacterial Genomic DNA
2. Quantitative and qualitative analysis of DNA by UV-spectrophotometer
3. Isolation of Plasmid DNA from E.coli
4. Agarose Gel electrophoresis of genomic and Plasmid DNA
5. Study the effect of chemical (HNO₂) and physical (UV) mutagens on bacterial cells
6. Study about comparison of plasmid and bacteriophage cloning vectors.
7. Preparation of competent cell and transformation
8. Preparation of Master and Replica Plates
9. Demonstration of genetic recombination in bacteria by conjugation.
10. Demonstration of bacterial transformation
11. Selection of recombinant clone

DSE-8b

MMBDSE-NP-123: ENVIRONMENTAL MICROBIOLOGY

Programme: Certificate/Diploma/Degree/PG		Year: I
Class: M.Sc. Microbiology		Semester: II
Credits: 6 Theory: 4 Practical: 2	Subject: MICROBIOLOGY	
Course Code: MMBDSE-NP-123	Title: ENVIRONMENTAL MICROBIOLOGY	
Course Objectives: CO1: To understand the diversity of microorganisms present in various ecosystems. CO2: The focus of the students' knowledge will be on how microorganisms interact with each other, with higher plants and animals, and with humans. CO3: Students will learn the details related to Microbial bioremediation. CO4: The students will learn about different techniques used in environment microbiology. CO5: Additionally, the students will learn about a variety of environmental problems and be inspired to develop novel, long-lasting solutions. CO6: To learn various techniques related to liquid and solid waste management.		
Nature of Paper: Core/DSE/SEC/GE/AECC [DSE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 2 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents No	No. of Lectures Allotted
I	History and development of environmental microbiology Historical highlights, Introduction of air, water and soil microbiology, Existence, diversity, adaptations and potential applications of extremophiles History and development of environmental microbiology Historical highlights, Introduction of air, water and soil microbiology, Existence, diversity, adaptations and potential applications of extremophiles	12
II	Microbial interactions and Biogeochemical cycling Microbes in nutrient cycling with particular reference to the carbon, phosphorous, sulphur, and nitrogen cycles; Microbial degradation of lignocellulosic compounds, keratin, and chitin, as well as Xenobiotics; Interaction between Microbes: Mutualism, synergism, commensalism, competition, amensalism, parasitism, and predation; Plants and microbes Interactions (associated with roots and aerial plant surfaces): Rhizobium Symbiosis, Anabaena-Azolla Symbiosis, Mycorrhizal Associations, Actinorhizal Associations; Animal and microbes interactions: Termite gut	12

	microflora, nematophagus fungus, and symbiotic luminous bacteria.	
III	Microbial bioremediation Cleanup of areas contaminated by heavy metals, oil spills and chlorinated solvents; Microbial degradation & decomposition of pesticides, hydrocarbons; Effluent's biological treatment of pulp, sugar and paper industry; The recovery of metals and minerals from ores, Biodeterioration of heritage buildings and cultural artefacts; microbiological deterioration of paint, paper, textiles, wood, and metal corrosion. Principal methods for their protection.	12
IV	Techniques in environment microbiology Understanding microbial diversity in the environment through culture-dependent techniques and their limitations, as well as through culture-independent molecular techniques (DNA heterogeneity by reannealing denatured environmental DNA, ARDRA, analysis of FAME profiles, determining metabolic capability using BIOLOG microtiter plates, using DNA probes and PCR primers, G+C analysis, slot-blot hybridization of community DNA, and fluorescent in situ hybridization of intact cells).	12
V	Liquid and solid waste management Solid waste: Types, sources and methods of solid waste disposal. Liquid waste management: Composition, strength and types of sewage treatment (primary, secondary and tertiary). Guidelines for tolerated levels of faecal contamination. Decontamination of potable water supplies. Biological and chemical indicators of water safety and quality determination. Microbial assessment for quality of water.	12

Reference / Text Books:

1. Microbiology by Chan ECS, Pelczar Michael J, Krieg NR, by Tata McGraw-Hill Education Pvt. Ltd, 7th Edition, (2009).
2. A textbook of microbiology by R.C. Dubey and D.K. Maheshwari, S Chand Publishing; Fourth edition (2016).
3. Modern concept of microbiology by H D Kumar & Swati Kumar.
4. Foundation in Microbiology by Talaro K P, Chess B, McGraw-Hill Education, 9th edition (2014).
5. Prescott's Microbiology, McGraw-Hill Education; 10th edition (2016).

If the course is available as Generic Elective then the students of following departments may opt it. NO

Evaluation/Assessment Methodology	
	Max. Marks:100
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcomes:	

CLO1: Will become familiar with natural habitats of varied microbial populations
CLO2: Will be familiar with the idea of metagenomics as well as soil, air, and water microbiology.
CLO3: With the aid of many instances, will be able to identify the interactions between microorganisms and higher plants and animals.
CLO4: Will learn in-depth information about various solid waste management strategies, with a focus on the benefits and drawbacks of each approach.
CLO5: will learn about the sewage's composition, strength, and treatments. will have gained knowledge of water treatment and safety.
CLO6: Will gain knowledge of a variety of environmental microbiology techniques, such as ARDRA, FAME profile analysis, assessing metabolic capacity using BIOLOG microtiter plates, and utilising DNA.

MMBDSE-NP-123P: ENVIRONMENTAL MICROBIOLOGY LAB

PRACTICALS

MMBDSE-NP-123P: ENVIRONMENTAL MICROBIOLOGY LAB

Marks: 50

Duration: 60 hours (2 credits)

List of Experiments-

1. To perform MPN test for determination of water quality
2. To determine BOD for given water sample
3. To determine COD for given water sample
4. IMViC Tests for identification of Enterobacteriaceae members
5. To isolate bacteria from soil by SPC.
6. To isolate fungi from air by settle plate technique
7. To determine efficacy of given disinfectant using Phenol coefficient method.
8. To study fungal spores by cello tape method.
9. To isolate algae from soil sample
10. To isolate microorganism's rhizosphere and phyllosphere.

GE-3a
MICROBIAL PHARMACEUTICALS AND FORENSIC RESEARCH
(MMBG-NPR-124a)

Programme: Certificate/Diploma/Degree/ UG(R)/PG/Ph.D.		Year: I
Class: M.Sc. Microbiology		Semester: II
Credits: 4 Theory: 4 Practical: 0	Subject: MICROBIOLOGY	
Course Code:MMBG-NPR-124a	Title: MICROBIAL PHARMACEUTICALS AND FORENSIC RESEARCH	
Course Objectives: CO1: To study the discovery and development of drugs, chemotherapeutic agents and their effects. CO2: The goal of this course is to provide advanced information on the genesis and mechanisms of antibiotic resistance. CO3: To study various sterilization techniques used to control spoilage of pharma products and their preservation. CO4: Understand the roles of Forensics in the biology. CO5: Students will be familiarized with the history and development in microbial pharmaceuticals CO6: Students will be able to understand the molecular principles of drug targeting and drug development.		
Nature of Paper: Core/DSE/SEC/GE/AECC [GE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Microbial Pharmaceuticals • Microorganisms in Drug Production • Paul Ehrlich's contributions and postulates about drug discovery and development • Discovery of Drug- Purification and characterization of bioactive compounds from natural sources, conventional process bioprospecting • (Medicinal Chemistry), extraction and purification principles, • Rational Drug Design- Tools (High Throughput Screening, Combinatorial Synthesis, Pharmacogenomics) and the SAR (Structure • Activity Relationship) Principle. • Drug development -Preclinical development: Toxicity testing (acute, subacute, and chronic toxicity); Clinical development: Clinical trials' • (Aims, Objectives, Conduct)	12

II	Molecular principles of drug targeting: • Drug delivery system in gene therapy, bacterial resistance to antibiotics; Mode of action of non-antibiotic antimicrobial agents; • Penetrating defenses- how the antimicrobial agents reach the targets, cellular permeability barrier, cellular transport system and drug diffusion. Drug development: • Therapeutic ratio, Minimum inhibitory concentration (MIC) and Minimum bactericidal concentration (MBC) • Testing for Susceptibility: Utilization of liquid and solid medium, Susceptibility testing influencing factors, CLSI recommendations, • Agar dilution technique, gradient plate techniques, E-test, Kirby Bauer, and Stokes method;	12
III	Microbial contamination and spoilage of pharmaceutical products: • Sterile injectibles, noninjectibles, and their sterilization; • Manufacturing procedures and in process control of pharmaceuticals. • Use of microbial enzymes in pharmaceuticals, biosensors, Immobilization procedures for pharmaceuticals application (Liposomes), Macromolecular, cellular and synthetic drugs carriers. • Good manufacturing practices (GMP) and good laboratory practices (GLP) in pharmaceutical industry, • Regulatory aspects of quality control, Quality assurance and quality management in pharmaceuticals ISO, WHO, and US certification, • chemical and biological indicators, Safety in microbiology laboratory	12
IV	Advanced Forensic Microbiology • Microbial Profiling in Forensic Science • Biocrime and Bioterrorism Investigations • Microbial Biodegradation in Forensic Research • Microbial Time of Death Estimation • Emerging Technologies in Forensic Microbiology	12
V	Microbial Forensics: • Introduction to Microbial Forensics • Microbial Source Tracking • Molecular Techniques in Microbial Forensics • Applications of Microbial Forensics • Legal and Ethical Issues in Microbial Forensics	12
Reference / Text Books: 1. Microbial Biotechnology: Fundamentals of Applied Microbiology" by Alexander N. Glazer and Hiroshi Nikaido 2. Industrial Microbiology" by L.E. Casida 3. Biotechnology of Antibiotics and Other Bioactive Microbial Metabolites" by G. Lancini and R. Lorenzetti 4. Microbial Forensics" by Bruce Budowle, Steven E. Schutzer, and Roger G. Breeze 5. Forensic Microbiology" by David O. Carter and Jeffrey T. Tomberlin 6. Molecular Biology and Pathogenicity of Mycobacteria" by Herbert N. Engelkirk and Janet Duben-Engelkirk.		

If the course is available as Generic Elective then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology	
	Max. Marks:100
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100
Prerequisites for the course:	
Course Learning Outcome: At the conclusion of this course, learners will be able to: CLO1: Explain the processes involved in the fermentation and biosynthesis of microbial drugs. CLO2: Classify various antimicrobial agents based on their mechanisms of action. CLO3: Assess the emergence and spread of antimicrobial resistance and propose strategies to mitigate it. CLO4: Apply principles of quality control, sterilization, and aseptic processing in pharmaceutical manufacturing. CLO5: Evaluate microbial contamination risks and implement Good Manufacturing Practices (GMP) in pharmaceutical settings and conduct advanced microbial profiling for forensic investigations and interpret the results.	

GE-3b

MYCOLOGY, PHYCOLOGY AND PARACITOLOGY (MMBG-NPR-124b)

Programme: Certificate/Diploma/Degree/PG		Year: I
Class: M.Sc. Microbiology		Semester: II
Credits: 4 Theory: 4 Practical: 0	Subject: MICROBIOLOGY	
Course Code:MMBG-NPR-124b	Title: MYCOLOGY, PHYCOLOGY AND PARASITOLOGY	
Course Objectives: CO1: The primary goal of this course is to provide students with a thorough understanding of fungi, algae, cyanobacteria and parasites. CO2: To understand the reproduction and life cycle of various classes of fungi. CO3: To understand the reproduction and life cycle of various classes of algae, cyanobacteria and important parasites. CO4: To give students in depth knowledge of biotechnological applications of various groups of algae and fungi. CO5: To understand the role of algae as pollution indicator. CO6: To study the industrial application of fungi and algae.		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 (In Hours/Week)- 4 Hours/week Theory - 1 Hr. = 1 Credit		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Mycology: • Diversity and Importance of Mycology (Overview of the diversity of fungi and their ecological, industrial, and medical significance) • Somatic Structure and Reproduction in Fungi (Somatic structures: hyphae, mycelium, Modes of reproduction: asexual (spores, conidia) and sexual (sporangia, gametangia), Concepts of heterothallism, heterokaryosis, parasexual cycle, and dimorphism in fungi) • Classification of Fungi (Overview of fungal classification systems, Ainsworth's classification system, Distinguishing characteristics of major fungal groups: Zygomycota, Ascomycota, Basidiomycota, euteromycota, and Oomycota) • Life Cycle of Fungi (Detailed study of the life cycles of various classes and representative genera: Acrasiomycetes, Myxomycetes, Chytridiomycetes, Oomycetes, Zygomycetes, Ascomycotina, Basidiomycotina, Deuteromycetes	12

II	Applied Mycology Industrial applications of fungi (Fungal fermentation processes, • Production of alcoholic beverages (beer, wine), Fermented foods (bread, mushrooms), Antibiotics production (e.g., penicillin from moulds), Use of fungi as biocontrol agents against plant pathogens) • Other applications: (Fungi as symbionts of insects and their role in attacking other microorganisms, Potential applications of fungi in agriculture, environment, industry, and food, Role of fungi in the biodegradation of wood, paper, and textiles.) • Mycotoxins and fungal quorum sensing mechanisms. • Lichens: ascolichens, basidiolichens, deuterolichens, Mycorrhiza: ecto-, endo-, ectendo-, VAM.	12
III	Introduction to Phycology: • Algae Distribution and General Characteristics (Distribution of algae in various habitats (marine, freshwater, terrestrial), General characteristics of algae: morphology, cellular structure including thallus structure, features, flagella, chloroplast, pyrenoid, pigments and their importance in classification, Nutrition, and reproduction) • Classification of Algae: {Criteria for algal classification - morphological, biochemical, and genetic factors, Overview of major algal groups: Chlorophyta (green algae), Bacillariophyta (diatoms), Phaeophyta (brown algae), Rhodophyta (red algae)} • Nutrition and Reproduction in Algae (Modes of nutrition: autotrophic (photosynthesis), heterotrophic, mixotrophic, Reproduction in algae: asexual (spores, fragmentation), sexual (gametogenesis, fertilization). • Cyanobacteria: (Distribution and ecological roles of cyanobacteria, Classification of cyanobacteria, Thallus structure and its significance, Modes of nutrition: photosynthesis, nitrogen fixation)	12
IV	Applied Phycology • Economic Importance of Algae: (Production of Algal Pigments, Biofuels, Hydrogen Production, Bioactive Molecules) • Algae in Environmental Management (Eutrophication Agents, Bioremediation Agents, Global Warming Agents, Environmental Sustainability. • Algal Biofertilizers (Role in Soil Fertility: Enhancement of soil health and productivity through algal biofertilizers, Nitrogen Fixation: Contribution of cyanobacteria and other algae to nitrogen enrichment in soils.) • Algae as Food and Medicine (Algae in Human Nutrition, Medicinal Uses) • Others: (Diatomaceous earth, Biological importance of phytoplanktons and water blooms Industrial applications and	12

	significance of algal and cyanobacteria)	
V	Parasitology • Host Parasite interaction: Overview of Host parasite relationship (parasitism and symbiosis) and types of parasites • Morphology and life cycle: Giardia (Giardia lamblia), Trichomonas (T.vaginalis), Malaria parasite, • Helminths: General introduction of helminthes. Life cycle of , T. solium, Ascaris lumbricoides and Wuchereria bancrofti,	12

Reference / Text Books:

1. Aneja, K.R. & Mehrotra, R.S. (2011). Fungal Diversity & Biotechnology. New Age International Publishers, New Delhi.
2. Alexopoulos, C. J., Mims, C.W. and Blackwell, M. (1996). Introductory Mycology. 4th edition John Wiley & Sons, USA.
3. Mehrotra, R.S. and Aneja, K.R. (2010). Introduction to Mycology. Wiley Eastern Ltd. New Delhi.
4. Moore –Lancker, E. (1996). Fundamentals of the Fungi. Prentice Hall.
5. Prescott, G.W. 1984. Algae: A review, Bishan Singh, Mahendra Pal Singh. Dehradun.
6. Kumar, H.D. Introductory Phycology. 2nd Ed. Affiliated East-West Press, New.
7. Vashishta, B.R and sinha, A.K., 2011. Fungi. 1st Edition. Published by S. Chand and Company Ltd. New Delhi.
8. Peleazar, J.M., chan E.C.S and Kreig, R.N. 2008. Microbiology. 13th Tata Mc. Graw Hill Publishing Company Ltd, New Delhi.

If the course is available as Generic Elective, then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology	
	Max. Marks:100
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar	-
3) Assignments	04
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	25
EXTERNAL MARKS	75
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

- CLO1: Students will develop the knowledge about the introduction of general properties of Fungi.
CLO2: Will be able to explain reproduction and life cycle of various classes of fungi.
CLO3: Will be able to explain reproduction and life cycle of various classes of algae and cyanobacteria.
CLO4: Has acquired knowledge of industrial application and biotechnology of Fungi.
CLO5: Can isolate the bioactive molecules from algal and cyanobacterial groups.
CLO6: Can be able to develop the algal strains for the bioremediations process.

School of Life Science & Technology

ACADEMIC HAND BOOK



ORDINANCE & ACADEMIC REGULATIONS MASTER OF SCIENCE (BOTANY)

1. Preamble:

Botany is the branch of science that deals with various aspects of plants and their lives. Scholar who has admitted in Master of Science in Botany can build his/her carrier in the different fields of botany. Postgraduate Degree Program of Botany. Masters of Science in Botany, M. Sc. (Botany) comprises of four semesters. This program helps the students those wants to build their career as an academicians in higher education, as a researcher in other sectors where masters in Botany is applicable. The Designing of the program had been done in such a way that a candidature would be job oriented and self-employed. Implementation of New Education Policy 2020 (NEP 2020), skills the students in several ways.

2. Definitions and Nomenclatures:

In these Regulations, unless the context otherwise requires:

1. “Programme” refers Degree Programme like. M.Sc. Botany
2. “Course” refers a theory or practical subject that is studied in a semester.
3. “Vice – Chancellor of IIMT - University” is the Head of the University.
4. “Registrar” is the Head of all Academic and General Administration of the University.
5. “Dean” indicates the authority of the school who is responsible for all academic activities of various programmes and implementation of relevant rules of these Regulations pertaining to the Academic Programmes.
6. “Controller of Examinations” is the authority of the University who is responsible for all activities related to the University Examinations, publication of results, award of grade sheets and degrees.
7. “Dean – Student Welfare” is responsible for all student related activities including student discipline, extra and co-curricular activities, attendance and meetings with class representatives, Student Council, and parent – teacher meet.
8. “HoD” refers the Head of the Department concerned.
9. “University” refers IIMT - University, Meerut.
10. “TCH” is Total Contact Hours – refers to the teaching – learning periods.
11. “DEC” refers Department Exam Committee.
12. “BOS” is Board of Studies.
13. “ACM” refers Academic Council meeting the highest authoritative body for approval for all Academic Policies.
14. “Class Co - ordinator” is a faculty of the class who takes care of the attendance, academic performance, and the general conduct of the students of that class.
15. “IA” is Internal Assessment which is assessed for every student for every course during the semester.
16. “ESE” is End Semester Examination conducted by the University at the End of the Semester for all the courses of that semester.
17. “UGC” means University Grants Commission.
18. “MHRD” is Ministry of Human Resource Development, Govt. of India.
19. “HEI” is Higher Education Institutions.
20. “AICTE” is All India Council of Technical Education.

3. Vision and mission of the School:

Vision: To become the finest institution and to create social, economic and intellectual well-being of the students through discovery, learning and innovations.

Mission: To fulfill the educational needs of students through imparting value based knowledge and innovative skills in an unbiased manner to meet greater challenges involving food, farming, fiber, feed, families, health, energy water and environment.

4. Program Educational objectives:

- Expertise the student to analyze problems, formulates a hypothesis, evaluate and validate results, and produce conclusions.
- To develop problem solving skills and creativity through assignments, seminars and research project work
- Prepare students for pursuing research or careers in fisheries, Entomology toxicology and applied fields
- Prepare students for teaching jobs in Schools, Colleges and Universities.

5. Program outcome:

PO-1: To impart the advanced knowledge on various fields of biology

PO-2: The curriculum of the program fosters problem-solving and critical thinking skills, so that a candidate may face any kind of challenges

PO-3: To inculcate the insights of the key research areas of botany into student's mind

PO-4: The program maintains a balance between theoretical and practical sessions which enables a candidate to apply their learning and may obtain good and satisfactory end results.

PO-5: Various applied fields of Botany like Microbial Genetics, Plant Pathology, Plant Tissue culture etc can be understand.

6. Program Specific outcome:

Program Specific outcome (M. Sc. Botany Ist year):

PSO-1: Students will get the knowledge about the diversity of microorganisms, their importance.

PSO-2: They will learn about the application of microorganisms in different aspects of life.

PSO-3: Students will know the difference between algae, fungi and lichens.

PSO-4: Student will gain knowledge about the biology of the cell at its molecular level.

PSO-5: After the completion of the course, student would be able to understand different fields of botany like anatomy, morphology, reproduction and molecular biology of different forms of life.

Program Specific outcome (M. Sc. Botany IInd year):

PSO-1: Understand recent concepts in Plant pathogenesis.

PSO-2: Student will be trained in skill enhancement courses.

PSO-3: Students completing the course may execute experiments related to basic studies on Plant pathology.

PSO-4: Students gained practical knowledge of handling the plants and using them as model organism

7. Admission:

The number of seats shall be in accordance with the directives by the university. The admission to the course will be on the basis of the merit and according to the guidelines from the university and Government of Uttar Pradesh. After the term-end examination at the end of each semester, the student will be provisionally admitted to the next semester. Each semester will be followed by a break not exceeding 15 days.

8. Eligibility in all year as NEP (entry & exit) as per NEHQF and NSQF (if applicable)

A Candidate who after having secured the B.Sc. degree with at least 40% Marks from a recognized University with a B.Sc. (ZBC)/B.Sc (Hons.) in Botany/subjects of Life Science, shall be eligible for admission to the course.

9. Curriculum:

For the purpose of awarding degrees, the curriculum for M.Sc (Botany) program is structured to have a minimum of credits as specified in the evaluation scheme approved by the university's Board of Studies and spread out across four semesters of study.

Under CBCS, the degree program will consist of the following categories of courses:

1. Core Course
2. Skill Enchantment Course – SEC
3. Generic Elective Course – GEC
4. Discipline Specific Elective – DSE
5. Ability Enhancement Compulsory Courses – AECC

10. Medium of Instruction:

The medium of instruction is ENGLISH for examinations, seminar presentations and project reports.

11. Choice base Credit system (CBCS)/LOCF/OBE:

The Course curriculum would be as per CBCS and NEP 2020.

The course of study shall contain the subjects of applied sciences and Skill Enhancement. The marks shall be awarded to the candidates pursuing the programme for the written papers, mini/major project report/industrial visits/presentation/viva-voce examinations, if any as specified in the scheme of Examinations. The student shall make the choice of course in consultation with the Class Coordinator and as stipulated from time to time.

12. Registration for course in a semester:

In the beginning of the semester the candidate will choose the subjects of his choice and will register for the current semester within the three days of commencement of the semester.

13. Attendance:

The faculty handling a course must finalize the attendance, 3 calendar days before the last instructional day of the course and submit to the HoD through the class teacher. A regular student shall not be permitted to appear in semester examination, unless he/she has regularly attended not less than 75% classes held in aggregate of all subjects. The university however may, condone the short age in attendance upto 10% in each subject for any of the following reasons.

13.1 Condonation of medical cases

For medical cases, submission of complete medical history and records with prior information from the parent / guardian to Dean (Students Welfare) is mandatory. The assessment of such cases will be done by the attendance sub – committee on the merit of the case and put-up recommendations to the Vice-Chancellor. Such condonation is permitted only twice for a student in the entire duration of the program.

The Vice-Chancellor, based on the recommendation of the attendance sub - committee may then give condonation of attendance, only if the Vice-Chancellor deems it fit and deserving. But in any case, the condonation cannot exceed 10%.

13.2 Additional Condonation:

Additional condonation may be considered in rare and genuine cases which includes, approved leave for attending select NCC / Sports Camps, cases requiring prolonged medical treatment and critical illness involving hospitalization. For such select NCC/Sports Camps prior permission for leave shall be obtained by the respective faculty coordinator / Director of sports from the designated authority, before reporting the students.

14. Assessment procedure:

Each Core paper shall be of 100 marks, out of which internal and external assessments will carry 25 marks and 75 marks respectively. While the Skill enhancement and Ability Enhancement Courses will be of 50marks, out of which internal and external assessments will carry 15 marks and 35 marks for Ability Enhancement courses and Skill Enhancement Courses will carry only internal assessment based on the certificates and credits. University Social Responsibility Courses are merely qualifying courses. However, the awarded marks will not be included in the grand total.

14.1 Internal Assessment (IA) & External Assessment (EA):

The Internal Assessment marks awarded to the students should be forwarded to the Controller of Examinations at least one week before the commencement of the semester examination. The internal assessment marks shall be based on factors such marks secured in Sessional examinations, submission of written assignments, classroom participation and attendance. The weightage given to each of these factors for a paper shall be decided and announced at the beginning of the semester.

ASSESSMENT:

INTERNAL AND EXTERNAL ASSESSMENT FOR THEORY			
Internal Assessment	Marks	External Assessment	Marks
Sessional	16	End Semester Final Examination	75
Assignment	5	-	-
Attendance	4	-	-
Total	25		75

14.2 Practical Assessment

Internal Assessment (IA) and External Assessment (EA) are of 20 and 30 marks respectively. External Assessment will be done by the External Examiner appointed by the University outside of the university while Internal Assessment of 20 marks will be based on the laboratory work, Lab attendance, Viva Voce and lab behavior etc.

15. **Field Visit/Survey/Research Project Assessment Criteria:**
Students will have to do a Field Visit/Survey/research project during IV semester. Only Internal assessment of 25% and External assessment of 75% will be done. The project can be under the guidance of any external faculty too. (Outside the University) with the prior permission of the Dean of the said school.
For the assessment of the project, student has to deliver a presentation regarding his work and give Viva voce in front of the external examiner appointed by the University. The student shall submit the project report (4 copies) in the format prescribed by the University.
16. **Internship – Research / Industrial Internship:**
A student may do an internship during summer and winter break.
17. **For non – credit courses / audit courses:**
The University has provided USR course and sports as non credit /audit course.
18. **Credit weightage:**
Credits are the weightages, assigned to the courses based on the following general pattern:
For theory One Hour= 1 Credit
For Practical Two Hour= 1 Credit
19. **Maximum duration of programme/promotion policy:**
A student may complete the program at a slower pace than the regular pace, but in any case, in not more than N+2 years. A student completing the degree programs in the extended period will not be eligible for university ranking.
20. **Maximum gaps between semester/year:**
A student maybe permitted by the Vice Chancellor to withdraw from the entire program for maximum of two semester for reason of ill health, start up venture or other valid reason as recommended by the committee consisting of Head of the Department, Dean of the School and Dean student's Welfare.
21. **Credit system & grading CGPA/SGPA:**
IIMT-University implemented the UGC guidelines to all Universities in 2015 for implementation of the choice-based credit system with a view to offer student's choice of courses within a program with a flexibility to complete the program by earning credits at a pace decided by the students themselves. The system allowed students to choose inter-disciplinary, intra-disciplinary courses according to their learning needs, interest and aptitude. It was considered as a cafeteria approach and was expected to provide mobility to students.

As per the Current credit system practiced in institutions needs comprehensive reforms as they offer very little flexibility, choice and are less learner centric. Degrees offered today are more self-contained focusing on a specialization area and depend a lot on knowledge available with the faculty from the department only. Though the most requisite credit system does exist, wherein students are given a wide choice and flexibility, these exist as small islands in the vast ocean of thousands of educational institutes in India. In such institutions, the curriculum is frequently designed which is learner centric and offering a wide specialization area for students to pick and choose courses from. The institutions shall make attempts wherein the design of the credit system and the teaching and evaluation modes shall be the responsibility of individual

course teachers. The students should have the freedom to opt for courses from other specializations and not just from their core specialization. For this there has to be stronger collaborations between departments of the University and outside. CGPA/ SGPA/ Grading will be done by the COE of the University.

22. Class / division:

The list of successful candidates after the four semesters examination of Master of Science (ZOOLOGY) course shall be arranged in as under in two divisions on the basis of the aggregate marks obtained in all semester examinations taken together, and the division obtained by the candidate will be state in his degree.

- First division those who obtain 60% or more of the aggregate marks.
- Second division who obtained 50% or more but less than 60% of the aggregate marks
- Those who passed all semester examinations in the first attempt obtaining 75% or more marks in the aggregate shall be declared to have passed with **DISTINCTION**.
- Each successful candidate shall receive a copy of detailed marks card on having passed the semester Examination

23. Transfer of credit /Academic:

- 23.1.** Within the broad framework of these regulations, the Academic Council, based on the recommendation of the Credit Transfer Committee so constituted may permit students to transfer part of the credit earned in other approved Universities of repute & status in the India or abroad.
- 23.2.** The Academic Council may also approve admission of students who have completed a portion of course work in another approved Institute of repute under Multiple entry & Exit system, based on the recommendation of the credit transfer committee on a case - to-case basis.
- 23.3.** Students who have completed coursework, at least first year, at some university other than the university to which transfer is sought (may request for transfer of admission to this university. A student may be granted admission only through an admission process that will follow the same policy as for fresh admissions. However, a uniform credit system must be followed by all universities to effect transfer of credits.
- 23.4.** Credit Transfer request can be submitted only after the student has been admitted in the concerned program and the following conditions are met:
- i. The course work has been completed at a UGC approved and accredited University through fulltime form all earning mode.
 - ii. The university accreditation grade/ranking is not lower than that of the university to which the transfer is sought.
 - iii. He courses prescribe to the common minimum syllabus under UGCCBCS system.

- iv. The letter grade obtained in the courses is “B” or better.
- v. The number of credits to be transferred does not exceed the prescribed limit.
- vi. The program in question must have a similar credit system, in particular, modular or semester and the same numeric and letter grading system along with common meaning of the term “credit” in numerical terms.

The aspect of shelf life of courses needs to be considered while accepting credits as obsolescence of knowledge of certain field in terms of its current relevance needs to be investigated. The time lapsed between successful completion of certain courses of the program and the admission to which program transfer is sought needs to be considered.

The maximum number of credit points that may be considered under a credit transfer needs to be specified. Contextual variables such as teaching-learning approach adopted, learning facilities offered, use of evaluation modes may also be considered while preparing the credit transfer policy.

24. Change of discipline:

Within 15 Days of the commencement of the classes if seats are available and eligibility matches.

25. Use of technological intervention:

With the prolife ration of different types of access devices, especially mobile access devices, technology has the potential to augment traditional classroom practices and revolutionize learning and evaluation methods. Technology, in fact can be an important driver to enable lifelong learning. Learning and engagement of students is facilitated by use of technology through several modes such as synchronous learning, semi-synchronous learning, blended learning, collaborative learning, flipped classroom etc. MOOC's, especially provided through SWAYAM, are a window of opportunity for lifelong learning and are offered through technology-based plat forms. Learning management systems (LMS) may be used by institutions to integrate the entire teaching, learning and evaluation process.

For a typical examination department of an institution will be an autonomous body right from registration of student to convocation through an integrated system. In fact, steps must be taken to implement a complete examination management system that considers the complete life cycle of examination process. The use of technology will reduce dependency on human intervention and be error free. The following functions will be automated:

- i. Registration of students and generating unique PRN,
- ii. Filling up of examination form,
- iii. Generation of seat numbers and admit cards/hall tickets,
- iv. Preparation of list of papers better,
- v. Use of question bank system to draw question sets, question paper generation,

- vi. Online distribution of question papers on the day of examination with system of encryption,
 - vii. Bar code system for answer books (this will eliminate issues related to errors, avoid malpractices etc.),
 - viii. Digitization of answers cripts and on screen evaluation of answer sheets,
 - ix. Tracking of student's performance,
 - x. Marks submission through online software,
 - xi. Viewing of result through online system,
 - xii. Online verification and revaluation system,
 - xiii. Digitization of certificates and mark sheets (to avoid tampering and easy retrieval),
 - xiv. Certificate authentication system,
 - xv. Submission of various other applications through online system.
The above will lead to conduct of functions of the examination system in an efficient and transparent manner and timely availability of information to students.
- 26. Student Discipline:**
Every student is required to observe utmost discipline and decorum both inside and outside the campus and not to indulge in any activity which may affect adversely the prestige reputation of the University.
- 27. Student Welfare:**
Any act of indiscipline of a student reported to the Dean (Students Welfare) and Head of the Department will be referred to a Discipline Committee constituted for the purpose. The Committee will enquire into the charges and decide on a suitable punishment if the charges are substantiated. The committee will also authorize the Dean (Students Welfare) to recommend to the Vice-Chancellor for the implementation of the decision. The student concerned may appeal to the Vice-Chancellor, whose decision will be the final.
- 28. Ragging:**
Ragging in any form is a criminal and non-bailable offence in our country. The current State and Central legislations provide stringent punishments including imprisonment. Once the involvement of a student(s) is established in ragging, offending fellow students/staff, harassment of any nature to the fellow students/staff etc. the student(s) will be liable to be dismissed from the University, as per the laid down procedures of the UGC / Govt. / Institute. Every senior student at the University, along with their parent, shall give an undertaking every year in this regard and the same should be submitted at the time of Registration.
- 28. Power of modify :**

Not with standing all that has been stated above, the Academic Council is vested with powers to mod if any or all the above regulations from time to time, if required, subject to the approval by the board of Studies and Final approval by Vice-Chancellor.

- 30. **Exit point:** Not applicable for post graduate courses.
- 31. **NC/Non Credit Course:** USR (University Social Responsibility) and Sports

Evaluation Scheme

**M.Sc. BOTANY
Semester-I**

S.No.	Course Code	Subject	Course Type	Study Scheme			Evaluation Scheme			Credit
				L	T	P	Internal	External	Total	
1	MBOC-NP-111	Microbiology	Core 19	4	0	0	25	75	100	4
2	MBOC-NP-112	Mycology, Phycology and Lichens	Core 20	4	0	0	25	75	100	4
3	MBODSE-NP-113a	Cell Biology	DSE 1	4	0	0	25	75	100	4
	MBODSE-NP-113b	Biotechnology in Human Welfare								
4	NHU-N-111	English Communication	AECC 5	3	0	0	15	35	50	3
5	GENCC-701	NCC	Gen E	2						2
6	NECC-472	University Social Responsibility	USEC				25		NC	0
PRACTICALS										
1	MBOC-NP-111P	Microbiology Lab	Core 19	0	0	2	20	30	50	2
2	MBOC-NP-112P	Mycology, Phycology and Lichens Lab	Core 20	0	0	2	20	30	50	2
3	MBODSE-NP-113aP	Cell Biology Lab	DSE 1	0	0	2	20	30	50	2
	MBODSE-NP-113P	Biotechnology in Human Welfare Lab								
		TOTAL					150	350	550	
4	SPT-471	Sports	USEC	0	0	0	50	0	NC	0
21 (23 including NCC)										

M.Sc. BOTANY Semester-II										
S.No.	Course Code	Subject	Course Type	Study Scheme			Evaluation Scheme			Credit
				L	T	P	Internal	External	Total	
1	MBOC-NP-121	Bryophytes, Pteridophytes and Gymnosperms	Core 21	4	0	0	25	75	100	4
2	MBOC-NP-122	Plant Systematics and Taxonomy	Core 22	4	0	0	25	75	100	4
3	MBODSE-NP-123a	Anatomy and Embryology of Angiosperms	DSE 2	4	0	0	25	75	100	4
	MSZDSE-NP-123b	Biochemistry and Instrumentation Techniques								
4	MBOGE- NP-124a	Environment, Ecology and Biodiversity	GE 4	4	0	0	25	75	100	4
	MSZGE- NP-124b	Entrepreneurship Development								
5	GENCC-801	NCC	Gen E	2						2
6	NECC-482	University Social Responsibility	USEC				25	0	NC	0
	NECC-484	MOOCs/ SWAYAM	SEC-1	2	0	0	50	0	50	2
PRACTICALS										
1	MBOC-NP-121P	Bryophytes, Pteridophytes and Gymnosperms Lab	Core 21	0	0	2	20	30	50	2
2	MBOC-NP-1222P	Plant Systematics and Taxonomy Lab	Core 22	0	0	2	20	30	50	2
3	MBODSE-NP-123aP	Anatomy and Embryology of Angiosperms Lab	DSE 2	0	0	2	20	30	50	2
	MSZDSE-NP-123bP	Biochemistry and Instrumentation Techniques Lab								
		TOTAL					210	390	600	
4	SPT-481	Sports	USEC	0	0	0	50	0	NC	0
24 (26 including NCC)										

**M.Sc. BOTANY
Semester-III**

S.No.	Course Code	Subject	Course Type	Study Scheme			Evaluation Scheme			Credit
				L	T	P	Internal	External	Total	
1	MBOC-NP-231	Principles of Plant Pathology & Disease Management	Core 23	4	0	0	25	75	100	4
2	MBOC-NP-232	Physiology of Plants & their Biochemistry	Core 24	4	0	0	25	75	100	4
3	MBOC-NP-233	Microbial genetics & Molecular Biology	Core 25	4	0	0	25	75	100	4
4	MBOGE-NP-234a	Economic Botany & Plant Biotechnology	GE-5	4	0	0	25	75	100	4
	MBOGE-NP-234b	Disease Biocontrol & Disease Resistance in Plants								
5	MBO-RP-231	Seminar/Industrial Training/ Research	Seminar/Industrial Training/ Research	0	0	4	25	75	100	4
6	GENCC-901	NCC	Gen E	2						2
7	NECC-592	University Social Responsibility	USEC				25	0	NC	0
PRACTICALS										
8	MBOC-NP-231P	Principles of Plant Pathology & Disease Management Lab	Core 5	0	0	2	20	30	50	2
9	MBOC-NP-232P	Physiology of Plants & their Biochemistry Lab	Core 6	0	0	2	20	30	50	2
10	MBOC-NP-233	Microbial genetics & Molecular Biology Lab	DSE 3	0	0	2	20	30	50	2
		TOTAL					185	465	650	
11	SPT-591	Sports	USEC	0	0	0	50	0	NC	0
26 (28 including NCC)										

M.Sc. BOTANY
Semester-IV

S.No.	Course Code	Subject	Course Type	Study Scheme			Evaluation Scheme			Credit
				L	T	P	Internal	External	Total	
1	MBO-RP-241	Industrial Training/Research Project	Industrial Training/Research Project				75	225	300	16
2	Gen E	GENCC-X01	NCC	2	0	0	25	75	100	2
3	USEC	NECC-5X2	University Social Responsibility				25		25	NC
4	SEC 5 (2 Cr.)	NECC-5X4	MOOCs/ SWAYAM	2	0	0	50	0	50	2
TOTAL										
		TOTAL					125	225	350	
4	SPT-5X1	Sports	USEC	0	0	0	50	0	NC	0
18 (20 including NCC)										



Evaluation Scheme

2024-2025

M.Sc. BOTANY
Semester-I

S.No.	Course Code	Subject	Course Type	Study Scheme			Evaluation Scheme			Credit
				L	T	P	Internal	External	Total	
1	MBOC-NP-115	Elements of Microbiology	Core 19	4	0	0	25	75	100	4
2	MBOC-NP-112	Mycology, Phycology and Lichens	Core 20	4	0	0	25	75	100	4
3	MBODSE-NP-116a	Plant Cell Biology	DSE 1	4	0	0	25	75	100	4
	MBODSE-NP-113b	Biotechnology in Human Welfare								
4	NHU-N-111	English Communication	AECC 5	3	0	0	15	35	50	3
5	VAC-111	VAC: (Ancient Sanskrit)	VAC 1	2	0	0	15	35	50	2
6	GENCC-701	NCC	Gen E	2						2
7	NECC-472	University Social Responsibility	USEC				25		NC	0
PRACTICALS										
1	MBOC-NP-115P	Elements of Microbiology Lab	Core 19	0	0	2	20	30	50	2
2	MBOC-NP-112P	Mycology, Phycology and Lichens Lab	Core 20	0	0	2	20	30	50	2
3	MBODSE-NP-116aP	Plant Cell Biology Lab	DSE 1	0	0	2	20	30	50	2
	MBODSE-NP-113	Biotechnology in Human Welfare Lab								
		TOTAL					165	385	550	
4	SPT-471	Sports	USEC	0	0	0	50	0	NC	0
23 (25 including NCC)										

M.Sc. BOTANY Semester-II										
S.No.	Course Code	Subject	Course Type	Study Scheme			Evaluation Scheme			Credit
				L	T	P	Internal	External	Total	
1	MBOC-NP-121	Bryophytes, Pteridophytes and Gymnosperms	Core 21	4	0	0	25	75	100	4
2	MBOC-NP-122	Plant Systematics and Taxonomy	Core 22	4	0	0	25	75	100	4
3	MBODSE-NP-123a	Anatomy and Embryology of Angiosperms	DSE 2	4	0	0	25	75	100	4
	MSZDSE-NP-123b	Biochemistry and Instrumentation Techniques								
4	MBOGE- NP-124a	Environment, Ecology and Biodiversity	GE 4	4	0	0	25	75	100	4
	MSZGE- NP-124b	Entrepreneurship Development								
5	GENCC-801	NCC	Gen E	2						2
6	NECC-482	University Social Responsibility	USEC				25	0	NC	0
	NECC-484	MOOCs/ SWAYAM	SEC-1	2	0	0	50	0	50	2
PRACTICALS										
1	MBOC-NP-121P	Bryophytes, Pteridophytes and Gymnosperms Lab	Core 21	0	0	2	20	30	50	2
2	MBOC-NP-1222P	Plant Systematics and Taxonomy Lab	Core 22	0	0	2	20	30	50	2
3	MBODSE-NP-123aP	Anatomy and Embryology of Angiosperms Lab	DSE 2	0	0	2	20	30	50	2
	MSZDSE-NP-123bP	Biochemistry and Instrumentation Techniques Lab								
		TOTAL					210	390	600	
4	SPT-481	Sports	USEC	0	0	0	50	0	NC	0
24 (26 including NCC)										

Format-1

College/ School: Life Science & Technology Programme: M.Sc.Botany Duration: 4 Semesters/ 2 Years	Credit range: 80 to 110 (Suggested by CBCS Committee)

Master of Science in Botany	95	7 th	C19- Elements of Microbiology C 20- Mycology, Phycology and Lichens	DSE 1- Plant Cell Biology/ Biotechnology in Human Welfare	AECC 5- English Communication			NC C	VAC-1 Ancient Sanskrit		23 (Excluding NCC)
		8 th	C-21 Bryophytes, Pteridophytes and Gymnosperms C-22- Plant Systematics and Taxonomy	DSE-1 Anatomy and Embryology of Angiosperms/ Environment, Ecology & Biodiversity Conservation	AECC 6- Research and Publication Ethics	SEC 4- MOOCs (E&I/IP R)	GE -4 Environment, Ecology and Biodiversity/ Entrepreneurship Development	NC C			27 (Excluding NCC)

		9 th	C-23- Principles of Plant Pathology & Disease Management C-24- Physiology of Plants & their Biochemistry C-25- Microbial genetics & Molecular Biology				GE-5 Economic Botany & Plant Biotechnology / Disease Biocontrol & Disease Resistance in Plants	NC C	VAC-2 Indian Ethos and Modern Managem ent	Seminar/Indust rial Training/ Research (Credits-4)	28 (Excluding NCC)
		10 th				SEC 5- MOOCs		NC C		Research Project (Credits -16)	18(Excludi ng NCC)

Format-2

IIMTU-NEP Implementation: Exit Points

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Code	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
Master of Science in Botany	FIRST YEAR	SEMESTER – I	i) C19: Elements of Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	MBOC-NP-115	V	B.Sc(CBZ)/ B.Sc. (Zool) Hons.	
			ii) C20: Mycology, Phycology and Lichens (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	MBOC-NP-112	V		
			iii) AECC-1 English Communication	3	3	60	NHU-N-111	V		
			iv) DSE-1: Plant Cell Biology/Biotechnology in Human Welfare (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	MBODSE-NP-116a/ MBODSE-NP-113b	V		
			v) VAC 4: Ancient Sanskrit	2	2	30	VAC-111	V		
		SEMESTER – II	i) C21: Bryophytes, Pteridophytes and Gymnosperms (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	MBOC-NP-121	V		
			ii) C22: Plant Systematics and Taxonomy (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	MBOC-NP-122 NECC-484	V		
			iii) SEC-1: MOOCs/ SWAYAM	2	2	30				
			iv) DSE2: (Th.4 Cr.+ P 2Cr.) Anatomy and Embryology of Angiosperms/ Biochemistry and Instrumentation Techniques	4+2	8	60+60	MBODSE-NP-123a/ MSZDSE-NP-123b	V		
			v) GE 4: Environment, Ecology and Biodiversity/Entrepreneurship Development	4	4	60	MBOGE- NP-124a/ MSZGE- NP-124b	V		

Programme Outcome:		Programme Specific Outcome:	
PO-1.	Apply the various fields of botany intended for graduate-level and post graduate-level courses and higher education.	PSO-1.	Students will get the knowledge about the diversity of microorganisms, their importance.
PO-2:	Describe basic concepts of microbes at molecular, cellular level, their physiology and reproduction at individual level.	PSO-2.	They will learn about the application of microorganisms in different aspects of life.
PO-3:	Learn the role of biosystematics in the study of plants	PSO-3.	Students will know the difference between algae, fungi and lichens.
PO-4:	Understand various applied fields of zoology like bryophytes, pteridophytes, gymnosperms and flowering plants.	PSO-4.	Student will gain knowledge about the biology of the cell at its molecular level.
PO-5:	Expertise in handling various laboratory equipment and accomplish the laboratory experiments.	PSO-5.	After the completion of the course, student would be able to understand different fields of botany like anatomy, morphology, reproduction and molecular biology of different forms of life.
PO-6:	Students will get in-depth understanding of botany through seminar presentations, project work, field visits and the combination of theoretical knowledge and practical skills.		
PO-7:			

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
Master of Science in Zoology	SECOND YEAR	SEMESTER –III	i) C 23: Principles of Plant Pathology & Disease Management (Th. 4 Cr. + P 2Cr.)	4+2	8	60+60	MBOC-NP-231	V		
			ii) C24 : Physiology of Plants & their Biochemistry (Th. 4 Cr. + P 2Cr.)	4+2	8	60+60	MBOC-NP-232	V		
			iii) C25: Microbial genetics & Molecular	4+2	8	60+60	MBOC-NP-233	V		

			Biology iv) GE-5Economic Botany & Plant Biotechnology /Disease Biocontrol & Disease Resistance in Plants v) VAC-5: Indian Ethos and Modern Management vi) Industrial training/Research Project	4 2 4	4 2 4	60 30	MBOGE-NP- 234a/MBOGE- NP-234b VAC-004 MBO-RP-231	V		
		SEMESTER – IV	i) Industrial training/Survey/Research Project(P 16Cr.)	16	32		MBO-RP-241	V		
Programme Outcome:							Programme Specific Outcome:			
PO-1:	To impart the advanced knowledge on various fields of biology						PSO-1:	Understand recent concepts in Plant pathogenesis.		
PO-2:	The curriculum of the program fosters problem-solving and critical thinking skills, so that a candidate may face any kind of challenges.						PSO-2:	Student will be trained in skill enhancement courses.		
PO-3:	To inculcate the insights of the key research areas of botany into student's mind.						PSO-3:	Students completing the course may execute experiments related to basic studies on Plant pathology.		
PO-4:	The program maintains a balance between theoretical and practical sessions which enables a candidate to apply their learning and may obtain good and satisfactory end results.						PSO-4:	Students gained practical knowledge of handling the plants and using them as model organism		
PO-5:	Various applied fields of Botany like Microbial Genetics, Plant Pathology, Plant Tissue culture etc can be understand.						PSO-5:	Students gained practical knowledge of handling the plants and using them as model organism		



Format 2

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
POST GRADUATE DEGREE IN BOTANY(90 Credits)	FIRST YEAR	SEMESTER -I	i) C-19- Elements of Microbiology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C-19- Elements of Microbiology	Unit=5/Period=60	40% Marks in Graduation with Botany, Zoology and Chemistry Stream.	N/A
			ii)C-20- Mycology, Phycology and Lichens (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii)C-20- Mycology, Phycology and Lichens	Unit=5/Period=60		N/A
			iii)DSE-1Plant Cell Biology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iii)DSE-1Plant Cell Biology	Unit=5/Period=60		N/A
			iv) AECC-1- English Communication (Th.3 Cr)	3	3	45	i) English Communication	Unit=5/Period=45		N/A
			v) Ancient Sanskrit (Th. 2 Cr.)	2	2	30	ii) Ancient Sanskrit	Unit=5/Period=30		N/A
Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
POST GRADUATE DEGREE IN BOTANY(90 Credits)	FIRST YEAR	SEMESTER -II	i) C-21- Bryophytes, Pteridophytes and Gymnosperms(Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i) C-21Bryophytes, Pteridophytes and Gymnosperms	Unit=5/Period=60	40% Marks in Graduation with Botany, Zoology and Chemistry Stream.	N/A
			ii)C-22Plant Systematics and Taxonomy (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii)C-22- Plant Systematics and Taxonomy	Unit=5/Period=60		N/A
			iii)DSE-2Anatomy and Embryology of Angiosperms(Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iii) DSE-2Anatomy and Embryology of Angiosperms	Unit=5/Period=60		N/A
			iv) GE-4- Environment, Ecology and Biodiversity(Th.4 Cr)	4	4	45	iv) GE-4- Environment, Ecology and Biodiversity	Unit=5/Period=60		N/A
			v) SEC-4 MOOCs/ SWAYAM(Th. 2 Cr.)	2	2	30	v) SEC-4 MOOCs/ SWAYAM	Unit=5/Period=30		N/A

Programme Specific Outcome:

PSO-1:Students will get the knowledge about the diversity of microorganisms, their importance.

PSO-2. They will learn about the application of microorganisms in different aspects of life.

PSO-3. Students will know the difference between algae, fungi and lichens.

PSO-4: Student will gain knowledge about the biology of the cell at its molecular level.

PSO-5. After the completion of the course, student would be able to understand different fields of botany like anatomy, morphology, reproduction and molecular biology of different forms of life.

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
POST GRADUATE DEGREE IN BOTANY(90 Credits)	SECOND YEAR	SEMESTER -III	i) C-23- Principles of Plant Pathology & Disease Management(Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	C-23- Principles of Plant Pathology & Disease Management ii)	Unit=5/Period=60	40% Marks in Graduation with Botany, Zoology and Chemistry Stream.	N/A
			ii) C-24Physiology of Plants & their Biochemistry (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	C-24Physiology of Plants & their Biochemistry	Unit=5/Period=60		N/A
			iii)C-25Microbial genetics & Molecular Biology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iii) C-25Microbial genetics & Molecular Biology	Unit=5/Period=60		N/A
					4	45		Unit=5/Period=60		N/A
								Unit=5/Period=30		N/A
			iv) GE-5- Economic Botany & Plant Biotechnology(Th.4 Cr)	4	2	30	vi) GE-5- Economic Botany & Plant Biotechnology			N/A
			v) SEC-4 MOOCs/ SWAYAM (Th. 2 Cr.)	2			vii) SEC-4 MOOCs/ SWAYAM			N/A
			Industrial Training/Research Project	4	4	60	Industrial Training/ Research Project			

Programme	Year	Semester (15 weeks)	Paper	Credit	Periods per Week	Periods (Hours) per Semester	Paper Title	Unit (Periods per semester)	Prerequisite	Elective (For other faculty)
POST GRADUATE DEGREE IN BOTANY(90 Credits)	SECOND YEAR	SEMESTER -IV	i)Industrial Training/Research Project	16	16	16	i) Industrial Training/Research Project	Unit=5/Period=30	40% Marks in Graduation with Botany, Zoology and Chemistry Stream.	N/A
			ii) SEC-5MOOCs/ SWAYAM (Th. 2 Cr.)	2	2	2	ii) SEC-5 MOOCs/ SWAYAM			N/A

Programme Outcome: After the completion of the program, a candidate will be able to-

PO-1: To impart the advanced knowledge on various fields of biology

PO-2: The curriculum of the program fosters problem-solving and critical thinking skills, so that a candidate may face any kind of challenges

PO-3: To inculcate the insights of the key research areas of botany into student's mind

PO-4: The program maintains a balance between theoretical and practical sessions which enables a candidate to apply their learning and may obtain good and satisfactory end results.

PO-5: Various applied fields of Botany like Microbial Genetics, Plant Pathology, Plant Tissue culture etc can be understand.

Programme Specific Outcome:

PSO-1: Understand recent concepts in Plant pathogenesis.

PSO-2: Student will be trained in skill enhancement courses.

PSO-3: Students completing the course may execute experiments related to basic studies on Plant pathology.

PSO-4: Students gained practical knowledge of handling the plants and using them as model organism

Format-3

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Program: Master of Science (Botany) Degree UG(R)/PG/Ph.D.: PG Class: M.Sc. Botany	Year: I Semester: I	
Credits: 4 Theory: 4 Practical: 0	Subject: Botany	
Course Code:MBOC-NP-111	Title: Microbiology	
Course Objectives: 1. To acquaint students with basic concepts of microbial diversity and how the microbe concept emerged. 2. To know General bacteriology and microbial techniques for isolation of pure cultures of bacteria, 3. Student would be able to understand the history, general properties of viruses and their mode of replications. 4. To know about the physiology of the microbial growth 5. To provide in-depth knowledge to students on different aspects of microbial growth and associated spoilage in foods as well as to demonstrate students on principles, different preservation methods of food and mode of action of various preservation methods on microbes.		
Nature of Paper: Core/DSE/SEC/GE/AECC: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 P: 4 (In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents	Lectures
I	Introduction to microbiology, history and scope of microbiology, tools and techniques used in microbiology laboratory, Microbial evolution, Systematics and taxonomy of microorganisms. Primitive organisms, their metabolic strategies and molecular coding. Microbes of the extreme environment and their metabolic strategies. The microbial cell: general organization of cell and cell wall of prokaryotes, eukaryotes and Archaea, prokaryotic and eukaryotic cell structure and function	14
II	Introduction and general characteristics of Viruses, bacteriophages, Plant Viruses—their morphology, taxonomy, reproduction and transmission, Viruses of algae, fungi and insects. General account of Mycoplasma.	10
III	Microbial nutrition, microbial growth, Gram negative and Gram-positive bacteria, Archaeobacteria, actinomycetes, Quorum sensing in Bacteria: gram negative bacteria: LUXI LUXR-Type: gram positive bacteria: peptide mediated quorum sensing, genetics, bacterial recombination and plasmids, Bacterial conjugation, DNA transformation, Transduction,	14
IV	Microbiology of food, food spoilage and preservation processes, microbiology of fermented foods, oriental foods, dairy foods, wine, beer and other fermented alcoholic beverages, bread and other fermented plant products, Microbial production of organic acids, antibiotics, amino acids,	14

	vitamins, recombinant products, microorganisms as source of foods.	
V	Rhizosphere, Phyllosphere, Mycorrhizae, Actinorrhizae, Tripartite associations, PGPRs, microbes in agriculture.	8

Reference / Text Books:

1. Madigan, M.T., Martinko, J.M., Dunlap, P.V., Clark, D.P., 2011. Brock Biology of Microorganism. 13th edition, Pearson Education Inc.
2. 4. Lim, DV. 2003. Microbiology. Kendall/Hunt.
3. Boundless.2013. Microbiology. Boundless Learning, Incorporated.
4. Comelissen, CN, Harvey, RA and Fisher, BD. 2012. Microbiology. Lippincott Williams & Wilkins.
5. Talaro, K.P., Chess, B. 2011, Foundations in Microbiology. 8th edition. McGraw-Hill.
6. Willey, J.M., Sherwood, L., Woolverton, C.J., 2010. Prescott's Microbiology. 8th edition, McGraw-Hill.
7. Dickinson, C. M., 2020. Molecular Plant Pathology, Bios Scientific Publisher.
8. Robert, N., Trigliano, Windham, M. T. and Windham, A.S., 2003. Plant Pathology: Concepts and Laboratory Exercises, CRC Press.
9. Singh, R. S., 2008. Plant Diseases, Oxford and IBH Publishing Co. Pvt Ltd.

If the course is available as Generic Elective, then the students of following departments may opt it.

1. M.Sc. in Agriculture.

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/ Assignments	05
3) Attendance	04
4) ESE	75
Total:	100

Prerequisites for the course:50% Marks in graduation from a recognized university with Zoology, Botany and Chemistry.

Course Learning Outcomes:

CO1: Students will gain knowledge about the different cell organelles of microorganisms and their detailed functions.

CO2: Students will also study the growth and control of microbes as well as different bacteriological techniques involved in microbiology.

CO3: Students will gain basic knowledge about knowledge on virus cultivation and will be able to describe the structure and replication of viruses.

CO4: Students will gain knowledge of significance and activities of microorganisms in food.

CO5: Students will learn about the different types of fermentation processes, equipment used and microbiological processes involved.

CO6: Recognize the characteristics of soil microorganisms.

IIMTU-NEP IMPLEMENTATION
Year: I / Semester: I

Program: Master of Science (Botany) Degree UG(R)/PG/Ph.D.: PG Class: M.Sc. Botany	Year: I Semester: I
Credits: 2 Theory: 0 Practical: 2	Subject: Botany
Course Code: MBOC-NP-111P	Title: Microbiology Lab
Course Objectives: 1. Upon completion of this course the student will have the knowledge and skills to: understand the Difference between: Prokaryotes and Eukaryotes 2. They may know about the cultivation and staining of bacterial cells. 3. They can understand to methods of food preservation and different types of fermented food products. 4. They can understand the microbes present in Rhizosphere as well as in phylloplane.	
Nature of Paper: Core	
Minimum Passing Marks/Credits: 50% Marks / 2 Credits	
L: T: P: 4(In Hours/Week) Theory – 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)	
	Contents (Minimum any three from each unit, based on the facilities)
1	Different types of bacterial staining techniques.
2	Isolation of bacteria from different sources.
3	Isolation of microbes from different sources.
4	Identification of different types of viruses.
5	To observe microbial growth in different types of cultures.
6	Isolation of microbes from different food stuffs.
7	Production of Beer.
8	Production of Wine.
9	Isolation of microbes from Rhizosphere.
10	Isolation of microbes from Phyllosphere.

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Programme: PG	Year: 1	
Class: M.Sc. Botany	Semester: 1	
Credits: 4	Subject: BOTANY	
Theory: 4		
Practical: 0		
Course Code:MBOC-NP-112	Title: MYCOLOGY, PHYCOLOGY & LICHENS	
Course Objectives:		
1. Students will learn about the ultra-structure, general affinities, and mode of reproduction of fungi. Additionally, to understand the traditional and contemporary methods for classifying fungus on the basis of distribution, nutrition and characteristics.		
2. Students will learn about the harmful microbes responsible for various plant diseases and the specific life cycle pattern of the major fungal groups. They will get learn in-depth information about the fungi that are symbiotic with different tree species and their applications.		
3. Students are will learn about the taxonomy, general characteristics, vegetative characteristics, and reproductive structural aspects of algae. And also going to get extensive understanding of the phylogeny, evolutionary tendencies, and thallus organization of the main algal taxa.		
4. They will come to know about conservation strategies, economic potential, and the diversity of algae. They will also learn about the diversity patterns of lower life forms on earth and the evolution of thallophytes, uses of the pigments found in algae to distinguish, recognize, and categorize the various types of algae and to comprehend the life cycle, distribution, structure, and reproduction of living species of algae.		
5. Students will understand common characters and structure of lichens, diversity of lichens, classification and its economic value. They will also learn the basic growth of lichens and its reproduction.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4		
T:		
P: 2 (In Hours/Week)		
Theory - 1 Hr. = 1 Credit		
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Fungi: Thallus organization and cell structure. • Nutritional types of fungi: biotrophs, hemibiotrophs, symbionts and necrotrophs. • Reproduction, hormonal mechanism of sexual reproduction, parasexuality, life cycles. Fungal systematics and phylogeny	10
II	Plant Pathology: Myxomycota and Plasmodiophoromycota- Stemonitis, Plasmodiophora Oomycota- Pythium, Phytophthora, Peronospora • Chytridiomycota- Syncytium.	12

	• Zygomycota- Zygorhynchus, Pilobolus, • Ascomycota- Yeasts, Aspergillus, Penicillium, Claviceps, Morchella • Basidiomycota- Puccinia, Uromyces, Ustilago, Urocystis,	
III	Introduction to Algae: General characteristics, life cycle and classification (by Fritsch, Smith, Lee), modern trends for algal classifications (molecular and chemotaxonomy), Fossil algae, Microscopy, cell organelles (cell wall, flagella, nucleus, eye-spot, pyrenoids), pigments, reserve food products, Algal blooms	8
IV	Range of thallus organization: A comparative study of range of thallus organization, cell structure, reproduction (asexual and sexual), phylogeny and inter-relationships of the following classes of Algae: • Cyanophyceae: Nostoc, Spirulina • Euglenophyceae: Euglena • Dinophyceae: Gymnodinium • Charophyceae: Closterium • Ulvophyceae: Cladophora • Chlorophyceae: Volvox,	10
V	A comparative study of range of thallus organization: cell structure, reproduction (asexual and sexual), phylogeny and inter-relationships of the following classes of Algae: • Bacillariophyceae: Melosira • Xanthophyceae: Botrydium • Phaeophyceae: Padina • Rhodophyceae: Gelidium, Corallina	10
VI	Lichen : A general account, classification and distribution of Lichens • A comparative study of lichen thallus organization, cell structure, physiology and reproduction • Chemotaxonomy of Lichens Lichenometry	10
Reference / Text Books: 1. Moderna Microbiology (hindi) (hb) ISBN: 9788177543599 Edition: 1 Year: 2018 Author: Dr. Purbhit SS, Dr. Singh T Publisher: Agrobios (India) 2. Suggested books “Plant Pathology by R.S. Mehrotra 2017. Tata McGraw-Hill Education” are included in reading resource list. 3. Microbiology and Plant Pathology by M. U. Charaya 2012. Pragati Publication, Meerut. 4. Suggested book- “Eminent Indian Botanists: Past and Present (Biographies and contributions)”, P. Suresh Narayan and T. Pullaiah, Regency Publications, (2011) 5. Introductory Mycology by Alexopoulos, Mims and Blackwell; John Wiley & Sons Publications, 1996. 6. Introduction to Fungi, J. Webster and R. Weber, 2007, 3rd edition, Cambridge University Press. 7. The Fungi, S.C. Watkinson, N.P. Money, L. Boddy, 3rd edition, Elsevier Science Publishing Co Inc.		
If the course is available as Generic Elective, then the students of following departments may opt it. 1. Agriculture 2. Pharmacy		

2. Microbiology	
3. Environmental Science	
Evaluation/Assessment Methodology	
	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/ Assignments	05
3) Attendance	04
4) ESE	75
Total:	100
Prerequisites for the course: 50% Marks in graduation from a recognized university with Zoology, Botany and Chemistry.	

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Program: Master of Science (Botany)		Year: I
Certificate/Diploma/Degree//PG/Ph.D.		Semester: I
Class: M.Sc. Botany		Subject: Botany
Credits: 4		
Theory: 4		
Practical: 0		
Course Code: MBODSE-NP-113a		Title: Cell Biology
Course Objectives: CO1: To understand the structure and function of all the cell organelles. CO2: To know about chromatin structure and its location. CO3: To be familiar with the basic principle of life and growth of an organism. CO4: To understand cell communication with its neighboring cells. CO5: To understand steps of Protein synthesis and Uptake into ER.		
Nature of Paper: Core/DSE/SEC/GE/AECC: DSE		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P: 4 (In Hours/Week)=8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Cell Theory Structure of prokaryotic and eukaryotic cells, Bio-membranes, Molecular composition and function, Transport across cell membrane: diffusion, active transport and pumps, Co-transport by symporters or antiporters.	12
II	Cytoskeleton: Microfilaments, intermediate filaments and microtubules-structure and dynamics, Cell movements-Intracellular transport, role of kinesin and dynein	12
III	Cell –Cell Signaling and Cell Interaction: Introduction, Cell surface receptors, Second messenger system, MDP kinase pathways, Cell junctions ,Cell adhesion	12
IV	Cell cycle: Cyclin and cyclin dependent kinases, Regulation of CDK – cyclin activity Chromosomes, Chromatin, and the Nucleosomes, Chromosome sequence and diversity.	12
V	Intracellular protein traffic: Protein synthesis, Uptake into ER, Membrane proteins, Golgi sorting, Post translational modifications, Apoptosis, Definition, mechanism and significance.	12
Reference / Text Books: 1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004). 2. Alberts et al: Molecular Biology of the Cell: Garland (2002). 3. Cooper: Cell: A Molecular Approach: ASM Press (2000). 4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).		

5. Lewin B. Genes VIII. Pearson (2004).
6. Watson et al. Molecular Biology of the Gene. Pearson (2004).
7. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis KubyKuby Immunology. W H Freeman (2007).

If the course is available as Generic Elective then the students of following departments may opt it.
 NO

Evaluation/Assessment Methodology

	Max. Marks:100
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/ Assignments	05
3)Attendance	04
4) ESE	75
Total:	100

Prerequisites for the course:

Course Learning Outcomes:

CLO1: After finishing this course, the student will be able to explain cell and its functions.

CLO2: Student will be able to explain cell signaling and cell interaction.

CLO3: Student will be able to explain chromosome sequence and diversity.

CLO4: Student will be able to handle microscopes in research lab.

CLO5: Student will be able to explain Protein synthesis and Uptake into ER.

CLO6: Student will be skilled to work in research institutions, industries, testing labs etc.

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Program:Master of Science (Botany)		Year: I
Certificate/Diploma/Degree//PG/Ph.D = PG		Semester: I
Class: M.Sc. Botany		
Credits: 2		Subject: Botany
Theory: 0		
Practical: 2		
Course Code: MBODSE-NP-113aP		TITLE: Cell Biology Lab
Course Objectives:		
CO1: To understand the structure and organization of invertebrate animals.		
CO2: To understand structure of Polytene chromosomes of salivary gland of Chironomus larva/Drosophila.		
CO3: To identify various stages of mitosis and meiosis.		
CO4: To study techniques of Barr body preparation in buccal epithelial cells		
CO5: To provide knowledge about light microscopic examination and preparation of tissue sections.		
Nature of Paper: DSE		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4		
T: 0		
P: 4(In Hours/Week)		
Theory - 1 Hr. = 1 Credit		
Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No	List of Experiments	No. of Lectures Allotted
1.	Study of Polytene chromosomes in salivary glands of Chironomus larva/Drosophila.	10
2.	Light microscopic examination and preparation of tissue sections.	10
3.	Study of mitotic and meiotic chromosomes from permanent prepared slides.	10
4.	Preparation of slides for mitotic study.	10
5.	Preparation of slides for meiotic study in the testis of grasshopper.	10
6.	Barr body preparation in buccal epithelial cells.	10

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Program: Master of Science (Botany) Certificate/Diploma/Degree//PG/Ph.D. Class: M.Sc. Botany		Year: 1 Semester: 1
Credits: 4 Theory: 4 Practical: 0		Subject: Botany
Course Code: MBODSE-NP-113b		Title: Biotechnology & Human Welfare
Course Objectives: CO 1 To aware students about various applications of different techniques of protein engineering, enzyme and polysaccharide synthesis also to update knowledge regarding various process of antibiotic production. CO 2 To aware students about different types of pollution and pollutants. CO 3 To aware students about agriculture waste processing and degradation of hydrocarbon, and helps in solving environmental issues. CO 4 To aware students about the development of biodegradable polymers also the stress management of environmental issues and forensic science. CO 5 To aware students about production of non-toxic therapeutic agents. CO 6 To aware students about the applications of vaccines and gene therapy.		
Nature of Paper: Core/DSE/SEC/GE/AECC: DSE		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P: 4 (In Hours/Week)=8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week = 4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Industrial application: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.	10
II	Agriculture: N ₂ fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock, bio-composting.	10
III	Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.	15
IV	Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.	13
V	Health: e.g. development of non-toxic the rapeu tic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in <i>E.coli</i> , human genome project.	12
Reference / Text Books: 1. BISWAS, SUBROTO (2020), Biotechnology and Human Welfare, McGraw-Hill		

Education India , 9789390177011	
2. William J. Thieman, Introduction to Biotechnology (August 1st 2021) - Copyright ©2019 Published by Pearson	
3. Naveen Dwivedi and Shubha Dwivedi (2013), Introduction to Biotechnology, University Science Press.	
4. Rup Lal, (2016) An Introduction to Biotechnology, a genetic manipulation perspective, Publisher Wiley.	
5. Srivastava, Thakur and Kumar, (2021) Agricultural Biotechnology: Latest Research and Trends, Publisher Springer.	
6. Richard Saferstein (2008),Forensic Science: An Introduction, Publisher Addison Wesley Longman	
If the course is available as Generic Elective, then the students of following departments may opt it.	
NO	
Evaluation/Assessment Methodology	
Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/ Assignments	05
3) Attendance	04
4) ESE	75
Total:	100
Prerequisites for the course:	
Course Learning Outcomes:	
CLO1: Student will study the application of biotechnology for production of various products having industrial applications and benefit of mankind	
CLO2: Student will be aware of application of biotechnology in agriculture sector.	
CLO3: Student will study about role of biotechnology in cleaning the environment.	
CLO4: Student will be aware of application of biotechnology forensic investigations.	
CLO5: Student will be aware of application of biotechnology in improving health and in diagnostics.	

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Program: Master of Science (Botany)		Year: I
Certificate/Diploma/Degree//PG/Ph.D = PG		Semester: I
Class: M.Sc. Botany		
Credits: 2		Subject: Botany
Theory: 0		
Practical: 2		
Course Code: MBODSE-NP-113bP		Title: Biotechnology & Human Welfare Lab
Course Objectives:		
CO1: To understand the structure and organization of invertebrate animals.		
CO2: To understand structure of Polytene chromosomes of salivary gland of Chironomus larva/Drosophila.		
CO3: To identify various stages of mitosis and meiosis.		
CO4: To study techniques of Barr body preparation in buccal epithelial cells		
CO5: To provide knowledge about light microscopic examination and preparation of tissue sections.		
Nature of Paper: DSE		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4		
T: 0		
P: 4(In Hours/Week)		
Theory - 1 Hr. = 1 Credit		
Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No	List of Experiments	No. of Lectures Allotted
1.	Perform of ethanolic fermentation using Baker’s yeast.	7
2.	Study of a plant part infected with a microbe.	7
3.	To perform quantitative estimation of residual chlorine in water samples.	7
4.	Isolation and analysis of DNA from minimal available biological samples.	7
5.	Case studies on Bioethics (any two).	7
6.	Model preparation of role of Nitrogen cycle in atmosphere	7
7	Model preparation of Bio-composting unit	7
8	Enrichment and isolation procedure for Azotobacter and Azomonas	7
9	Demonstration of Ammonification of soil	4

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: II

Programme:PG Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: M.Sc. Botany		Year: I Semester: II
Credits: 4 Theory: 4 Practical: 0		Subject: Botany
Course Code: MBOC-NP-121		Title: Bryophytes, Pteridophytes and Gymnosperms
Course Objectives: 1. To know about the evolutionary trends of various orders of Bryophytes, Pteridophytes and their different organs. 2. To appreciate connections between plant anatomy and the other major disciplines of biology, including taxonomy, cell biology, physiology, genetics, biochemistry, and ecology. 3. To identify the role of anatomy in solving taxonomic and phylogenetic problems. 4. To understand the shoot structure and functional development aspects of various tissue systems and organs in plants. 5. To acquire knowledge on morphogenesis and organogenesis in plants. 6. To learn about plant development and its various aspects like microspore genesis, megaspore genesis, fertilization etc.		
Nature of Paper: Core/DSE/SEC/GE/AECC/ CORE		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 P: 4 (In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Bryophytes: Contribution of some Indian Bryologists. Classification of Bryophytes their distribution, Habitat, external and internal morphology, reproduction, gametophytes and sporophytes, phylogeny and interrelationships of the orders: Sphaerocarpaceae, Takakiales, Marchantiales and Jungermanniales, Anthocerotales, Sphagnales, Andreales and Bryales.	14
II	Pteridophyta: Classification, Origin and evolution, Phylogenetic relationship with Bryophyta. Morphology, anatomy, phylogeny and interrelationships of the orders Psilopsida- Psilotales and Psilophytales, Lycopodiophyta- Lycopodiales, Selaginellales, Isoetales, Equisetopsida – Equisetales and Pteropsida- Filicales.	14
III	Sporophyte and gametophyte in Pteridophytes, Stelar organization and evolution, Origin of leaf and Telome concept, Sporocarp, Heterospory and seed habit, Comparison of Pteridophyta with Bryophyta and Gymnosperms.	12

IV	Introduction, Classification and distribution of Gymnosperms, Morphology, anatomy, reproduction, phylogeny of the orders Pteridospermales (Caytoniaceae, Medullosaceae) Bennettitales (Williamsoniaceae, Cycadeoideaceae) Cycadales (Cycadaceae) Ginkgoales (Ginkgoaceae) Coniferales (Pinaceae, Araucariaceae) Taxales (Taxaceae) Gnetales (Gnetaceae).	14
V	Economic importance of Bryophytes, Pteridophytes and Gymnosperms	6
Reference / Text Books:		
1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.		
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.		
Evaluation/Assessment Methodology		
		Max. Marks
1) Class tasks/ Sessional Examination		10
2) Presentations /Seminar		5
3) Assignments		5
4) Attendance		5
5) ESE		75
Total:		100
Prerequisites for the course:		
Course Learning Outcomes:		
CO1- Apply the knowledge of biology to make scientific queries and enhance the comprehension potential.		
CO2- Students will be benefitted by studying the plant anatomy enables to identify fragmentary plant materials, wood, forensic investigation, and applied aspects of meristems cultures.		
CO3- Students will be able to utilize embryological studies in various aspects like analysis of evolutionary trends, circumscription and delimitation of taxa and making a decision on systematic positions.		

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: II

Programme:PG Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: M.Sc. Botany	Year: I Semester: II
Credits: 2 Theory: 0 Practical: 2	Subject: Botany
Course Code: MBOC-NP-121P	Title: Bryophytes, Pteridophytes and Gymnosperms Lab
Course Objectives: 1. To make student aware about the differences between Bryophytes, Pteridophytes and Gymnosperms. 2. To impart knowledge of thallus of Bryophytes and their importance. 3. To identify the role of pteridophytes in stelar evolution. 4. To understand the structure of gymnosperms and their reproductive organs. 5. To acquire knowledge on morphogenesis and organogenesis in plants. 6. To learn about plant development and its various aspects like microspore genesis, megaspore genesis, fertilization etc.	
Nature of Paper: Core/DSE/SEC/GE/AECC/CORE	
Minimum Passing Marks/Credits: 50% Marks / 2Credits	
L: 4 T: 0 P: 4 (In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)	
S.No.	Contents
1.	Study of Thallus of Marchantia
2	Study of rhizoids and scales of bryophytes
3	Study of Gemma cup of bryophytes
4	Study of Funaria capsule
5	Study of Lycopodium, Selaginella, Equisetum stem
6	Study of Sporangium of fern
7	Study of different types of stelar system
8	Study of Pinus needle
9	Study of Cycas leaflet
10	Study of Gymnosperm cone

IIMTU-NEPIMPLEMENTATION

Year: I /Semester: II

Program: Master of Science (Botany)		Year: I
Degree: PG		Semester: II
Class: M.Sc. Botany		
Credits: 4	Subject: Botany	
Theory: 4		
Practical: 0		
Course Code: MBOC-NP-122	Title: Plant Systematics and Taxonomy	
Course Objectives:		
1. The phylogeny, taxonomy, and applications of angiosperms in the system will be learned.		
2. Using plant nomenclature, students will be able to name and identify various plants.		
3. The importance of botanic gardens and national and regional centers for plant research and conservation will be recognized and appreciated by the students.		
4. Students will have an understanding of advanced instruments used in plant taxonomy research.		
5. Based on key traits, they will learn to identify various angiosperm families.		
Nature of Paper: Core/DSE/SEC/GE/AECC: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4		
T: 0		
P: 4 (In		
Hours/Week)Theory-		
1Hr.=1Credit		
Practical-2Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	Lectures
I	Plant Systematics and classification system: Taxonomic hierarchy; Concept of taxa (family, genus, species) History of different systems of classification (introduction only).Artificial, Natural and phylogenetic systems of classification Important systems- i) Bentham and Hooker, Engler and Prantl , Hutchinson, A. Takhtajan, ii) Relative merits and demerits of major systems of classification. APG system of classification	14
II	International code of Botanical Nomenclature: History, Principles and rules, Principles, typification and principal of priority, Author citation and its limitation, Effective and valid publication, rank of taxa. Taxonomic hierarchy, species, genus, family and other categories, Taxonomy in relation to anatomy, embryology, palynology, cytology, secondary metabolites in Plants	10
III	Systematic in practices: Botanical Garden: important botanic gardens of the World. Herbarium: Preparation, Importance and role of herbarium, important herbaria s of the World. Specimens and their preparation, Botanical Survey of India. Identification Keys of Angiosperm: Type of Inflorescence, Type of Placentations, Type of Aestivation, and Technical Description of flowers.	10

IV	Modern Taxonomy: Numerical taxonomy: Concepts, Characters and attributes, OTU's Cluster analysis, Cladistics. Phenograms, cladograms, Monophyletic, polyphyletic and paraphyletic groups, plesiomorphy, apomorphy; Digital Taxonomy: E-Flora, Virtual Herbaria, DELTA Taxonomy, Plant Identification App.	10
V	Special features of important families of Angiosperm: Monocots : Cyperaceae, Poaceae, Orchidaceae, Liliaceae Eudicots : Ranunculaceae, Papaveraceae, Rutaceae, Fabaceae, Cucurbitaceae, Apiaceae, Rubiaceae, Asteraceae, Solanaceae, Lamiaceae, Euphorbiaceae, Asclepiaceae	16
Reference/Text Books: 1. Radford A E. (1986). Fundamentals of Plant Systematics, Harper and Row N Y.4 2. Hickey M and King C. (2000). The Cambridge Illustrated Glossary of Botanical Terms. Cambridge University Press, UK. 3. Crawford, D.J. (2003). Plant Molecular Systematics. Cambridge University Press, Cambridge, UK. 4. Singh G (2004). Plant Systematics, 2nd edn, Oxford and IBH, New Delhi. 5. Judd et al. (2007). Plant Systematics – A phylogenetic approach. Sinauer Pub. 3rd edition 6. Stuessy, T.F. (2009). Plant Taxonomy: The systematic Evaluation of Comparative Data. Columbia University Press, New York. 7. Simpson, M.G. (2010). Plant Systematics. Elsevier, Amsterdam. 8. Stuessy, T.F., Crawford, D.J., Soltis, D.E. and Soltis, P.S. (2014). Plant Systematics: The origin, interpretation, and ordering, of plant biodiversity. Koeltz Scientific Books, Konigstein, Germany. 9. Kathirvelu, Sambandan. (2014). E-Flora and Digital Herbaria: Complementary tools for Plant Taxonomy. 10. Angiosperm Phylogeny Group. (2016). An update of the Angiosperm Phylogeny Group Classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society 181: 1-20.		
If the course is available as Generic Elective, then the students of following departments may opt it.		
Evaluation/Assessment Methodology		
		Max. Marks
1) Class tasks / Sessional Examination		16
2) Presentations / Seminar/Assignments		05
3) Attendance		04
4) ESE		75
Total:		100
Prerequisites for the course: 50% Marks in graduation from a recognized university with Zoology, Botany and Chemistry.		
Course Learning Outcomes: CO1: Students will gain knowledge about the different plant angiosperm Families CO2: Students will also study about various classification systems. CO3: Students will gain basic knowledge ICBN, its significance and role in botanical carrier. CO4: Students will learn about modern techniques to study plant taxonomy.		

IIMTU-NEPIMPLEMENTATION
Year: I / Semester: II

Program: Master of Science (Botany) Degree: PG Class: M.Sc. Botany	Year: I
Credits: 2 Theory: 0 Practical: 0	Semester: II
Course Code: MBOC-NP-122P	Subject: Botany
Course Objectives: 1. They will learn to identify plant and flower related features. 2. They will learn to prepare Herbarium sheets, 3. They will learn to prepare virtual herbaria by digital taxonomy. 4. Students will learn to identify various angiosperms families with specific key characters. 5. They will come to know about various advanced tools to study plant taxonomy.	
Nature of Paper: Core	
Minimum Passing Marks/Credits: 50% Marks / 2 Credits	
L: T: P: 4(In Hours/Week)Theory- 1Hr.=1Credit Practical-2Hrs.=1Credit(4Hrs./Week=4Credits)	
Contents (Minimum any three from each unit, based on the facilities)	
1	Description of Identification keys.
2	Description of locally available representative families.
3	Identification of plant specimens using floras and identification keys.
4	Study of herbarium specimens of different families covered in theory course
5	A field Field trips within the campus and outside the campus for other botanical collections
6	Preparation of herbarium sheets of wild or cultivated abundant plants
7	Preparation of virtual herbaria on the basis of Digital Taxonomy
8	Description of a plant Identification app.

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme:PG Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: M.Sc. Botany	Year: I	
	Semester: II	
Credits: 4 Theory: 4 Practical: 2	Subject: Botany	
Course Code: MBOC-NP-123a	Title: Anatomy & Embryology of Angiosperms	
Course Objectives: 1. To know about the internal structure and reproduction of the most evolved group of plants, the Angiosperm. 2. To appreciate connections between plant anatomy and the other major disciplines of biology, including taxonomy, cell biology, physiology, genetics, biochemistry, and ecology. 3. To identify the role of anatomy in solving taxonomic and phylogenetic problems. 4. To understand the shoot structure and functional development aspects of various tissue systems and organs in plants. 5. To acquire knowledge on morphogenesis and organogenesis in plants. 6. To learn about plant development and its various aspects like microsporogenesis, megasporogenesis, fertilization etc.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 4 Theory - 1 Hr. = 1 Credit(In Hours/Week) Practical- 2 Hrs.=1 Credit (4Hrs./Week=2Credits)		
Unit	Contents	No. of Lectures Allotted
I	Simple Tissue: Types and Functions. Complex Tissues: Types & Functions.	8
II	Structure of dicot and monocot root, stem and leaf.	4
III	Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood).	8
IV	Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.	8
V	Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, Organization and ultrastructure of mature embryo sac.	8
VI	Microsporogenesis, Megasporogenesis, Apomixis, Parthenocarpy	8
VII	Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.	8
VIII	Endosperm types, structure and functions; Dicot and monocot embryo; Embryo endosperm relationship.	8
Reference / Text Books:		

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	10
2) Presentations /Seminar	5
3) Assignments	5
4) Attendance	5
5) ESE	75
Total:	100

Prerequisites for the course:

Course Learning Outcomes:

CO1- Apply the knowledge of biology to make scientific queries and enhance the comprehension potential.

CO2- Students will be benefitted by studying the plant anatomy enables to identify fragmentary plant materials, wood, forensic investigation, and applied aspects of meristems cultures.

CO3- Students will be able to utilize embryological studies in various aspects like analysis of evolutionary trends, circumscription and delimitation of taxa and making a decision on systematic positions.

Practical List: MBOC-NP-123P

1. To study cell structure and apical meristem.
2. To study simple tissues in given plant material.
3. To study complex tissues in given plant material.
4. To perform sectioning of dicot & monocot root.
5. To perform sectioning of dicot & monocot stem.
6. To perform sectioning of dicot & monocot leaf.
7. To study Secondary growth in dicot
8. To study anomalous Secondary growth in monocot stem
9. To study T.S. of anther (young and mature) at various stages of Development
10. To study L.S. of ovule
11. To study types of ovules – orthotropous and Anatropous
12. To study Embryogenesis
13. To perform Dissection of embryo / endosperm from developing seeds
14. To study preparation of culture media (MS)
15. To study Stock solution preparation and Sterilization of culture media

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme:Master of Science in Botany		Year: I
Certificate/Diploma/Degree//PG/Ph.D.		Semester: II
Class: M.Sc. Botany		
Credits: 4		Subject: Botany
Theory: 4		
Practical: 0		
Course Code:MBOGE-NP-124a		Title: Environment, Ecology & Biodiversity
Course Objectives:		
CO1: To provide knowledge about basic of Environment and its component.		
CO2: To understand the knowledge about ecology and Ecological relationships.		
CO3: To understand environment pollution with special reference to Air, Water & Noise Pollution.		
CO4: To impart knowledge about Biodiversity status.		
CO5: To provide knowledge about Biodiversity management.		
Nature of Paper: Core/DSE/SEC/GE/AECC: DSE/ Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4		
T:0		
P: 2 (In Hours/Week) 8		
Theory - 1 Hr. = 1 Credit		
Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Environment: Meaning and definition of environment, Structure and composition of Atmosphere, Hydrosphere, Lithosphere. Concept of Biosphere. Habitats: Terrestrial and aquatic (Fresh water and marine) habitat. Bio-geochemical cycles with special reference to nitrogen cycle.	12
II	Ecology: Introduction of ecology, Definition, brief history, scope and branches of ecology. Organizational level of ecological systems. Ecological successions definition, Causes of succession, Succession in Aquatic System. Habitat and Niche, Ecotone, Ecotype, Edge effect. Population Ecology, Community Ecology. Ecological relationships- (<i>Antagonistic relationship and Symbiosis relationship</i>).	12
III	Environmental Pollution: Introduction, meaning, definition. Pollutants and their types. Sources, Effects and control of Air pollution, Water pollution and Noise Pollution. Concept of Solid Waste Management (SWM), Eutrophication.	12
IV	Biodiversity: Concept of Biodiversity, Meaning, Varieties of ecological diversity (Species diversity, Resource diversity, Habitat diversity), Types of Species diversity (point diversity, Alpha diversity, Gamma diversity, Epsilon diversity). Threats to Biodiversity (Habitat destruction, deforestation, Poaching of wildlife, impact of introduced species, pollution etc.), Hot spot of Biodiversity.	12

V	Biodiversity Management: Introduction to sustainable development. Strategies for Biodiversity conservation, In-situ conservation: sanctuaries, biospheres reserves, national parks, nature reserves, preservation plots. Ex-situ conservation: botanical gardens, zoos, aquaria, homestead garden; herbarium, gene Bank and DNA bank.	12
Reference / Text Books: 1. A text book of Ecology and Environment, P.C. Joshi & Namita Joshi, Himalaya Publishing House, Mumbai 2. Ecology and Environment, P.D. Sharma, Rastogi Pub., New Delhi. 3. Ecology and Environment, H.R. Singh and Neeraj Kumar, Rastogi Publication. 4. Fundamentals of Ecology, E.P. Odum, W.B. Saunders Co., Philadelphia. 5. Essentials of Ecology & Environmental Science, S.V.S. Rana, Prentice Hall of India Pvt. Ltd., New Delhi. 6. Environmental Science, Santra S.C., New Central Book Agency Pvt Ltd., Kolkata., 2001		
If the course is available as Generic Elective then the students of following departments may opt it.		
1. Agriculture Sciences, B. Pharma, B.Sc. Biotechnology, B.Sc. Microbiology		
Evaluation/Assessment Methodology		
		Max. Marks:100
1. Sessional Examination		15
2. Assignments		5
3. Presentations /Seminar /Attendance		5
4. ESE		75
Total:		100
Prerequisites for the course:		
Course Learning Outcomes: CLO1: Student will be aware about Environment and its Components. CLO2: Student will be able to explain Ecology and Ecological relationships. CLO3: Student will be able to explain Environment pollution and their control measures. CLO4: Student will be able to describe the different level of biodiversity. CLO5: Student will be able to explain about Biodiversity management with special reference to in-situ and ex-situ conservation. CLO6: The overall course outcome focused on the role of Environment management in human welfare.		

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: Master of Science in Botany Certificate/Diploma/Degree//PG/Ph.D. Class: M.Sc. Botany		Year: I Semester: II
Credits: 4 Theory: 4 Practical: 0		Subject: Botany
Course Code: MBOGE-NP124a		Title: Environment, Ecology & Biodiversity
Course Objectives: CO1: To understand the procedure of estimation of DO of given water sample. CO2: To understand the Biodiversity Conservation. CO3: To understand the step of . CO4: To understand the procedure of alkalinity of water. CO5: To study community of quadrat.		
Nature of Paper: DSE		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4 Hrs./Week=4 Credits)		
S.No	List of Experiments	No. of Lectures Allotted
1.	Study of Fresh water Ecosystem	8
2.	Estimation of TDS of given water sample.	8
3.	To determine the DO of given water sample.	8
4.	Biodiversity studies: (Map studies - One exercises to be given) A. Biodiversity Hotspots location in I. World II. India B. Protected Areas of India (National Parks, Biosphere Reserves)	8
5.	To study and enlist various biotic and abiotic components of Grassland Ecosystem.	8
6.	To study hypothetical EIA of Urbanization.	8
7.	To determine the hardness of given water sample.	8.
8	Population dynamics and community composition To take up marbles of 5-6 different colours mix these in different ratio Selecting one colour for one species and find out: (a) Species composition/Diversity. (b) Dominant and rare Species	8.

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: III

Programme: M.Sc. (Botany) Certificate/Diploma/Degree/	Year: II Semester: III	
Credits: 4 Theory: 4 Practical: 0	Subject: Botany	
Course Code: MBOC-NP-231	TITLE: Principles of Plant Pathology & Disease Management	
Course Objectives: The objective of this is to develop 1. understanding about the diseases of plant, their symptoms in plants, 2. How the pathogens affect the physiology of plant. 3. Effects of environment on disease development 4. Host plant nutrition and causal organism, diseases caused by them 5. Symptoms and disease cycle and their control methods		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents	Lectures
I	Introduction: Definition of disease, causes and classification of diseases, plant pathology in India, significance of plant diseases, disease cycle and symptoms of plant disease, Contribution of various plant pathologists. Pathogenesis (disease development), host-parasite relationship, enzymes and microbial toxins in plant diseases.	8
II	Diseases caused by Fungi: Damping-off of seedlings, late blight of potato, downy mildew and powdery mildew of cucurbits, rusts of wheat, loose smut of wheat, covered smut of barley and wilt of pigeon pea, Non-Parasitic diseases caused by environmental factors.Effects of pathogens on physiology of plants, Host defense mechanism	8
III	Diseases caused by Bacteria and Mollicutes: General symptoms and control of bacterial diseases, bacterial leaf blight of rice, red stripe of sugarcane, bacterial rot or tundu of wheat, Crown Gall disease, diseases caused by mollicutes: Witche’s broom of potato. Diseases and Symptoms caused by Viruses, Classification, nomenclature and transmission of plant viruses, tobacco mosaic, yellow vein mosaic of bhindi, leaf curl of papaya, bunchy top of banana.	7
IV	Overview of treatment modalities (pharmacological, surgical, lifestyle interventions), Development and implementation of treatment plans Personalized medicine and targeted therapies. Principles of infectious disease management (antibiotics, antivirals, vaccines), Strategies for infection control and prevention, Emerging infectious diseases and global health challenges	7
V	Methods of control of plant diseases: bioinsecticides, bionematicides, bioherbicides, pest management, mechanisms of biological control;	7

	competition, antibiosis, hyperparasitism, hypovirulence, induced resistance, predation, parasitism, Biocides in crop protection, Role of Quarantine.	
VI	Recent advancements in disease management (biotechnology, genomics), Future trends and innovations, Integration Advances in Disease Management.	7
VII	Diseases and Control Symptoms, Causal organism, Disease cycle and Control measures of –Early & Late Blight of Potato, Black Stem Rust of Wheat, <i>Alternaria</i> spot and white rust of Crucifers, Red Rot of Sugarcane, Wilting of Arhar, Mosaic diseases on tobacco and cucumber, yellow vein mosaic of bhindi; citrus canker, little leaf of brinjal; Damping off of seedlings, Disease management; Quarantine, Chemical, Biological, Integrated pest disease management.	8
Evaluation/Assessment Methodology		
		Max. Marks
1) Sessional Examination		16
2) Assignments		5
3) Attendance		4
4) ESE		75
Total:		100
Prerequisites for the course:40% Marks in 12 th from a recognized Board with a subject of life Science/ Biology (PCB)		
Course Outcome: 1. Have the knowledge of diseases, their causal organism, symptoms of the diseases, and their control measures for enhancement of global knowledge 2. The students will also learn how the pathogens affect the physiology of plants, host defense mechanism for skill development. 3. Know the effects of environment on disease development, host plant nutrition and disease forecasting for skill development. 4. Learn host – pathogen relationship and disease management for enhancement of global knowledge. 5. The students will be taught about different methods of disease control enhancement of global knowledge. Suggested Readings: 1. Agrios, G. N. 1978: Plant Pathology. 2. Aneja, K. R. 1993: Experiments in Microbiology, plant pathology and Tissue culture. 3. Cooke, A. A. 1981: Diseases of Tropical and Subtropical field, Fiber and oil plants. 4. Gangopadhyay, S. 2004: Clinical Plant Pathology. 5. Kuijit, J. 1969: The Biology of parasitic flowering plants. 6. Mahadevan, A. and R. Shridhar, 1982. Methods in physiological plant pathology. 7. Mehrotra, R. S. 1980: Plant Pathology. Tata M Hill Pub. 8. Nyvall, R. F. 1970: Field Crop Diseases Handbook. 9. Paul Khurama, S. M. 1998: Pathological Problems of Economic crop plants and their management. 10. Planke, J. E. and R. Vander, 1968: Disease Resistance in plants. 11. Planke, J. E. Vander. 1963: Plant Diseases Epidemics and control. 12. Rangaswami, G. 1979: Diseases of crop plants in India. 13. Singh, R. S. 1998: Plant Diseases.		

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: III

Programme: M.Sc. (Botany) Certificate/Diploma/Degree/	Year: II Semester: III
Credits: 2 Theory: 0 Practical: 2	Subject: Botany
Course Code: MBOC-NP-231P	TITLE: Principles of Plant Pathology & Disease Management Lab
Course Objectives: The objective of this is to develop 1. understanding about the diseases of plant, their symptoms in plants, 2. How the pathogens affect the physiology of plant. 3. Effects of environment on disease development 4. Host plant nutrition and causal organism, diseases caused by them 5. Symptoms and disease cycle and their control methods	
Nature of Paper: Core	
Minimum Passing Marks/Credits: 40% Marks / 4 Credits	
List of Experiments: 1. Study of some important bacterial, viral and fungal diseases in plants. 2. Bacterial leaf blight of rice, 3. Red stripe of sugarcane, 4. Bacterial rot or tundu of wheat, 5. Witches' broom of potato, 6. Tobacco mosaic, 7. Yellow vein mosaic of bhindi, 8. Leaf curl of papaya, 9. Bunchy top of banana, 10. Damping-off of seedlings, 11. Late blight of potato, 12. Downy mildew and powdery mildew of cucurbits, 13. Rusts of wheat, 14. Loose smut of wheat, 15. Covered smut of barley and wilt of pigeon pea. 16. Fungal disease identification 17. Bacterial disease identification	

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: III

Programme: M.Sc. (Botany) Certificate/Diploma/Degree/	Year: II Semester: III	
Credits: 4 Theory: 4 Practical: 0	Subject: Botany	
Course Code: MBOC-NP-232	TITLE: Physiology of Plants & Their Biochemistry	
Objective: The course will deal with 1. Physiology of plants 2. advance topics on plant growth and development, 3. 3.Plant growth hormones, 4. Role of plant hormones and stress physiology. 5. deal with biochemical properties.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 2 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents	Lectures
I	Photosynthesis: photosynthetic apparatus; photosynthetic pigments and light harvesting complexes; Photo oxidation of water; Mechanism of electron transport system, Carbon assimilation-the Calvin Cycle; Photorespiration and its significance, C ₄ Plants, the CAM pathway.	8
II	Respiration: Mechanism of respiration-Glycolysis, aerobic oxidation of Pyruvic acid (Krebs Cycle), Electron Transport Chain, Fermentation, Respiratory Quotient (RQ) and factors affecting the rate of respiration. Mineral Nutrition in Plants: General role of mineral elements in plants; important symptoms of deficiency of mineral elements; Nitrogen Metabolism: biological nitrogen fixation, mechanism of nitrate uptake and reduction, ammonia assimilation.	8
III	Nitrogen fixation and assimilation, Amino acid biosynthesis and metabolism, Role of nutrients in plant growth and development. Secondary metabolites (alkaloids, flavonoids, terpenoids), Biochemical pathways for secondary metabolite production, Role of secondary metabolites in plant defense.	7
IV	Structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interactions, etc). Metabolism of carbohydrates, lipids, amino acids, nucleotides and vitamins.	7
V	Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes. Conformation of proteins (Ramachandran plot, secondary structure, tertiary and quaternary structure, domains, motif and folds).	7

VI	Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA). Stability of proteins and nucleic acids; Torsion Angles, Sugar Puckering.	7
Evaluation/Assessment Methodology		
		Max. Marks
1) Sessional Examination		16
2) Assignments		5
3) Attendance		4
4) ESE		75
Total:		100
Prerequisites for the course: 40% Marks in 12 th from a recognized Board with a subject of life Science/ Biology (PCB)		
Course Outcomes This course will provide the better understanding of - various physiological processes like absorption of water and minerals, photosynthesis, respiration, transpiration, seed germination and seed dormancy. - This course will provide an understanding of nitrogen metabolism in plants. - This course will help to understand the Phytohormones and their role in the development of plants. - The students will be learning abiotic stress signaling, stress tolerance/adaptive physiological and biochemical changes focusing on mechanisms. - They should be in a position to extrapolate this knowledge for creating stress tolerance crops. - The students will also learn about various types of stress and defense mechanisms in plants.		
Suggested Readings: - Hopkins, W. C. (1995): Introduction to Plant Physiology. - Krishnamurthy, H.N. (1992): Physiology of Plant Growth and Development. - Marschner, H. W. (1986): Mineral nutrition of Higher Plants. - Miller, P (1973) : Phytochemistry Vol.I, II and III. - Moore, T.C. (1974): Research experience in Plant Physiology, a laboratory manual. - Randhir Singh and Sawhney, S. K. (1988): Advances in frontier Areas of Plant Biochemistry. - Sadashivam and Manikam (1996): Plant Biochemical methods - Taiz, L. and Ziegler, F. (1998): The Plant Physiology. - Pessarkli, M. (2004): Handbook of Plant and Crop Physiology, Marcel Dekkar Inc. NY.		

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: III

Programme: M.Sc. (Botany) Certificate/Diploma/Degree/	Year: II Semester: III
Credits: 2 Theory: 0 Practical: 2	Subject: Botany
Course Code: MBOC-NP-232P	TITLE: Physiology of Plants & Their Biochemistry Lab
Objective: The objective of this course is to 1. Share the knowledge to the students about the experiments. 2. The students will get a better understanding of the concept studied by them in theory course and correlate with experimental observations.	
Nature of Paper: Core	
Minimum Passing Marks/Credits: 50% Marks / 2 Credits	
List of Experiments: 1. Study of photosynthetic rate under different condition by using Wilmot's Bubbblers. 2. Study of osmosis (exosmosis and endosmosis) by potato osmoscope. 3. Study of plasmolysis in Tradescantia/Hydrilla leaves. 4. Study of transpiration rate under different condition by using Ganong's/Farmer's Potometer. 5. Study of RQ of different respiratory substrates (carbohydrates, proteins, fats etc) by using Ganong's respirometer. 6. Find out the R _f values of amino acids in germinating seeds of any crop plant. 7. Preparation of the standard curve of protein (BSA) and estimation of the protein content in extracts of plant material by Lowry's method. 8. Qualitative and quantitative analysis of photosynthetic pigments and anthocyanins by spectrophotometric and chromatographic techniques. 9. To test the presence of starch in green leaf. 10. To test the presence of reducing sugar in germinating barley seeds by Benedicts reagent test 11. Study the seed germination and seedling growth under the salt stress condition. 12. Study of salt stress effect on amino acids in germinating seeds of any crop. 13. To study the chlorophyll content in leaves of growing crop plants (wheat, pea, gram and barley etc) under different salt stress condition.	

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: III

Programme: M.Sc. (Botany) Certificate/Diploma/Degree/	Year: II Semester: III	
Credits: 4 Theory: 4 Practical: 0	Subject: Botany	
Course Code: MBOC-NP-233	TITLE: MICROBIAL GENETICS & MOLECULAR BIOLOGY	
Objective: 1. Understanding microbial genes, genomes, and gene expression is essential for understanding the biology and evolution of microorganisms and their interactions with the environment. 2. Understand the detailed account of the plant cell and biological membrane. 3. Describe cytological, biochemical, physiological and genetic aspects of the cell, including cellular processes common to all cells, to all eukaryotic cells as well as processes in certain specialized cells. 4. Explain cellular processes and mechanisms that lead to physiological functions as well as examples of pathological state.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents	Lectures
I	Introduction to microbial genetics: DNA as genetic material, Flow of genetic information, Nucleic acid structure, DNA replication, GeneStructure. Gene Expression and Regulations: Levels of Regulation of Gene Expression- transcriptional (lac and trp operon, Two-component signal transduction systems.	8
II	Mutation: Types and induction by various agents. Site directed mutagenesis. Detection and isolation of mutantsDNA .Bacterial Gene Transfer methods: Conjugation, Transformation, and Transduction. Bacterial genome mapping Gene variation by Recombination- homologous recombination, site-specific recombination, and transposition. Horizontal Gene transfer. Recombination and genome mapping in viruses.	8
III	Overview of microbial genetics, Introduction to molecular biology, Importance of microorganisms in genetics and molecular research. Introduction to DNA technology, Cloning vectors, Restriction enzymes, Techniques used in molecular biology, Restriction Fragment Length Polymorphism, Randomly Amplified Polymorphic DNA, PCR, DNA finger printing, DNA sequencing and Gene therapy.	7
IV	DNA replication (enzymes involved, origin of replication and replication fork, models of DNA replication, fidelity of replication, extra chromosomal replicons); DNA damage and repair mechanisms.	7
V	Transcription- RNA synthesis and processing (transcription factors and	7

	machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, RNA splicing, structure and function of different types of RNA, RNA transport.	
VI	Translation – Ribosome & formation of initiation complex, elongation and termination. Translational proof-reading, translation inhibitors, Post-translational modification of proteins. Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).	7
Evaluation/Assessment Methodology		
		Max. Marks
1) Sessional Examination		16
2) Assignments		5
3) Attendance		4
4) ESE		75
Total:		100
Prerequisites for the course: 40% Marks in 12 th from a recognized Board with a subject of life Science/ Biology (PCB)		
On completing the course, the students will be able to:		
1. Understand the detailed account of the plant cell and biological membrane. 2. Describe cytological, biochemical, physiological and genetic aspects of the cell. 3. Describe the cellular processes common to all cells, to all eukaryotic cells as well as processes in certain specialized cells. 4. Explain cellular processes and mechanisms that lead to physiological functions as well as examples of pathological state.		
Suggested Readings		
1. Understand the detailed account of the plant cell and biological membrane. 2. Describe cytological, biochemical, physiological and genetic aspects of the cell, including cellular processes common to all cells, to all eukaryotic cells as well as processes in certain specialized cells. 3. Explain cellular processes and mechanisms that lead to physiological functions as well as examples of pathological state.		

IIMTU-NEP IMPLEMENTATION
Year: II / Semester: III

Programme: M.Sc. (Botany) Certificate/Diploma/Degree/	Year: II Semester: III
Credits: 2 Theory: 0 Practical: 2	Subject: Botany
Course Code: MBOC-NP-233P	TITLE: MICROBIAL GENETICS & MOLECULAR BIOLOGY LAB
Nature of Paper: DSE	
Minimum Passing Marks/Credits: 50% Marks / 2 Credits	
List of Experiments 1. Bacterial genomic DNA isolation 2. Agarose gel electrophoresis 3. Plasmid DNA isolation 4. Restriction digestion 5. Transformation of <i>E.coli</i> with pUC18 6. Polymerase chain reaction 7. Soil DNA isolation and purification 8. Bacterial RNA isolation 9. Bacterial protein profiling using SDS PAGE 10. Genomic DNA Extraction from plant tissue 11. Optimization of Annealing temperature 12. Sanger Sequencing	

IIMTU-NEP IMPLEMENTATION

Year: II / Semester: III

Programme: M.Sc. (Botany) Certificate/Diploma/Degree/	Year: II Semester: III	
Credits: 4 Theory: 4 Practical: 0	Subject: Botany	
Course Code: MBOGE-NP- 234a	TITLE: ECONOMIC BOTANY AND PLANT BIOTECHNOLOGY	
Objective: The objective of proposed course is expose 1. to expose to the students of centres of origin of crop plants, 2. To expose the concept of primary and secondary homes of domestication, green revolution in India with special reference to Norman E. Borlaug, M. S. Swaminathan. 3. Economic importance of various plants 4. to develop the understanding of genetic engineering, recombinant DNA technology, different kinds of cloning vectors, methods of transfer of recombinant DNA into a bacterial cell, various techniques of direct gene transfer, tissue culture, culture media 5. Its application of tissue culture in welfare of human beings, Genomic and proteomics, DNA chip technology structural and functional proteomics		
Nature of Paper: Generic Elective		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: P: 0(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents	Lectures
I	Origin of agriculture, world centers of domesticated plants, primary and secondary homes of domesticated plants, Vavilov contribution. Green revolution in India with special reference to contribution of Norman E. Borlaug, M. S. Swaminathan; Second green revolution: prospects	8
II	Plants as source of food (carbohydrates, proteins and fats /oils). Fiber and timber yielding plants and Sugar yielding plants: sugarcane, Beet Root and Maple Rubber yielding Plants	8
III	Non wood forest products (NWFPs): such as Bamboos, Rattans, raw material for paper making, gums, resins, tannins & dyes. Non-alcoholic beverages yielding plants: Tea, Coffee and Coco	7
IV	Medicinal Plants: Important commercially available drugs obtained from roots, stem, woods, barks, leaves, flowers and fruits. Plants as sources of spices and condiments.	7
V	Transfer of recombinant DNA into a bacterial host: transformation, transfection, selection and screening of recombinants. Gene transfer techniques in plants: direct methods (electroporation, microprojection bombardment, microinjection and liposome); Agrobacterium-mediated gene transfer in plants	7
VI	Tissue culture: Totipotency, culture media and its constituents, Explant,	7

	callus and suspension culture, culture of single cell, Protoplast fusion, direct and indirect regeneration, somatic embryogenesis, organogenesis; Acclimatization. Practical application of plant tissue culture, Somaclonal variations, artificial seeds	
Evaluation/Assessment Methodology		
		Max. Marks
1) Sessional Examination		16
2) Assignments		5
3) Attendance		4
4) ESE		75
Total:		100
Prerequisites for the course:40% Marks in 12 th from a recognized Board with a subject of life Science/ Biology (PCB)		
On completing the course, the students will be able to:		
1. Know origin of agriculture, world centers of domesticated plants.		
2. Have the knowledge of medicinal values of the plants, spices ad condiments.		
Suggested Readings		
1. A manual of ethnobotany Ed., S. K. Jain, Eciatic publications Jodhpur		
2. A New moral Economy to India's forests – Roger Feffery and NandiniSundar (1999). Sage Pub., New Delhi.		
3. Advances in Oilseeds Production and Technology, G. V. Ramanamurthy. ICAR New Delhi (1985)		
4. General Microbiology by S.B. Sullia and S Shantharam. Oxford & IBH, Pub.Co.2005		
5. Molecular Biotechnology, Principles and Applications of Recombinant DNA- Bernard and Glick and J.J Pasternals.-Ason Press Washington 1984		

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Program: Master of Science (Botany)		Year: I
Degree UG(R)/PG/Ph.D.: PG		Semester: I
Class: M.Sc. Botany		Subject: Botany
Credits: 4		
Theory: 4		
Practical: 0		
Course Code: MBOC-NP-115		Title: Elements of Microbiology
Course Objectives: 1. To acquaint students with basic concepts of microbial diversity and how the microbe concept emerged. 2. To know General bacteriology and microbial techniques for isolation of pure cultures of bacteria, 3. Student would be able to understand the history, general properties of viruses and their mode of replications. 4. To know about the physiology of the microbial growth 5. To provide in-depth knowledge to students on different aspects of microbial growth and associated spoilage caused by toxins secreted by them.		
Nature of Paper: Core/DSE/SEC/GE/AECC: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 P: 4 (In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents	Lectures
I	History and development of microbiology, Whittakar's five kingdom concept, Carl Woese's 3 domain classification, f Bergy's manual for classification of microbes and its basis, Isolation, culture and maintenance of microorganisms, Microbial growth, continuous culture (chemostat), Factors influencing growth of microbes, Role of microbes in agriculture and industry.	14
II	General features of Archaea, Structure, Nutrition and Reproduction of Eubacteria, Genetic recombination in bacteria (Transformation, Conjugation and Transduction), General features and pathogenecity of mycoplasma, Rickttsia and Spirochaetes. Cyanobacteria: Cell structure and reproduction. Heterocysts: Structure, development and function	10
III	Virus: General characteristics and classification of viruses, nature, morphology and chemistry of virus, transmission of virus, virus-vector relationship, replication of Bacteriophage Plant virus- TMV, structure, transmission, pathogenicity and replication Animal viruses - HIV, structure, transmission, pathogenicity and replication Treatment and prevention by anti-virals and vaccine. Viroids and Prions.	14
IV	Microbial toxins: types, mode of actions and pathogenicity. Bacterial toxins: Endo and exotoxins Fungal toxins: toxins of Aspergillus, Penicillium, Fusarium and	14

	Alternaria Algal toxins: cyanotoxins and dinotoxins	
V	Chemotherapeutic agents: antibiotics and their mode of action; bacterial drugs (Penicillin, fluoroquinolones, tetracycline and aminoglycosides)	8

Reference / Text Books:

1. Madigan, M.T., Martinko, J.M., Dunlap, P.V., Clark, D.P., 2011. Brock Biology of Microorganism. 13th edition, Pearson Education Inc.
2. Lim, DV. 2003. Microbiology. Kendall/Hunt.
3. Boundless.2013. Microbiology. Boundless Learning, Incorporated.
4. Comelissen, CN, Harvey, RA and Fisher, BD. 2012. Microbiology. Lippincott Williams & Wilkins.
5. Talaro, K.P., Chess, B. 2011, Foundations in Microbiology. 8th edition. McGraw-Hill.
6. Willey, J.M., Sherwood, L., Woolverton, C.J., 2010. Prescott's Microbiology. 8th edition, McGraw-Hill.
7. Dickinson, C. M., 2020. Molecular Plant Pathology, Bios Scientific Publisher.
8. Robert, N., Trigliano, Windham, M. T. and Windham, A.S., 2003. Plant Pathology: Concepts and Laboratory Exercises, CRC Press.
9. Singh, R. S., 2008. Plant Diseases, Oxford and IBH Publishing Co. Pvt Ltd.

If the course is available as Generic Elective, then the students of following departments may opt it.

1. M.Sc. in Agriculture.

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/ Assignments	05
3) Attendance	04
4) ESE	75
Total:	100

Prerequisites for the course: 50% Marks in graduation from a recognized university with Zoology, Botany and Chemistry.

Course Learning Outcomes:

CO1: Students will gain knowledge about the different cell organelles of microorganisms and their detailed functions.

CO2: Students will also study the growth and control of microbes as well as different bacteriological techniques involved in microbiology.

CO3: Students will gain basic knowledge on virus cultivation and will be able to describe the structure and replication of viruses.

CO4: Students will gain knowledge of significance and activities of microorganisms caused by the toxins released by them.

IIMTU-NEP IMPLEMENTATION
Year: I / Semester: I

Program: Master of Science (Botany) Degree UG(R)/PG/Ph.D.: PG Class: M.Sc. Botany	Year: I Semester: I
Credits: 2 Theory: 0 Practical: 2	Subject: Botany
Course Code: MBOC-NP-115P	Title: Elements of Microbiology Lab
Course Objectives: 1. Upon completion of this course the student will have the knowledge and skills to: understand the Difference between: Prokaryotes and Eukaryotes 2. They may know about the cultivation and staining of bacterial cells. 3. They can understand the structure of viruses, their replication and transmission. 4. They can understand the role of toxins secreted by microbes.	
Nature of Paper: Core	
Minimum Passing Marks/Credits: 50% Marks / 2 Credits	
L: T: P: 4 (In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)	
S.No.	Contents (Minimum any three from each unit, based on the facilities)
1	Different types of bacterial staining techniques.
2	Isolation of bacteria from different sources.
3	Isolation of microbes from different sources.
4	Identification of different types of viruses.
5	To observe microbial growth in different types of cultures.
6	Isolation of toxins secreted by microbes.
7	Production of Antibiotics.
8	Production of other substances by using secondary metabolites.

IIMTU-NEP IMPLEMENTATION
Year: I / Semester: I

Programme: PG Class: M.Sc. Botany	Year: I Semester: I	
Credits: 4 Theory: 4 Practical: 0	Subject: BOTANY	
Course Code: MBOC-NP-112	Title: MYCOLOGY, PHYCOLOGY & LICHENS	
Course Objectives: 1. Students will learn about the ultra-structure, general affinities, and mode of reproduction of fungi. Additionally, to understand the traditional and contemporary methods for classifying fungus on the basis of distribution, nutrition and characteristics. 2. Students will learn about the harmful microbes responsible for various plant diseases and the specific life cycle pattern of the major fungal groups. They will get learn in-depth information about the fungi that are symbiotic with different tree species and their applications. 3. Students are will learn about the taxonomy, general characteristics, vegetative characteristics, and reproductive structural aspects of algae. And also going to get extensive understanding of the phylogeny, evolutionary tendencies, and thallus organization of the main algal taxa. 4. They will come to know about conservation strategies, economic potential, and the diversity of algae. They will also learn about the diversity patterns of lower life forms on earth and the evolution of thallophytes, uses of the pigments found in algae to distinguish, recognize, and categorize the various types of algae and to comprehend the life cycle, distribution, structure, and reproduction of living species of algae. 5. Students will understand common characters and structure of lichens, diversity of lichens, classification and its economic value. They will also learn the basic growth of lichens and its reproduction.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T: P: 2 (In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Fungi : Thallus organization and cell structure. • Nutritional types of fungi: biotrophs, hemibiotrophs, symbionts and necrotrophs. • Reproduction, hormonal mechanism of sexual reproduction, parasexuality, life cycles. Fungal systematics and phylogeny	10
II	Plant Pathology: Myxomycota and Plasmodiophoromycota-Stemonitis, Plasmodiophora Oomycota-Pythium, Phytophthora, Peronospora • Chytridiomycota-Syncytium, • Zygomycota-Zygorhynchus, Pilobolus.	12

	- Ascomycota-Yeasts, Aspergillus, Penicillium, Claviceps, Morchella - Basidiomycota-Puccinia, Uromyces, Ustilago, Urocystis,	
III	Introduction to Algae: General characteristics, life cycle and classification (by Fritsch, Smith, Lee), modern trends for algal classifications (molecular and chemotaxonomy), Fossil algae, Microscopy, cell organelles (cell wall, flagella, nucleus, eye-spot, pyrenoids), pigments, reserve food products, Algal blooms	8
IV	Range of thallus organization: A comparative study of range of thallus organization, cell structure, reproduction (asexual and sexual), phylogeny and inter-relationships of the following classes of Algae: - Cyanophyceae: Nostoc, Spirulina - Euglenophyceae: Euglena - Dinophyceae: Gymnodinium - Charophyceae: Closterium - Ulvophyceae: Cladophora - Chlorophyceae: Volvox,	10
V	A comparative study of range of thallus organization: cell structure, reproduction (asexual and sexual), phylogeny and inter-relationships of the following classes of Algae: - Bacillariophyceae: Melosira - Xanthophyceae: Botrydium - Phaeophyceae: Padina - Rhodophyceae: Gelidium, Corallina	10
VI	Lichen : A general account, classification and distribution of Lichens - A comparative study of lichen thallus organization, cell structure, physiology and reproduction - Chemotaxonomy of Lichens Lichenometry	10

Reference / Text Books:

1. Moderna Microbiology (hindi) (hb) ISBN: 9788177543599 Edition: 1Year: 2018 Author: Dr. Purbhit SS, Dr. Singh T Publisher: Agrobios (India)
2. Suggested books “Plant Pathology by R.S. Mehrotra 2017. Tata McGraw-Hill Education” are included in reading resource list.
3. Microbiology and Plant Pathology by M. U. Charaya 2012. Pragati Publication, Meerut.
4. Suggested book- “Eminent Indian Botanists: Past and Present (Biographies and contributions)”, P. Suresh Narayan and T. Pullaiah, Regency Publications, (2011)
5. Introductory Mycology by Alexopoulos, Mims and Blackwell; John Wiley & Sons Publications, 1996.
6. Introduction to Fungi, J. Webster and R. Weber, 2007, 3rd edition, Cambridge University Press.
7. The Fungi, S.C. Watkinson, N.P. Money, L. Boddy, 3rd edition, Elsevier Science Publishing Co Inc.

If the course is available as Generic Elective, then the students of following departments may opt it.

1. Agriculture
2. Pharmacy
2. Microbiology

3. Environmental Science	
Evaluation/Assessment Methodology	
	Max. Marks
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/ Assignments	05
3) Attendance	04
4) ESE	75
Total:	100
Prerequisites for the course: 50% Marks in graduation from a recognized university with Zoology, Botany and Chemistry.	

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Program: Master of Science (Botany)		Year: I
Certificate/Diploma/Degree//PG/Ph.D.		Semester: I
Class: M.Sc. Botany		Subject: Botany
Credits: 4		
Theory: 4		
Practical: 0		
Course Code: MBODSE-NP-115a		Title: Plant Cell Biology
Course Objectives: CO1: To understand expose the students to structure and functions of plant cell. CO2: To know about biological membrane and cell organelles. CO3: Students will understand how these cellular components are used to generate and utilize energy in cells. CO4: This course also aims to enhance the knowledge on cell cycle. CO5: To understand steps of DNA replication, DNA damage and its repairing, and protein synthesis.		
Nature of Paper: Core/DSE/SEC/GE/AECC: DSE		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P: 4 (In Hours/Week)=8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week = 4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Plant cell wall: structure, biogenesis and expansion; Biological membranes with special emphasis on plasma membrane and tonoplast membrane structure and function. Conformation of nucleic acids (A, B, Z), tRNA, micro RNA.	12
II	Structural organization and function of intracellular organelles (nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility). Cell cycle (steps in cell cycle, regulation and control of cell cycle), Mitosis, Meiosis.	12
III	Cell–Cell Signaling and Cell Interaction: Introduction, Cell surface receptors, Second messenger system, MDP kinase pathways, Cell junctions, Cell adhesion	12
IV	Cell cycle: Cyclin and cyclin dependent kinases, Regulation of CDK – cyclin activity Chromosomes, Chromatin, and the Nucleosomes, Chromosome sequence and diversity. Cancer: Genetic rearrangements in progenitor cells, oncogene, tumor suppressor genes, cancer and cell cycle, metastasis, interaction of cancer cells with normal cell, apoptosis.	12
V	Intracellular protein traffic: Protein synthesis, Uptake into ER,	12

Membrane proteins, Golgi sorting, Post translational modifications, Apoptosis, Definition, mechanism and significance.	
Reference / Text Books: 1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004). 2. Alberts et al: Molecular Biology of the Cell: Garland (2002). 3. Cooper: Cell: A Molecular Approach: ASM Press (2000). 4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004). 5. Lewin B. Genes VIII. Pearson (2004). 6. Watson et al. Molecular Biology of the Gene. Pearson (2004). 7. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby Kuby Immunology. W H Freeman (2007).	
If the course is available as Generic Elective then the students of following departments may opt it. NO	
Evaluation/Assessment Methodology	
Max. Marks:100	
1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/ Assignments	05
3) Attendance	04
4) ESE	75
Total:	100
Prerequisites for the course:	
Course Learning Outcomes: CLO1: After finishing this course, the student will be able to explain cell and its functions. CLO2: Student will be able to explain cell signaling and cell interaction. CLO3: Student will be able to explain chromosome sequence and diversity. CLO4: Student will be able to handle microscopes in research lab. CLO5: Student will be able to explain Protein synthesis and Uptake into ER. CLO6: Student will be skilled to work in research institutions, industries, testing labs etc.	

IIMTU-NEP IMPLEMENTATION
Year: I / Semester: I

Program: Master of Science (Botany) Certificate/Diploma/Degree//PG/Ph.D = PG Class: M.Sc. Botany	Year: I Semester: I
Credits: 2 Theory: 0 Practical: 2	Subject: Botany
Course Code: MBODSE-NP-115aP	TITLE: Cell Biology Lab
Course Objectives: CO1: To understand the structure and organization of Plant Cell. CO2: To identify various stages of mitosis. CO3: To identify various stages of meiosis. CO4: To study techniques of Barr body preparation in buccal epithelial cells CO5: To provide knowledge about light microscopic examination and preparation of tissue sections.	
Nature of Paper: DSE	
Minimum Passing Marks/Credits: 50% Marks / 2 Credits	
L: 4 T: 0 P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)	
S.No.	List of Experiments
1.	Study of a typical plant cell
2.	Light microscopic examination and preparation of tissue sections.
3.	Study of mitotic and meiotic chromosomes from permanent prepared slides.
4.	Preparation of slides for mitotic study.
5.	Preparation of slides for meiotic study in anthers.
6.	Demonstration of protein synthesis
7.	Demonstration of cell signaling

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Program: Master of Science (Botany)		Year: I
Certificate/Diploma/Degree//PG/Ph.D.		Semester: I
Class: M.Sc. Botany		Subject: Botany
Credits: 4		
Theory: 4		
Practical: 0		
Course Code: MBODSE-NP-113b		Title: Biotechnology & Human Welfare
Course Objectives: CO1 To aware students about various applications of different techniques of protein engineering, enzyme and polysaccharide synthesis also to update knowledge regarding various process of antibiotic production. CO2 To aware students about different types of pollution and pollutants. CO3 To aware students about agriculture waste processing and degradation of hydrocarbon, and helps in solving environmental issues. CO4 To aware students about the development of biodegradable polymers also the stress management of environmental issues and forensic science. CO5 To aware students about production of non-toxic therapeutic agents. CO6 To aware students about the applications of vaccines and gene therapy.		
Nature of Paper: Core/DSE/SEC/GE/AECC: DSE		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P: 4 (In Hours/Week)=8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week = 4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Industrial application: protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol and antibiotic formation.	10
II	Agriculture: N ₂ fixation: transfer of pest resistance genes to plants; interaction between plants and microbes; qualitative improvement of livestock, bio-composting.	10
III	Environments: e.g. chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers such as PHB.	15
IV	Forensic science: e.g. solving violent crimes such as murder and rape; solving claims of paternity and theft etc. using various methods of DNA finger printing.	13
V	Health: e.g. development of non-toxic therapeutic agents, recombinant live vaccines, gene therapy, diagnostics, monoclonal in <i>E.coli</i> , human genome project.	12
Reference / Text Books: 1. BISWAS, SUBROTO (2020), Biotechnology and Human Welfare, McGraw-Hill Education India,		

9789390177011

2. William J. Thieman, Introduction to Biotechnology (August 1st 2021) - Copyright © 2019 Published by Pearson
3. Naveen Dwivedi and Shubha Dwivedi (2013), Introduction to Biotechnology, University Science Press.
4. Rup Lal, (2016) An Introduction to Biotechnology, a genetic manipulation perspective, Publisher Wiley.
5. Srivastava, Thakur and Kumar, (2021) Agricultural Biotechnology: Latest Research and Trends, Publisher Springer.
6. Richard Saferstein (2008), Forensic Science: An Introduction, Publisher Addison Wesley Longman

If the course is available as Generic Elective, then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

Max. Marks: 100

1) Class tasks/ Sessional Examination	16
2) Presentations /Seminar/ Assignments	05
3) Attendance	04
4) ESE	75
Total:	100

Prerequisites for the course:

Course Learning Outcomes:

CLO1: Student will study the application of biotechnology for production of various products having industrial applications and benefit of mankind

CLO2: Student will be aware of application of biotechnology in agriculture sector.

CLO3: Student will study about role of biotechnology in cleaning the environment.

CLO4: Student will be aware of application of biotechnology forensic investigations.

CLO5: Student will be aware of application of biotechnology in improving health and in diagnostics.

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: I

Program: Master of Science (Botany)		Year: I
Certificate/Diploma/Degree//PG/Ph.D= PG		Semester: I
Class: M.Sc. Botany		
Credits: 2		Subject: Botany
Theory: 0		
Practical: 2		
Course Code: MBODSE-NP-113bP		Title: Biotechnology & Human Welfare Lab
Course Objectives:		
CO1: To understand the structure and organization of invertebrate animals.		
CO2: To understand structure of Polytene chromosomes of salivary gland of Chironomus larva/Drosophila.		
CO3: To identify various stages of mitosis and meiosis.		
CO4: To study techniques of Barr body preparation in buccal epithelial cells		
CO5: To provide knowledge about light microscopic examination and preparation of tissue sections.		
Nature of Paper: DSE		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4		
T: 0		
P: 4(In Hours/Week)		
Theory - 1 Hr. = 1 Credit		
Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No.	List of Experiments	No. of Lectures Allotted
1.	Perform of ethanolic fermentation using Baker’s yeast.	7
2.	Study of a plant part infected with a microbe.	7
3.	To perform quantitative estimation of residual chlorine in water samples.	7
4.	Isolation and analysis of DNA from minimal available biological samples.	7
5.	Case studies on Bioethics (any two).	7
6.	Model preparation of role of Nitrogen cycle in atmosphere	7
7.	Model preparation of Bio-composting unit	7
8.	Enrichment and isolation procedure for Azotobacter and Azomonas	7
9.	Demonstration of Ammonification of soil	4

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme:PG Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: M.Sc. Botany		Year: I Semester: II
Credits: 4 Theory: 4 Practical: 0		Subject: Botany
Course Code: MBOC-NP-121		Title: Bryophytes, Pteridophytes and Gymnosperms
Course Objectives: 1. To know about the evolutionary trends of various orders of Bryophytes, Pteridophytes and their different organs. 2. To appreciate connections between plant anatomy and the other major disciplines of biology, including taxonomy, cell biology, physiology, genetics, biochemistry, and ecology. 2. To identify the role of anatomy in solving taxonomic and phylogenetic problems. 3. To understand the shoot structure and functional development aspects of various tissue systems and organs in plants. 4. To acquire knowledge on morphogenesis and organogenesis in plants. 5. To learn about plant development and its various aspects like microsporogenesis, megasporogenesis, fertilization etc.		
Nature of Paper: Core/DSE/SEC/GE/AECC CORE		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T: 0 P: 4 (In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Bryophytes: Contribution of some Indian Bryologists. Classification of Bryophytes their distribution, Habitat, external and internal morphology, reproduction, gametophytes and sporophytes, phylogeny and interrelationships of the orders: Sphaerocarpaceae, Takakiales, Marchantiales and Jungermanniales, Anthocerotales, Sphagnales, Andreales and Bryales.	14
II	Pteridophyta: Classification, Origin and evolution, Phylogenetic relationship with Bryophyta. Morphology, anatomy, phylogeny and interrelationships of the orders Psilopsida- Psilotales and Psilophytales, Lycopsidea- Lycopodiales, Selaginellales, Isoetales, Equisetopsida – Equisetales and Pteropsida-Filicales.	14
III	Sporophyte and gametophyte in Pteridophytes, Stelar organization and evolution, Origin of leaf and Telome concept, Sporocarp, Heterospory and seed habit, Comparison of Pteridophyta with Bryophyta and Gymnosperms.	12
IV	Introduction, Classification and distribution of Gymnosperms, Morphology, anatomy, reproduction, phylogeny of the orders Pteridospermales (Caytoniaceae, Medullosaceae) Bennettitales (Williamsoniaceae,	14

	Cycadeoideaceae) Cycadales (Cycadaceae) Ginkgoales (Ginkgoaceae) Coniferales (Pinaceae, Araucariaceae) Taxales (Taxaceae) Gnetales (Gnetaceae).	
V	Economic importance of Bryophytes, Pteridophytes and Gymnosperms	6
Reference / Text Books:		
1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.		
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.		
Evaluation/Assessment Methodology		
		Max. Marks
1) Class tasks/ Sessional Examination		10
2) Presentations /Seminar		5
3) Assignments		5
4) Attendance		5
5) ESE		75
Total:		100
Prerequisites for the course:		
Course Learning Outcomes:		
CO1- Apply the knowledge of biology to make scientific queries and enhance the comprehension potential.		
CO2- Students will be benefitted by studying the plant anatomy enables to identify fragmentary plant materials, wood, forensic investigation, and applied aspects of meristems cultures.		
CO3- Students will be able to utilize embryological studies in various aspects like analysis of evolutionary trends, circumscription and delimitation of taxa and making a decision on systematic positions.		

IIMTU-NEP IMPLEMENTATION
Year: I / Semester: II

Programme:PG Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: M.Sc. Botany	Year: I Semester: II
Credits: 2 Theory: 0 Practical: 2	Subject: Botany
Course Code: MBOC-NP-121P	Title: Bryophytes, Pteridophytes and Gymnosperms Lab
Course Objectives: 1. To make student aware about the differences between Bryophytes, Pteridophytes and Gymnosperms. 2. To impart knowledge of thallus of Bryophytes and their importance. 3. To identify the role of pteridophytes in stelar evolution. 4. To understand the structure of gymnosperms and their reproductive organs. 5. To acquire knowledge on morphogenesis and organogenesis in plants. 6. To learn about plant development and its various aspects like microsporogenesis, megasporogenesis, fertilization etc.	
Nature of Paper: Core/DSE/SEC/GE/AECC CORE	
Minimum Passing Marks/Credits: 50% Marks / 2 Credits	
L: 4 T: 0 P: 4 (In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)	
S.No.	Contents
1.	Study of Thallus of Marchantia
2.	Study of rhizoids and scales of bryophytes
3.	Study of Gemma cup of bryophytes
4.	Study of Funaria capsule
5.	Study of Lycopodium, Selaginella, Equisetum stem
6.	Study of Sporangium of fern
7.	Study of different types of stelar system
8.	Study of Pinus needle
9.	Study of Cycas leaflet
10.	Study of Gymnosperm cone

IIMTU-NEPIMPLEMENTATION

Year: I / Semester: II

Program: Master of Science (Botany)		Year: I
Degree: PG		Semester: II
Class: M.Sc. Botany		Subject: Botany
Credits: 4		
Theory: 4		
Practical: 0		
Course Code: MBOC-NP-122		Title: Plant Systematics and Taxonomy
Course Objectives: 1. The phylogeny, taxonomy, and applications of angiosperms in the system will be learned. 2. Using plant nomenclature, students will be able to name and identify various plants. 3. The importance of botanic gardens and national and regional centers for plant research and conservation will be recognized and appreciated by the students. 4. Students will have an understanding of advanced instruments used in plant taxonomy research. 5. Based on key traits, they will learn to identify various angiosperm families.		
Nature of Paper: Core/DSE/SEC/GE/AECC: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T: 0 P: 4 (In Hours / Week) Theory-1Hr.=1Credit Practical-2Hrs.=1Credit (4Hrs./Week=4Credits)		
Unit	Contents	Lectures
I	Plant Systematics and classification system: Taxonomic hierarchy; Concept of taxa (family, genus, species) History of different systems of classification (introduction only). Artificial, Natural and phylogenetic systems of classification Important systems- i) Bentham and Hooker, Engler and Prantl, Hutchinson, A. Takhtajan, ii) Relative merits and demerits of major systems of classification. APG system of classification.	14
II	International code of Botanical Nomenclature: History, Principles and rules, Principles, typification and principal of priority, Author citation and its limitation, Effective and valid publication, rank of taxa. Taxonomic hierarchy, species, genus, family and other categories, Taxonomy in relation to anatomy, embryology, palynology, cytology, secondary metabolites in Plants	10
III	Systematic in practices: Botanical Garden: important botanic gardens of the World. Herbarium: Preparation, Importance and role of herbarium, important herbaria s of the World. Specimens and their preparation, Botanical Survey of India. Identification Keys of Angiosperm: Type of Inflorescence, Type of Placentations, Type of Aestivation, and Technical Description of flowers.	10

IV	Modern Taxonomy: Numerical taxonomy: Concepts, Characters and attributes, OTU's Cluster analysis, Cladistics. Phenograms, cladograms, Monophyletic, polyphyletic and paraphyletic groups, plesiomorphy, apomorphy; Digital Taxonomy: E-Flora, Virtual Herbaria, DELTA Taxonomy, Plant Identification App.	10
V	Special features of important families of Angiosperm: Monocots : Cyperaceae, Poaceae, Orchidaceae, Liliaceae Eudicots : Ranunculaceae, Papaveraceae, Rutaceae, Fabaceae, Cucurbitaceae, Apiaceae, Rubiaceae, Asteraceae, Solanaceae, Lamiaceae, Euphorbiaceae, Asclepiaceae	16
Reference/TextBooks:		
1. Radford A E. (1986). Fundamentals of Plant Systematics, Harper and Row N Y.4 2. Hickey M and King C. (2000). The Cambridge Illustrated Glossary of Botanical Terms. Cambridge University Press, UK. 3. Crawford, D.J. (2003). Plant Molecular Systematics. Cambridge University Press, Cambridge, UK. 4. Singh G (2004). Plant Systematics, 2nd edn, Oxford and IBH, New Delhi. 5. Judd et al. (2007). Plant Systematics – A phylogenetic approach. Sinauer Pub. 3rd edition 3 Stuessy, T.F. (2009). Plant Taxonomy: The systematic Evaluation of Comparative Data. Columbia University Press, New York. 6. Simpson, M.G. (2010). Plant Systematics. Elsevier, Amsterdam. 7. Stuessy, T.F., Crawford, D.J., Soltis, D.E. and Soltis, P.S. (2014). Plant Systematics: The origin, interpretation, and ordering, of plant biodiversity. Koeltz Scientific Books, Konigstein, Germany. 8. Kathirvelu, Sambandan. (2014). E-Flora and Digital Herbaria: Complementary tools for Plant Taxonomy. 9. Angiosperm Phylogeny Group. (2016). An update of the Angiosperm Phylogeny Group Classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society 181: 1-20.		
If the course is available as Generic Elective, then the students of following departments may opt it.		
Evaluation/Assessment Methodology		
		Max. Marks
1. Class tasks/ Sessional Examination		16
2. Presentations/Seminar/Assignments		05
3. Attendance		04
4. ESE		75
Total:		100
Prerequisites for the course: 50% Marks in graduation from a recognized university with Zoology, Botany and Chemistry.		
Course Learning Outcomes:		
CO1: Students will gain knowledge about the different plant angiospermic Families		
CO2: Students will also study about various classification systems.		
CO3: Students will gain basic knowledge ICBN, its significance and role in botanical carrier.		
CO4: Students will learn about modern techniques to study plant taxonomy.		

IIMTU-NEPIMPLEMENTATION

Year: I / Semester: II

Program: Master of Science (Botany)		Year: I
Degree: PG		Semester: II
Class: M.Sc. Botany		Subject: Botany
Credits: 2		
Theory: 0		
Practical: 2		
Course Code: MBOC-NP-122P		Title: Plant Systematics and Taxonomy Lab
Course Objectives:		
1. They will learn to identify plant and flower related features. 2. They will learn to prepare Herbarium sheets, 3. They will learn to prepare virtual herbaria by digital taxonomy. 4. Students will learn to identify various angiosperms families with specific key characters. 5. They will come to know about various advanced tools to study plant taxonomy.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: T: P: 4(In Hours/Week)T heory-1Hr.=1Credit Practical-2Hrs.=1Credit (4Hrs./Week=4Credits)		
S.No.	Contents	
	(Minimum any three from each unit, based on the facilities)	
1	Description of Identification keys.	
2	Description of locally available representative families.	
3	Identification of plant specimens using floras and identification keys.	
4	Study of herbarium specimens of different families covered in theory course	
5	A field Field trips within the campus and outside the campus for other botanical collections	
6	Preparation of herbarium sheets of wild or cultivated abundant plants	
7	Preparation of virtual herbaria on the basis of Digital Taxonomy	
8	Description of a plant Identification app.	

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme:PG Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: M.Sc. Botany	Year: I Semester: II	
Credits: 6 Theory: 4 Practical: 2	Subject: Botany	
Course Code: MBOC-NP-123a	Title: Anatomy & Embryology of Angiosperms	
Course Objectives: 1. To know about the internal structure and reproduction of the most evolved group of plants, the Angiosperm. 2. To appreciate connections between plant anatomy and the other major disciplines of biology, including taxonomy, cell biology, physiology, genetics, biochemistry, and ecology. 3. To identify the role of anatomy in solving taxonomic and phylogenetic problems. 4. To understand the shoot structure and functional development aspects of various tissue systems and organs in plants. 5. To acquire knowledge on morphogenesis and organogenesis in plants. 6. To learn about plant development and its various aspects like microsporogenesis, megasporogenesis, fertilization etc.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits 50% Marks / 2 Credits		
L: 4 T: 0 P: 4 Theory - 1 Hr. = 1 Credit(In Hours/Week) Practical- 2 Hrs.=1 Credit (4Hrs./Week=2Credits)		
Unit	Contents	No. of Lectures Allotted
I	Simple Tissue: Types and Functions. Complex Tissues: Types & Functions.	8
II	Structure of dicot and monocot root, stem and leaf.	4
III	Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood).	8
IV	Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.	8
V	Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, Organization and ultrastructure of mature embryo sac.	8
VI	Microsporogenesis, Megasporogenesis, Apomixis, Parthenocarpy	8
VII	Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.	8
VIII	Endosperm types, structure and functions; Dicot and monocot embryo; Embryo endosperm relationship.	8
Reference / Text Books:		

1. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	10
2) Presentations /Seminar	5
3) Assignments	5
4) Attendance	5
5) ESE	75
Total:	100

Prerequisites for the course:

Course Learning Outcomes:

CO1- Apply the knowledge of biology to make scientific queries and enhance the comprehension potential.

CO2- Students will be benefitted by studying the plant anatomy enables to identify fragmentary plant materials, wood, forensic investigation, and applied aspects of meristems cultures.

CO3- Students will be able to utilize embryological studies in various aspects like analysis of evolutionary trends, circumscription and delimitation of taxa and making a decision on systematic positions.

Practical List: MBOC-NP-123P

1. To study cell structure and apical meristem.
2. To study simple tissues in given plant material.
3. To study complex tissues in given plant material.
4. To perform sectioning of dicot & monocot root.
5. To perform sectioning of dicot & monocot stem.
6. To perform sectioning of dicot & monocot leaf.
7. To study Secondary growth in dicot
8. To study anomalous Secondary growth in monocot stem
9. To study T.S. of anther (young and mature) at various stages of Development
10. To study L.S. of ovule
11. To study types of ovules – orthotropous and Anatropous
12. To study Embryogenesis
13. To perform Dissection of embryo / endosperm from developing seeds
14. To study preparation of culture media (MS)
15. To study Stock solution preparation and Sterilization of culture media,

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: Master of Science in Botany Certificate/Diploma/Degree//PG/Ph.D. Class: M.Sc. Botany		Year: I
Credits: 4 Theory: 4 Practical: 0		Semester: II
Course Code: MBOGE-NP-124a		Subject: Botany
Course Objectives: CO1: To provide knowledge about basic of Environment and its component. CO2: To understand the knowledge about ecology and Ecological relationships. CO3: To understand environment pollution with special reference to Air, Water & Noise Pollution. CO4: To impart knowledge about Biodiversity status. CO5: To provide knowledge about Biodiversity management.		Title: Environment, Ecology & Biodiversity
Nature of Paper: Core/DSE/SEC/GE/AECC: DSE/ Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L:4 T:0 P: 2 (In Hours/Week) 8 Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Environment: Meaning and definition of environment, Structure and composition of Atmosphere, Hydrosphere, Lithosphere. Concept of Biosphere. Habitats: Terrestrial and aquatic (Fresh water and marine) habitat. Bio-geochemical cycles with special reference to nitrogen cycle.	12
II	Ecology: Introduction of ecology, Definition, brief history, scope and branches of ecology. Organizational level of ecological systems. Ecological successions definition, Causes of succession, Succession in Aquatic System. Habitat and Niche, Ecotone, Ecotype, Edge effect. Population Ecology, Community Ecology. Ecological relationships- (<i>Antagonistic relationship and Symbiosis relationship</i>).	12
III	Environmental Pollution: Introduction, meaning, definition. Pollutants and their types. Sources, Effects and control of Air pollution, Water pollution and Noise Pollution. Concept of Solid Waste Management (SWM), Eutrophication.	12
IV	Biodiversity: Concept of Biodiversity, Meaning, Varieties of ecological diversity (Species diversity, Resource diversity, Habitat diversity), Types of Species diversity (point diversity, Alpha diversity, Gamma diversity, Epsilon diversity). Threats to Biodiversity (Habitat destruction, deforestation, Poaching of wildlife, impact of introduced species, pollution etc.), Hot spot of Biodiversity.	12

Page | 797

IIMTU-NEP IMPLEMENTATION

Year: I / Semester: II

Programme: Master of Science in Botany Certificate/Diploma/Degree//PG/Ph.D. Class: M.Sc. Botany		Year: I Semester: II
Credits: 2 Theory: 0 Practical: 2		Subject: Botany
Course Code: MBOGE-NP124aP		Title: Environment, Ecology & Biodiversity
Course Objectives: CO1: To understand the procedure of estimation of DO of given water sample. CO2: To understand the Biodiversity Conservation. CO3: To understand the step of . CO4: To understand the procedure of alkalinity of water. CO5: To study community of quadrate.		
Nature of Paper: DSE		
Minimum Passing Marks/Credits: 50% Marks / 2 Credits		
L: 4 T: P: 4(In Hours/Week) Theory - 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit (4 Hrs./Week=4 Credits)		
S.No	List of Experiments	No. of Lectures Allotted
1.	Study of Fresh water Ecosystem	8
2.	Estimation of TDS of given water sample.	8
3.	To determine the DO of given water sample.	8
4.	Biodiversity studies: (Map studies - One exercises to be given) A. Biodiversity Hotspots location in (i) World (ii) India C. Protected Areas of India (National Parks, Biosphere Reserves)	8
5.	To study and enlist various biotic and abiotic components of Grassland Ecosystem.	8
6.	To study hypothetical EIA of Urbanization.	8
7	To determine the hardness of given water sample.	8
8	Population dynamics and community composition To take up marbles of 5-6 different colours mix these in different ratio Selecting one colour for one species and find out: (a) Species composition/Diversity. (b) Dominant and rare Species	8

School of Life Science & Technology

ACADEMIC HAND BOOK



Ph.D. Botany Coursework

Evaluation Scheme

Evaluation Scheme
Ph.D. Botany Coursework

The PhD course for the Research Scholars would consist of five papers. Out of these three papers would be compulsory, one optional (to be chosen from five options given as under) and one Oral/seminar-

S. No.	Subject Code	Subjects	Category	Periods			Marks					Credits
				L	T	P	Internal					
							CT	TA	Total	External	Total	
1	DBTC-113	Research Methodology	CORE	4	0	0	20	10	30	70	100	4
2	DBOC-112	Techniques in Biochemistry	CORE	2	0	1	10	5	15	35	50	2
3	CPE-RPE	Research and Publication Ethics (RPE)	CORE	2	0	1	10	5	15	35	50	2
4	PHD-SP	Seminar/ Oral	DSE	2	0	0	0	0	50	0	50	2
Discipline Specific Elective Courses (Any one)												
1	DDSE -002	Immunology	Elective	4	0	0	20	10	30	70	100	4
2	DDSE -003	Molecular Biology	Elective	4	0	0	20	10	30	70	100	4
3	DDSE -005	Enzyme Technology	Elective	4	0	0	20	10	30	70	100	4
4	DDSE-007	Recent Advances in Mycology and Plant Pathology	Elective	4	0	0	20	10	30	70	100	4
5	DDSE-008	Recent Advances in Plant Physiology	Elective	4	0	0	20	10	30	70	100	4
TOTAL											350	14

Format-3

**IIMTU-NEP IMPLEMENTATION
COURSE WORK**

Programme: Ph.D. Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Class: Ph.D		Course Work
Credits: 4 Theory: 4 Practical: 0		Subject: Botany
Course Code: DBTC-113		Title: Research Methodology
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Scientific Process: Meaning and Definition, a brief history of scientific process. Introduction of Research Methodology- Meaning of research, objectives of research, types of research, significance of research, problems encountered by researchers in India.	12
II	Research Problem: Definition, necessity and techniques of defining research problem. Formulation of research problem. Objectives of research problem. Research Design: Meaning, need and features of good research design. Types of Research Designs, Basic Principles of Experimental Designs. Design of experiments.	12
III	Sampling Designs: Census and Sample surveys, Different types of sample designs, and characteristics of good sample design. Techniques of selecting a random sample. Data Collection: Primary and secondary data. Methods of collecting primary and secondary data. Hypothesis: Definition, testing of hypothesis, procedures of hypothesis testing, flow diagram for hypothesis testing, Parametric and non-parametric tests for testing of hypothesis, Limitations of tests of hypothesis.	12
IV	Paper Writing and Report Generation: Basic concepts of paper writing and report generation, review of literature, Concepts of Bibliography and References, significance of report writing, steps of report writing, Types of Research reports, Methods of presentation of report.	12
V	Computer Applications: Fundamentals of computers- definition, types of computers, RAM, ROM, CPU, I/O devices. Number system- binary, octal and hexadecimal, base conversion. Logic gates- AND, OR, NOT. Data Structure- array, stack (push, pop), queue (insert, delete), linked list- singly, doubly. Operating system- definition, types of OS. Use of software- MS Office- Power Point, WORD and EXCEL and ACCESS. Field and Computer hazards: viruses, misuse of internet, hacking. Field	12

	hazards. Instrumentation: Description and principles of (i) Electrophoresis (ii) PCR Machine (iii) Laminar Flow (iv) Ultracentrifuge (v) Autoclave and (vi) Light and electron microscopy. Chromatography and HPLC. Handling of instruments and precautions.	
SUGGESTED READINGS: 1. C.R. Kothari (2014). Research Methodology: Methods and Technique, New Age publishers, New Delhi. 2. Heiman, G. W. (2001). <i>Understanding research methods and statistics</i>. (2nd ed.) Boston, MA: Houghton Mifflin Company. 3. Becker, H. S. (1986). Writing for Social Scientists: How to Start and finish Your Thesis, Chicago; University of Chicago Press. 4. Krishnaswami, O. R. (2000). Research Methodology in Social Sciences, Delhi: Himalaya Publications. 5. Kumar, Renjith (2009). Research Methodology: A Step by Step Guide for Research, Delhi: Pearson Education.		

**IIMTU-NEP IMPLEMENTATION
COURSE WORK**

Programme: Ph.D. Certificate/Diploma/Degree/UG(R)/PG/Ph.D. Class: Ph.D		Course Work
Credits: 2 Theory: 2 Practical: 0		Subject: Botany
Course Code: DBOC-112		Title: Techniques in Biochemistry
Course Objectives: This course provides 1. The theory and knowledge relevant to the plant Biochemistry principles 2. Techniques employed in bio molecules purification and characterization are also emphasized in this course. 3. Students will also be introduced to the theory as well as applications of biochemical technology in food, medical, and household industries. 4. This course serves to provide an awareness of the current and possible future applications of Biochemistry.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 2 Credits		
L: 4 P: 4 Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits) Practical- 2 Hrs.= 1 Credit (4Hrs./Week=2Credits)		
Unit	Contents	No. of Lectures Allotted
I	Techniques of Genomic Biology: Introduction to recombinant DNA technology; PCR, Southern and Northern blotting, Microarray Technology, DNA foot printing; Electrophoretic Mobility Shift assays, transgenic technology, Targeted gene knock-out; Gene Silencing (anti-sense and Si RNA). 16sr RNA sequencing, Metagenomics, Transcriptoms analysis, High throughput gene sequencing.	6
II	Basics of Immunological Techniques: Techniques based on antigen-antibody interaction: Precipitation and agglutination reactions; ELISA, Immunofluorescence; Western blotting; Fluorescence Activated Cell Sorting; Immuno-histochemistry; Hybridoma technology and Monoclonal Antibodies;	6
III	Instrumentation: Description and principles of (i) Electrophoresis (ii) PCR Machine (iii) Laminar Flow (iv) Ultracentrifuge (v) Autoclave and (vi) Light and electron microscopy. Chromatography and HPLC. Handling of instruments and precautions. GC-MS	6
IV	Basic Techniques of Protein Chemistry: Protein isolation and purification (including column chromatographies), Polyacrylamide Gel Electrophoresis (PAGE)	6
V	Microbial biotechnology: Isolation, purification, cultivation and preservation of microbes, identification based on molecular methods.	6

Basic introduction to Bioinformatics	
Reference / Text Books: ▪ V S Mathura, 2009, Bioinformatics a concepts based introduction. ▪ Neil & Jones, 2009, An Introduction to Bioinformatics. ▪ Mosier, 2009, Modern Biotechnology. ▪ Chirikjian, 2009, Biotechnology theory & techniques.	
Evaluation/Assessment Methodology	
	Max. Marks
1) CT	10
2) TA	5
3) ESE	35
Total:	50
Course Learning Outcomes: Upon successful completion of this course, the student will be able to: 1. Understand on the kingdoms of bio molecules, Bioenergetics principals that are the prerequisites and consequences of physiological phenomenon for further manipulations. 2. Develop integrative approach for visions in biological problems. 3. Apply biochemical calculation for enzyme kinetics 4. Discuss various application of enzymes that can benefit human life 5. Plot graphs based on kinetics data	

**IIMTU-NEP IMPLEMENTATION
COURSE WORK**

Programme: Ph.D. Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Ph.D	Course Work	
Credits: 4 Theory: 4 Practical: 0	Subject: Botany	
Course Code: DDSE-002	Title: IMMUNOLOGY	
Course Objectives: This course aims to help students to 1. Understand the principles governing vaccination and the mechanisms of protection against infectious diseases 2. Understand and explain the basis of immunological tolerance, autoimmunity and transplantation 3. Understand and explain the basis of allergy and allergic diseases understand and explain the immune system in cancer; tumor immunology and principles of immunotherapy		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	• Introduction: Innate and acquired immunity, clonal nature of immune response. • Nature of antigens. • Antibody structure and function. • Antigen - antibody reactions and applications.	12
II	• Major his to compatibility complex (MHC). • Complement system. • Hematopoiesis and differentiation. • Regulation of the immune response: Activation of B and T-lymphocytes, Cytokines, T-cell regulation, MHC restriction, Immunological tolerance.	12
III	• Cell-mediated cytotoxicity: Mechanism of cytotoxic T cells and NK cells mediated target cell lysis, Antibody dependent cell mediated cytotoxicity, macrophages mediated cytotoxicity.	12
IV	• Hypersensitivity • Autoimmunity	12
V	• Transplantation. • Immunity to infection and tumours. • Different approach to development of vaccines	12

Suggested Readings:

1. Hannigan, 2008, Immunology. Viva Books Pvt. Ltd., New Delhi.
2. Kuby, 2014, Immunology. WH Freeman and Company, NY, USA.
3. Roitt & Maled, 2007, Immunology. Mosby Edinburgh, NY, USA.
4. E. Benjamini Richard Coico, Geoffery, 2008, Immunology A Short Course. Sunshine A John Wiley & Sons. Canada.

Evaluation/Assessment Methodology

	Max. Marks
1) CT	20
2) TA	10
3) ESE	70
Total:	100

Course Learning Outcomes:

After completing the course, the student should be able to:

1. demonstrate the basic knowledge of immunological processes at a cellular and molecular level
2. define central immunological principles and concepts
3. outline, compare and contrast the key mechanisms and cellular players of innate and adaptive immunity and how they relate
4. elucidate the genetic basis for immunological diversity and the generation of adaptive immune responses
5. outline key events and cellular players in antigen presentation, and how the nature of the antigen will shape resulting effector responses
6. identify the main mechanisms of inflammation outline key events and cellular players governing mucosal immunity

**IIMTU-NEP IMPLEMENTATION
COURSE WORK**

Programme: Ph.D. Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Ph.D.	Course Work	
Credits: 4 Theory: 4 Practical: 0	Subject: Botany	
Course Code: DDSE-003	Title: Molecular Biology	
Course Objectives: 1. To understand about the DNA structure and replication. 2. To study the concepts of DNA damage and its repair. 3. Understand the concept of homologous recombination. 4. To develop the concept of RNA processing. 5. To learn basic concept of transcription and translation.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Marks		
L: 4 Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Double helix and chemical structure of DNA and RNA. Organization of prokaryotic and eukaryotic genomes, super coiling, repetitive DNA.	12
II	DNA replication: Mechanism of replication of Prokaryotic and Eukaryotic Chromosome. Mutation: Types and molecular mechanisms of mutations, mutagens, DNA damage & Repair.	12
III	Recombination: Homologous and site - specific recombination. Gene expression in bacteria: Transcription and its regulation; operons, attenuation, anti-termination and anti-sense controls.	12
IV	Prokaryotic translation machinery, mechanism and regulation of translation. Gene expression in eukaryotes: Transcription, general and specific transcription factors, regulatory elements and mechanism of regulation, processing of transcripts.	12
V	Transposition: Mechanisms of transposition, role of transposons in mutation. Experiment of Barbara Mc Clintock.	12
Suggested Readings: 1. Julio Lodge, 2007, Gene Cloning. Gard land Science Taylor & Amp; Francess Group USA & amp; 2. London 3. S Surzycki, 2000, Basic Techniques in Molecular Biology. Springer Science, USA. 4. Helen Kreuzer, 2008, Molecular Biology & amp; Biotechnology: A Guide for Student. ASM Press 5. Washington DC, USA.		

6. Jun Ma, 2006, Gene Expression & Regulation. Springer Science, USA.
7. Cooper, 2007, The Cell : A Molecular Approach. ASM Press Washington DC, USA.
8. T.A. Brown, 2006, Genome 3. Garland Science Taylor & Francis Group USA & London.
9. Alberts/Watson, 2008, Molecular Biology of the cell. Garland Publishing, Inc. NY & London.
10. HD Kumar, 2010, Molecular & Synthetic Biology. Vitasta Pub., New Delhi.
11. Snustad, 2010, Principles of Genetics. John Wiley & Sons. Inc. NY, USA.

Evaluation/Assessment Methodology

	Max. Marks
1) CT	20
2) TA	10
3) ESE	70
Total:	100

Course Learning Outcomes:

By the end of this syllabus students will be able to:

1. Analyze and interpret data and graphs related to protein expression and function, enzyme catalysis, and malfunctions of these processes in disease.
2. Discuss chromatin structure and how it can be modified to affect gene expression.
3. Explain the mechanisms of DNA replication and repair, RNA synthesis and processing, and protein synthesis.
4. Describe how gene expression is regulated at the transcriptional and post-transcriptional level.

**IIMTU-NEP IMPLEMENTATION
COURSE WORK**

Programme: Ph.D. Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Ph.D	Course Work	
Credits: 4 Theory: 4 Practical: 0	Subject: Botany	
Course Code: DDSE-005	Title: ENZYME TECHNOLOGY	
Course Objectives: 1. The objective of this programme is to give knowledge about nomenclatures, characteristics and mechanism of enzymes, their biochemical calculation for enzyme kinetics, various applications of enzymes that can benefit food industry. 2. The scope of the application of enzyme technology ranges from medical to industrial uses and in the future even living organisms as a source of enzymes may be replaced by fully synthetic enzymes - "synzymes". 3. Learn about Recent advances in nanocomposite material that have presented more opportunities for enzyme immobilization. Discover about Enzymes immobilized on nanomaterials that mainly feature improved biocatalytic efficiencies, enhanced stabilities, increased enzyme-substrate affinities, and promising recyclability.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Enzymes General introduction and historic background-General Terminology, Nomenclature and Classification of Enzymes. Criteria of purity of enzymes- Specific activity. Enzyme units-Katal and IU. Enzyme activity-chemical nature of enzymes. Protein nature of enzymes and Non protein enzymes- Ribozymes and DNazymes. Metalloenzymes and metal activated enzymes. Coenzymes and Cofactors- Prosthetic group, coenzymes involved in different metabolic pathways. Classification of coenzymes. Isozymes, Abzymes, Synzyme	10
II	Enzyme Catalysis and Inhibition Lock and key, Induced fit and Transition state Hypotheses. Mechanism of enzyme catalysis- Acid-base catalysis, covalent catalysis, Metal ion catalysis, Proximity and orientation effects etc. Mechanism of Serine proteases-Chymotryspin, Lysozyme, Carboxypeptidase A and Ribonuclease., Proenzymes (Zymogens).	10
III	Reversible Inhibition- Competitive, Non Competitive. Uncompetitive,	10

	Mixed, Substrate, Allosteric and Product Inhibition. Irreversible Inhibition- Suicide inhibition. Examples and Mechanism of various Inhibitions like Penicillin, Iodoacetamide and DIPF.	
IV	Enzyme Kinetics Factors affecting the enzyme activity- Concentration, pH and temperature. Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, Km, Vmax, L.B Plot, Turnover number, Kcat. Kinetics of Enzyme Inhibition. Kinetics Allosteric enzymes.	10
V	Industrial and Clinical uses of Enzymes (Applied Enzymology) Industrial Enzymes- Thermophilic enzymes, amylases, lipases, proteolytic enzymes in meat and leather industry, enzymes used in various fermentation processes, cellulose degrading enzymes, Metal degrading enzymes	10
VI	Enzyme Structure activity Relationship (SAR) and Drug Discovery- Properties of Enzymes. Lead Compound, Structure based drug design, combinatorial chemistry, High-throughput screening, Case study of DHFR etc.	10
REFERENCES:		
➤ Fundamentals of Enzymology : Nicholas Price & Lewis Stevens ➤ Enzymes : Biochemistry, Biotechnology and Clinical Chemistry- Trevor Palmer ➤ Biochemistry text books by Stryer, Voet and Lehninger (Relevant Chapters) ➤ Proteins by Gary Walsh Internet/ Journal Resources		
Evaluation/Assessment Methodology		
		Max. Marks
1) CT		20
2) TA		10
3) ESE		70
Total:		100
Course Learning Outcomes:		
By the end of this syllabus students will be able to:		
1. Distinguish the fundamentals of enzyme properties, nomenclatures, characteristics and mechanisms. 2. Compare methods for production, purification, characterization and immobilization of enzymes 3. acquire knowledge about different databases of biomolecule and enzyme 4. Discover the current and future trends of applying enzyme technology for the commercialization purpose of biotechnological products.		

**IIMTU-NEP IMPLEMENTATION
COURSE WORK**

Programme: Ph.D. Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Ph.D		Course Work	
Credits: 4 Theory: 4 Practical: 0		Subject: Botany	
Course Code:DDSE-007		Recent Advances in Mycology and Plant Pathology	
Course Objectives: 1. To study the nature of pathogenic microorganisms. 2. Understand the concept of labotaory diagnosis. 3. To develop the concept transmission, prevention and control of diseases. 4. To learn basic concept of virology, mycology, immunology and parasitology.			
Nature of Paper: Core			
Minimum Passing Marks/Credits: 40% Marks / 4 Credits			
L: 4 Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)			
Unit	Contents		No. of Lectures Allotted
I	Introduction to Mycology Current concept of fungi as a taxonomic group. True fungi v/s Pseudo fungi (Fungal Nomenclature) Medicinal Mushrooms		12
II	Plant Diseases Molecular techniques for Identification and classification of fungi; Seed pathology: Major seed borne plant pathogens of fungal, bacterial and viral origin. Techniques involved in identification of seed borne pathogens.		12
III	Plant Defense Recent concept of plant defence: Mechanism of sensing pathogenecity, Systemic Acquired Resistance (SAR), Biochemical defence, Regulation of lignifications in defence.		12
IV	Fungal Biotechnology Fungal protoplast: Isolation, mycolytic enzymes, hyphal organization and protoplast formation, PEG induced and electro fusion of protoplast, Application and future prospect of protoplast, Chemical management of plant pathogens.		12
V	Role of Fungi in Biotechnology: Selection, Production formulation and Commercial use of fungi in biocontrol of plant diseases, insect and weeds.		12
Reference Books: 1. Dennis, E.S.et al, 1992 Plant Gene Research: Basic knowledge and Application. Springer Verlag Wien Publ. New York. 2. Gengopadhyay, S 1984 Clinical plant pathology, Kalyani Publ. New Delhi 3. Nene Y. L and P.N. Thapliyal. 2018 Fungicides in plant disease control – Fourth Edition, Oxford IBH, Publ. New Delhi. 4. Smith, J.E and D.R. Berry. 1978. The filamentous fungi. Vol-I Industrial mycology. Vol-II Development Mycology, Edward Arnold Publ. London			

5. Taiz, I, and E. Zeiger. 2003. Plant physiology, Vol. 3 Sinauer Assoc Inc. Publ. New York.
6. Trehan. K. 1994. Biotechnology, Wiley Eastern Ltd, New Delhi.
7. Vaidya, J.G 1995 Biology of the fungi, Satyajeet Prakashan, Pune.
8. Vyas, S.C. 1992. Hand Book of Systemic fungicides, Vol-I, II, III, Tata McGraw Hill, New Delhi.
9. Whipps, J.M. and R.D. Lumsden. 1989. Biotechnology of Fungi for Improving plant Growth. Cambridge Univ. Press, New York.

Journals

- a) Indian Phytopathology
- b) Annual Review of Plant pathology
- c) Index of Fungi
- d) Phytopathology
- e) Kavaka

Evaluation/Assessment Methodology

	Max. Marks
1) CT	20
2) TA	10
3) ESE	70
Total:	100

Course Learning Outcomes:

Upon successful completion of this course/paper, students should be able to:

1. Understanding and knowledge of microbes.
2. Have an ability to understand the differentiate between gram negative and gram positive.

**IIMTU-NEP IMPLEMENTATION
COURSE WORK**

Programme: Ph.D. Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: Ph.D		Course Work
Credits: 4 Theory: 4 Practical: 0	Subject: Botany	
Course Code:DDSE-008	Title: RECENT ADVANCES IN PLANT PHYSIOLOGY	
Course Objectives: 1. Take students to higher levels of learning about the mineral nutrition in plants. 2. Acquire basic knowledge about growth and development in plants. 3. Understand the mechanism of various metabolic processes in plants. 4. To understand the principle of bio statistics. 5. Recognise the data and knowledge of bio statistics.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Lipids and Amino Acids Biosynthesis Lipids- structural and storage lipids and their functions; Amino acid biosynthesis and assimilation in plants	12
II	Secondary Metabolites Secondary metabolites- Role of natural products in plant defense, pharmaceuticals and cosmetics; Development of transgenic plants for abiotic stress tolerance.	12
III	Stress physiology Biotic and Abiotic stress; Physiological and Biochemical responses of plants to environmental stress; Plant responses to salinity and chilling stress; Abiotic stress and secondary metabolite production.	12
IV	Hormones & Signal Transduction Hormonal regulation of plant growth and development, Role of PGR in agriculture and horticulture.	12
V	Phytoremediation Stress Proteins in plants- HSP, osmotin, PR, BSIPS, salt-, cold- and UV light- induced proteins.	12
References: 1. L. Taiz and E. Zeiger (2002) Plant Physiology (Second Edition) Simauer Associates Inc Publishers Sunderlands, Massachusetts 2. H.W. Heldt (1997) Plant Biochemistry and Molecular Biology Oxford University Press 3. W.G. Hopkins (1985) Introduction to Plant Physiology John Wiley and Sons, Inc. New York 4. Methods in Enzymology Colowick and Caplan Academic Press, New York 5. Coombs, Hall, Long and Scurlik (1985) Techniques in Bio productivity and Photosynthesis, Pergmon Press, Oxford		

6. Hall, Securlik, Bolhar, Norden Kamf, Leagood and Long (1993) Photosynthesis and production in a Changing Environment. A Field and Laboratory Manual, Chapman and Hall Publication
7. Buchanan, B.B., Gruissem, W. and Jones, R.L. (2000) Biochemistry and Molecular Biology of Plants. I.K. International Pvt. Ltd., New Delhi.

Journals

- a) Annual Review of Plant Physiology and Molecular Biology
- b) Trends of Plant Sciences
- c) Plant Physiology
- d) Physiologia Plantarum
- e) Journal of Experimental Botany
- f) Indian Journal of Plant Physiology.

Evaluation/Assessment Methodology	
	Max. Marks
1) CT	20
2) TA	10
3) ESE	70
Total:	100
Course Learning Outcomes: Upon successful completion of this course/paper, students should be able to: 1. Develop Understanding and knowledge of Plant Physiology. 2. Have an ability to understand the mechanism of plant growth and development. 3. Understand the role various metabolic agents in physiological processes related with plants.	

Academic Hand Book (School of Life Sciences & Technology)

Evaluation Scheme

Evaluation Scheme
Ph.D. Biotechnology Coursework

The PhD course for the Research Scholars would consist of five papers. Out of these three papers would be compulsory, one optional (to be chosen from five options given as under) and one Oral/seminar-

S. No.	Subject Code	Subjects	Category	Periods			Marks					Credits
							Internal			External	Total	
				L	T	P	CT	TA	Total			
1	DBTC-113	Research Methodology	CORE	4	0	0	20	10	30	70	100	4
2	DBTC-112	Techniques in Biotechnology	CORE	2	0	1	10	5	15	35	50	2
3	CPE-RPE	Research and Publication Ethics (RPE)	CORE	2	0	1	10	5	15	35	50	2
4	PHD-SP	Seminar/ Oral	DSE	2	0	0	0	0	50	0	50	2
Discipline Specific Elective Courses (Any one)												
1	DDSE -002	Immunology	Elective	4	0	0	20	10	30	70	100	4
2	DDSE -003	Molecular Biology	Elective	4	0	0	20	10	30	70	100	4
3	DDSE -004	Recombinant DNA Technology	Elective	4	0	0	20	10	30	70	100	4
4	DDSE -005	Enzyme Technology	Elective	4	0	0	20	10	30	70	100	4
5	DDSE-006	Cell Biology	Elective	4	0	0	20	10	30	70	100	4
6.	DDSE-007	Bioremediation and WasteWaterTreatment Technologies.	Elective	4	0	0	20	10	30	70	100	4
TOTAL											350	14

Format-3

**IIMTU-NEP IMPLEMENTATION
IMMUNOLOGY
(CREDITS: 4) (CODE: DDSE -002)**

Programme: Ph.D. in Biotechnology		Coursework
Class: Ph.D. Biotechnology		Semester: I
Credits: 4 Theory: 4 Practical: 0	Subject: Immunology	
Course Code:DDSE-007	Title: Immunology	
COURSE OBJECTIVES		
1. To study the immune response, Innate and acquired immunity, Structure and function of Antigen and Antibody, Major his to compatibility complex (MHC).		
2. To study the Complement system, Regulation and Activation of B and T-lymphocytes.		
3. To study the Mechanism of Cell-mediated cytotoxicity, Antibody, and macrophages mediated cytotoxi city, Hypersensitivity and Autoimmunity.		
4. To study the blood transfusion reactions, vaccines and its types.		
5. To study the immunotherapy graft versus leukemia effect and cancer cell targeted therapy.		
6. To study the types and functions of antigens and graft rejection and immuno modulation.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4		
T:0		
P:0		
Theory – 1 Hr. = 1 Credit		
Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction: Innate and acquired immunity, clonal nature of immune response, Nature of antigens Antibody structure and function. Antigen - antibody reactions and applications.	15
II	Major his to compatibility complex (MHC).Complement system. Hematopoietic and differentiation. Regulation of the immune response: Activation of B and T-lymphocytes, Cytokines, T-cell regulation, MHC restriction, Immunological tolerance.	13
III	Cell-mediated cytotoxi city: Mechanism of cytotoxic T cells and NK cellsmediated target cell lysis, Antibody dependent cell mediated cytotoxicity, and macrophages mediated cytotoxicity. Hyper sensitivity. Auto immunity. Transplantation. Immunity to infection and tumours Primary immunodeficiency disorders (PIDS),	10
IV	Cross matching in blood transfusion, artificial blood, blood transfusion reactions, vaccines types, haptens, adjuvants including recent advances like dendritic cell vaccine; immunotherapy graft versus leukemia effect; cancer cell targeted therapy, anticancer vaccines,	12
V	Human leukocyte antigens (including types, function), human platelet antigens, types of graft rejection, graft versus host disease, immuno modulation, role in solid organ transplants role in bone marrow transplant.	10

Suggestive reading

1. Kuby, 8th ED/ 2018, Immunology. WH Freeman and Company, NY, USA. 978-1319114701
2. Basics of Immunology, by Dr. Preeti Sharma (Author), Dr. Pradeep Kumar (Author), I ed /2021, 978-8195175055
3. Basic Immunology, by Abul K. Abbas MBBS (Author), Andrew H. Lichtman MD PhD (Author), South Asia Edition Paperback – 28 June 2019, 978-8131259573.
4. Cellular and Molecular Immunology, by Abbas South Asia Edition Paperback – 1 January 2021 ISBN-13-978-8131264577
5. Hannigan, 2008, Immunology. Viva Books Pvt. Ltd., New Delhi.
6. Roitt & Maled, 2007, Immunology. Mosby Edinburgh, NY, USA.
7. E. Benjamini Richard Coico, Geoffery, 2008, Immunology A Short Course. Sunshine A John Wiley & Sons. Canada.
8. Kumar, Abbas, Fausto, Aster, ROBBINS AND COTRAN PATHOLOGIC BASIS OF DISEASE, (2010) 8/E. Saunders, Elsevier inc.
9. Punt, Owen, Stranford, (2013) KUBY immunology, 7th edition, WH freeman and company
10. Brigham Narins, (2003) World of microbiology and immunology, volume 1 and 2,
11. Thomson and Gales publication.
12. Warren Levinson, (2008) Review of Medical Microbiology & Immunology, Tenth Edition,
13. Mc Graw hill publication.
14. Arthur Rabson, lean M. Roitt, Peter J. Delves (2005) Really Essential Medical Immunology, black well publishing.

Course Learning Outcome

After completion of the course, students may able to understand

1. Student will study the types and functions of immune response.
2. Student will be aware for Major Histocompatibility and regulation and activation of B and T-lymphocytes.
3. Student will study the Mechanism and functions of different types of Cell-mediated cytotoxicity, Hypersensitivity and Autoimmunity.
4. Student will be aware for various types of blood transfusion reactions and vaccines and its types.
5. Students will able to understand types and functions of antigens and graft rejection and immuno modulation.
6. Student will gain knowledge different types of transplantation and various technologies used in the field of immunology.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	20
2) Tutorial Assessment	10
3) ESE	70
Total:	100

**IIMTU-NEP IMPLEMENTATION
MOLECULAR BIOLOGY
(CREDITS: 4) (CODE: DDSE -003)**

Programme: Ph.D. in Biotechnology		Coursework
Class: Ph.D. Biotechnology		Semester: I
Credits: 4 Theory: 4 Practical: 0	Subject: Molecular Biology	
Course Code:DDSE-007	Title: Molecular Biology	
COURSE OBJECTIVES This course aims to introduce the basics of molecular biology, genetic formulation of prokaryotes and eukaryotes, transcription and translation. The objectives of this curriculum are to help the students to acquire alertness and sensitivity towards the molecular biology. The objective of the course is to prepare PhD students to comprehend the issues, questions and problems related to central dogma of molecular biology and its various alterations. Student opt this course in their PhD course work those who are interested to work in the field of molecular biology. 1. To teach basics the genetic material and replication process. 2. To study the transcription and its regulation. 3. To study about the translation and whole process of conversion from gene to protein. 4. To learn about various regulatory mechanism to control overall process of translation. 5. Students will aware about post translational modifications and protein stability. 6. To aware students about advancements and recent research in the molecular biology.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T:0 P:0 Theory – 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to genetic material: Physico-chemical considerations. Concept of Gene, Chemical nature of Gene. Complexity of prokaryotic and eukaryotic genomes, DNA super coiling, repetitive DNA. DNA replication: Mechanism of replication of Prokaryotic & Eukaryotic Chromosome. DNA repair, DNA repair deficiencies.	12
II	Transcription: Gene expression in Prokaryotes and Eukaryotes: Overview of Transcription, general and specific transcription factors, synthesis and processing of Ribosomal, Transfer and Messenger RNA. Split genes. Creating Ribozymes in laboratory, micro RNA, RNA interference. Regulatory elements and mechanism of regulation, processing of transcripts.	12
III	From Genes to Proteins: Encoding genetic information, Mechanism of translation in prokaryotes and eukaryotes. Decoding the codons, Role of Transfer RNA, Messenger RNA, Ribosomal RNA. m RNA surveillance, Polyribosome's.	14

IV	The control of Gene expression. Control of gene expression in bacteria and eukaryotes. Transcription level control, processing level control, translational level control, post translational control, Determining protein stability	12
V	Recent Advances in Molecular biology, DNAi Protein microarray, DNA/Protein markers, DNA finger printing, Gene Knockout, RNAi and Gene silencing, Metagenomics, Stem cell technology, Types of stem cells, Manipulation of stem cells and applications, Bioethics and IPR.	10

Suggestive reading

1. Molecular Biology, Third Edition, David P. Clark, Nanette J. Pazdernik and Michelle R. Mc Gehee, 978-0-12-813288-3, Copyright © 2019 Elsevier Inc. All rights reserved.
2. Wilson And Walkers Principles And Techniques Of Biochemistry And Molecular Biology, by HOFMANN A (Author) 8th/ 2018, 978-1107606227/Cambridge University press
3. Cooper, 2015, The Cell: A Molecular Approach. ASM Press Washington DC, USA.
4. T.A. Brown, 2007, Genome 3. Gardland Science Taylor & Francess Group USA & London
5. Alberts/Watson, 2016, Molecular Biology of the cell. Garland Publishing, Inc. NY & London.
6. Julio Lodge, 2007, Gene Cloning. Gardland Science Taylor & Francess Group USA & London
7. S Surzycki, 2000, Basic Techniques in Molecular Biology. Springer Science, USA.
8. Helen Kreuzer, 2008, Molecular Biology & Biotechnology: A Guide for Student. ASM Press Washington DC, USA.
9. Jun Ma, 2006, Gene Expression & Regulation. Springer Science, USA.
10. HD Kumar, 2010, Molecular & Synthetic Biology. Vitasta Pub., New Delhi.
11. Snustad, 2010, Principles of Genetics. John Wiley & Sons. Inc. NY, USA.

Course Learning Outcome

After completion of the course, students may able to understand the molecular biology principles and develop their interest in the field of molecular biology.

1. Clear their basics related with the genetic material and replication process.
2. Student comes up with the knowledge about the transcription and its regulation.
3. Student comes up with the knowledge about the translation and whole process of conversion from gene to protein.
4. Student learns about various regulatory mechanisms to control overall process of translation.
5. Student comes up with the knowledge about post translational modifications and protein stability.
6. Student comes up with the knowledge about advancements and recent research in the molecular biology.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	20
2) Tutorial Assessment	10
3) ESE	70
Total:	100

**IIMTU-NEP IMPLEMENTATION
RECOMBINANT DNA TECHNOLOGY
(CREDITS: 4) (CODE: DDSE-004)**

Programme: Ph.D. in Biotechnology		Coursework
Class: Ph.D. Biotechnology		Semester: I
Credits: 4 Theory: 4 Practical: 0	Subject: RECOMBINANT DNA TECHNOLOGY	
Course Code:DDSE-004	Title: RECOMBINANT DNA TECHNOLOGY	
COURSE OBJECTIVES		
An aim of the course to the recombinant DNA technology involves involves different enzymes and techniques used to manipulate and isolate the desired DNA segments of interest. This method can be used to combine or splice the DNA from different species or to create genes with new functions. The objectives of this curriculum are to help the students to acquire the knowledge for gene editing and produce new combination of genes. The overall objective of the course is to prepare the PhD students to comprehend the issues, questions and problems related to recombinant DNA technology. Student opt this course in their PhD course work those who are interested in gene editing and develop new products as well as biotechnologists.		
1. To study the restriction enzymes, its different types used in genetic engineering. 2. To study the use of restriction enzymes in gene cloning and vectors and also sequencing methods. 3. To impart knowledge of genome analysis, PCR, Microarrays and their applications. 4. Students will able to learn about the various direct and indirect gene delivery methods. 5. To aware students regarding various Construction and Screening of Genomic and cDNA libraries. 6. The overall objective is to impart knowledge of various enzymes, tools and techniques involved in the genetic engineering.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T:0 P:0 Theory – 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Molecular Cloning- Tools and Strategies Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering.	12
II	Use of Restriction and modification enzymes in cloning; Plasmid vector; Transformation and Plasmid isolation; PCR; DNA sequencing methods (Sanger’s chain termination method, and automated DNA sequencing); Next generation sequencing (NGS)	14

III	Global expression profiling; Whole genome analysis of mRNA and protein expression; Real time PCR and Microarrays and their applications.	10
IV	Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral mediated delivery, <i>Agrobacterium</i> - mediated delivery.	12
V	Construction and Screening of Genomic and cDNA libraries, Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping.	12

Suggestive Reading

1. Current Developments in Biotechnology and Bioengineering Synthetic Biology, Cell Engineering and Bio processing Technologies, 978-0-444-64085-7, Copyright © 2019 Elsevier B.V. All rights reserved.
2. Laboratory Manual for Biotechnology and Laboratory Science: The Basics, Revised Edition 1st Edition by Lisa A. Seidman (Author), Mary Ellen Kraus (Author), Diana Lietzke Brandner (Author), 978-1032419916, CRC Press; 1st edition (December 23, 2022).
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (ASM Books) 6th Edition by Bernard R. Glick (Author), Cheryl L. Patten (Author), 978-1683673644 ASM Press; 6th edition (March 15, 2022)
4. Textbook on Cloning, Expression and Purification of Recombinant Proteins, ISBN : 978-981-16-4986-8, Springer. Part of Springer Nature. 2022
5. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
6. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
7. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
8. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
9. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
10. Brown TA. (2007). Genomes-3. Garland Science Publishers
11. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

Course Learning Outcome

After completion of the course, students may able to understand

This course is designed in such a way that it simply provides the use of various restriction enzymes, vectors, plasmids, techniques, screening and sequencing of desired gene under genetic engineering. On completion of course, students will be able to understand and used the advanced tools and techniques for genetic engineering.

1. Students understand the restriction enzymes and its various types used in genetic engineering.
2. Students are able to know the vectors, plasmids, transformation and various DNA sequencing methods.
3. Students understand the gene and protein expressions via various methods of genetic engineering.
4. Students able to know the different direct and indirect methods for gene delivery.
5. Students understand the gene construction and screening of Genomic and cDNA libraries through various methods.
6. The overall outcome of the course is that students understand the gene editing tools and techniques involved in genetic engineering.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	20
2) Tutorial Assessment	10
3) ESE	70
Total:	100

**IIMTU-NEP IMPLEMENTATION
ENZYME TECHNOLOGY
(CREDITS: 4) (CODE: DDSE -005)**

Programme: Ph.D. in Biotechnology		Coursework
Class: Ph.D. Biotechnology		Semester: I
Credits: 4 Theory: 4 Practical: 0	Subject: Enzyme Technology	
Course Code: DDSE -005	Title: Enzyme Technology	
COURSE OBJECTIVES		
1. To study the Introduction, Nomenclature and Classification of Enzymes.		
2. To study the Coenzymes and Cofactors involved in different metabolic pathways.		
3. To study about interaction between substrate and enzyme through models like induced fit model and lock and key model and Mechanism of enzyme catalysis.		
4. To study the various types of Enzyme inhibition process.		
5. To study about various factors affecting enzyme catalysis process such as, enzyme concentration, temperature, substrate concentration and pH for the velocity of enzyme catalyzed reaction and Michealis-Menten Equation.		
6. To study the Industrial and Clinical applications and uses of Enzymes.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4		
T:0		
P:0		
Theory – 1 Hr. = 1 Credit		
Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Introduction to Enzymes General introduction and historic background- General Terminology, Nomenclature and Classification of Enzymes. Criteria of purity of enzymes-Specific activity. Enzyme activity- chemical nature of enzymes. Protein nature of enzymes and Non protein enzymes- Ribozymes and DNAzymes. Metalloenzymes and metal activated enzymes. Coenzymes and Cofactors-Prosthetic group, coenzymes involved in different metabolic pathways. Classification of coenzymes. Isozymes, Abzymes, Synzyme.	12
II	Enzyme Catalysis and Inhibition- Lock and key, Induced fit and Transition state Hypotheses. Mechanism of enzyme catalysis- Acid-base catalysis, covalent catalysis, Metal ion catalysis, Proximity and orientation effects etc. Mechanism of Serine proteases-Chymotryspin, Lysozyme, Carboxypeptidase A and Ribonuclease, Proenzymes (Zymogens).	12
III	Reversible Inhibition- Competitive, Non Competitive, Uncompetitive, Mixed, Substrate, Allosteric and Product Inhibition. Irreversible Inhibition-Suicide inhibition. Examples and Mechanism of various Inhibitions.	12

IV	Enzyme Kinetics- Factors affecting the enzyme activity- Concentration, pH and temperature. Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, Km, Vmax, L.B Plot, Turnover number, Kcat. Kinetics of Enzyme Inhibition. Kinetics Allosteric enzymes.	12
V	Industrial and Clinical uses of Enzymes (Applied Enzymology)- Industrial Enzymes- Thermophilic enzymes, amylases, lipases, proteolytic enzymes in meat and leather industry, enzymes used in various fermentation processes, cellulose degrading enzymes, Metal degrading enzymes. Enzyme Structure activity Relationship (SAR) and Drug Discovery- Properties of Enzymes, Lead Compound, Structure based drug design, combinatorial chemistry, High-throughput screening, Case study of DHFR etc.	12

Suggestive reading

- Advances in Enzyme Technology, A volume in Biomass, Biofuels, Biochemicals, 978-0-444-64114-4 Copyright © 2019 Elsevier Inc. All rights reserved.
- Enzymes in Food Biotechnology Production, Applications, and Future Prospects, 978-0-12-813280-7 Copyright © 2019 Elsevier Inc. All rights reserved.
- Principles of Enzyme Technology, ISBN 9788120350410 PHI Learning Pvt. Ltd., 31-Aug-2015
- Enzymology and Enzyme Technology, Publisher: S Chand (3 March 2014) ISBN: 978-8121935845

Course Learning Outcome

After completion of the course, students may able to understand

1. Student will learn about General introduction Nomenclature and Classification of Enzymes.
2. Students will get aware of Classification of co-enzymes and Cofactors involved in different metabolic pathways.
3. Student will learn about interaction between substrate and enzyme and Mechanism of enzyme catalysis.
4. Students will able to understand various types of Enzyme inhibition process and Mechanism of various Inhibitions.
5. Student will learn about various factors affecting enzyme catalysis process such as, enzyme concentration, temperature, substrate concentration and pH for the velocity of enzyme catalyzed reaction and Michealis-Menten Equation.
6. Student will gain the knowledge about Industrial and Clinical applications and uses of Enzymes.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	20
2) Tutorial Assessment	10
3) ESE	70
Total:	100

IIMTU-NEP IMPLEMENTATION
CELL BIOLOGY
(CREDITS: 4) (CODE: DDSE-006)

Programme: Ph.D. in Biotechnology		Coursework
Class: Ph.D. Biotechnology		Semester: I
Credits: 4 Theory: 4 Practical: 0	Subject: CELL BIOLOGY	
Course Code:DDSE-006	Title: CELL BIOLOGY	
COURSE OBJECTIVES		
This course aims to introduce the basics of cell cycle and its regulation, apoptosis, oxidative stress in cell stress, cell survival, cell signaling, growth factors, cell signaling pathway and cancers and its diagnosis. The objectives of this curriculum are to help the students to acquire alertness and sensitivity towards the cell biology. The objective of the course is to prepare PhD students to comprehend the issues, questions and problems related to cell cycle and its various regulations. Student opt this course in their PhD course work those who are interested to cell cycle and its different regulation mechanisms.		
1. To teach basics the cell cycle, death, diseases and regulation of cell cycles through various mechanisms.		
2. To study the cell death, apoptosis pathway and role of oxidative stress in cell death.		
3. To study about the cellular adhesion, cell survival and proliferation, its regulators and methods of detection.		
4. To learn about cell signaling molecules and various receptors involved in cell regulations.		
5. Students will aware about signal transduction pathways such as MAP kinase, Cyclic AMP pathway and cyclic GMP.		
6. To study about the carcinogenesis and its diagnosis.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T:0 P:0 Theory – 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	Importance of study of cell cycle and death and diseases. Cell cycles and its regulations. Basic, Clinical and Translational Research, Clinical Trials. Cell surface protrusions, intermediate filaments, microtubules.	14
II	Mechanism of cell death- Pathways of Apoptosis. Detection of modes of cell death. Regulators of cell death- role of oxidative stress in cell death and its detection.	12
III	Importance of study of cell survival, cellular adhesion and proliferation, its regulators and methods of detection (Microscopy and other methods)	11
IV	Signaling molecules and their receptors. Function of cell surface receptors. Signal transduction in cells- Growth Factors and receptor studies. Pathways	13

	of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway.	
V	Carcinogenesis, types of carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer and its diagnosis.	10
Suggestive reading 1. The Cell, A Molecular Approach, 8th edition, Geoffrey M Cooper (2019). Boston University. Sunderland (MA): ISBN-10: 0-87893-106-6. 2. Molecular Biology of the Cell, 6th edition, Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D Watson (2014) New York: Garland Science; ISBN-10: 0-8153-1619-4. 3. Molecular Cell Biology, 9th edition, Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell (2021). New York: W. H. Freeman ISBN-10: 0-7167-3136-3. 4. Cell Death Techniques: A Laboratory Manual, Edited by Ricky Johnstone, PhD, Peter Mac Callum Cancer Centre; John Silke, PhD, The Walter and Eliza Hall Institute ISBN 978-1-621820-05-5. 5. Cellular Signal Processing: An Introduction to the Molecular Mechanisms of Signal Transduction, 2nd edition, Friedrich Marks, Ursula Klingmuller, Karin Muller-Decker (2017) Published by Garland Publishing. 6. Structure and Function in Cell Signalling, John Nelson, (2008), Wiley ISBN: 978-0-470-02551-2.		
Course Learning Outcome After completion of the course, students may able to understand This course is designed to provide the cell cycle and its regulation by various ways, apoptosis and its regulators, cell survival and proliferation, growth factors, cell signaling and different signaling pathways. On completion of course, students able to understand the cell signaling, apoptosis, disease and cell regulations. 1. Students able to understand the cell cycle and death and diseases, Clinical and Translational Research. 2. Able to understand the mechanism of apoptosis and its regulators and detection methods. 3. Students are understood the cellular adhesion and proliferation, its regulators. 4. Students able to knowledge the cell signaling, receptors and various signaling pathways. 5. Students able to understand the carcinogenesis, its types and diagnosis. 6. The overall outcome of the course is that student worked in cell cycles, its regulations, diseases, death and signaling pathways and various receptors used to regulate the pathways.		
Instructional Method and Pedagogy 1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course. 2. Various teaching aids are used for smooth conduction of Lectures. 3. 75% attendance in academic sessions is mandatory. 4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics. 5. PPT presentation method is also incorporated in teaching. 6. Case-study based learning will also be used. 7. Promotion of Ex-situ and In-situ learning. 8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.		
Evaluation/Assessment Methodology		
		Max. Marks
1) Class tasks/ Sessional Examination		20
2) Tutorial Assessment		10
3) ESE		70
Total:		100

IIMTU-NEP IMPLEMENTATION
GREEN REMEDIATION AND WASTEWATER TREATMENT
(CREDITS: 4) (CODE: DDSE-007)

Programme: Ph.D. in Biotechnology		Coursework
Class: Ph.D. Biotechnology		Semester: I
Credits: 4 Theory: 4 Practical: 0	Subject: GREEN REMEDIATION AND WASTEWATER TREATMENT	
Course Code: DDSE-007	Title: GREEN REMEDIATION AND WASTEWATER TREATMENT	
COURSE OBJECTIVES This course aims to introduce basics of green remediation and Wastewater Treatment Technologies. The course content consist main groups of microorganisms as potential tools in bioremediation and environmental applications. The objectives of this curriculum are to help the students to acquire alertness and sensitivity towards the environment. The overall objective of the course is to prepare PhD students to comprehend the issues, questions and problems related to environment and its development. Student opt this course in their PhD course work those who are environment warrior and developed their carrier as an environmental biotechnologists. 1. To teach basics of green remediation technologies for environmental clean-up. 2. To equip student with skill based analysis of water sample. 3. To impart knowledge of core engineering design in environmental waste treatment using biological process and bioreactor system.(SDG 6) 4. To develop mathematical and analytical skills required to design and operate system for source-based waste treatment.(SDG 7) 5. To aware students regarding various environmental legislations and sustainable development goal. (SDG 13) 6. The overall objective is to impart knowledge of various available green technologies to various issues and to achieve the SDG 6 and SDG 7 and SDG 13.		
Nature of Paper: Core		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
L: 4 T:0 P:0 Theory – 1 Hr. = 1 Credit Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)		
Unit	Contents	No. of Lectures Allotted
I	UNIT I: Green remediation 1. Bioremediation, <i>in situ</i> and <i>ex situ</i> bioremediation, constrains and priorities of bioremediation, Evaluating Bioremediation, Bioremediation of VOCs. 2. Biodegradation. Factors affecting on process of biodegradation. Methods in determining biodegradability. Contaminant availability for biodegradation. 3. Sources of heavy metal, inorganic and organic pollution, Microbial interactions with inorganic pollutants. Microbial metal resistance,	15

	Microbial transformation, accumulation and concentration of metals, Biosorption Biotechnology and heavy metal pollution. 4. Phytoremediation: mechanism and process	
II	UNIT II: Water pollution monitoring and analysis 1. Biological methods- Detection methods for DO, BOD, Pathogen monitoring by heterotrophic plate count, multiple tube method, membrane filtration methods, Other emerging techniques such as enzyme detection, hybridization, PCR, gene probe technology etc. Strategies for controlling pathogen transfer. 2. Chemical methods- Detection methods for COD, pH, alkalinity, TSS, TDS, Total organic carbon, oil, grease etc. Nature based solutions, characteristics of bioadsorption 3. Ultimate analysis 4. Proximate analysis	13
III	UNIT III: Waste water treatment systems 1. Sewage and waste water treatments systems. Primary, secondary and tertiary treatments. Measurement of treatment efficiencies. Biological treatments aerobic versus anaerobic treatments. 2. Bio films in treatment of waste water. Bio film development and bio film Kinetics. Aerobic Bio films. 3. Bioreactors for waste water treatments. Reactors types and design. Reactors in series. 4. Development and optimization of membrane bioreactor process for use in sanitary and industrial sewage treatment. 5. Bio nanotechnology for wastewater treatment	10
IV	UNIT IV: Biotechnological application of hazardous waste management and management of resources. 1. Use of microbial systems. 2. Phyto remediation. Waste water treatment using aquatic plants, root zone treatment. 3. Development of new biocatalysts to be applied in waste water biotechnology. 4. Reclamation of wasteland, biomass production, Biogas and bio fuel production.	12
V	UNIT V: Environmental Legislations 1. Water pollution act, Sustainable development goals, CPCB and state pollution control board framework 2. Advanced Methods of monitoring of water pollution. 3. Need for management of resources. Role of environmental biotechnology in management of resources. 4. Development of environmentally friendly processes such as integrated waste management.	10
Suggestive reading 1. Bio nanotechnology towards Sustainable Management of Environmental Pollution by Naveen Dwivedi and Shubha Dwivedi, CRC Press 2022. 2. Bio nanotechnology towards Green Energy: Innovative and Sustainable Approach by Shubha Dwivedi and Naveen Dwivedi CRC Press 2023. 3. Naveen Dwivedi, Shubha Dwivedi and Maulin P Shah. “Integrated biotechnological solutions for		

the treatment of industrial wastewater for a healthy and sustainable environment" (Edited book- Publisher: Elsevier).

4. Charles Oluwaseun Adetunji, Julius Kola Oloke, Naveen Dwivedi, Sabeela Beevi Ummalyma, Shubha Dwivedi and Daniel Ingo Heff. "Next-Generation Algae, Volume 1: Applications in Agriculture, Food and Environment" (Publisher: Wiley–Scrivener, ISBN: 9781119857273, 2023).
5. The International Law of Biotechnology: Human Rights, Trade, Patents, Health and the Environment (Principles of International Law series) 2nd Edition by Matthias Herdegen (Author), Edward Elgar Publishing; 2nd edition (April 10, 2023), ISBN 978-1035302048
6. Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications. McGraw-Hill 2nd edition (July 25, 2000) ISBN: 0072345535.
7. Raina M. Maier, Ian L. Pepper, Charles P. Gerba. Environmental Microbiology. Publisher: Academic Press; (February 23, 2000).
8. Wastewater Engineering Metcalf & Fuddy, 3rd ed. 2013.

Course Learning Outcome

After completion of the course, students may able to understand

This course is designed in such a way that it simply provides sustainable way for cleaning up environment by enhancing natural biological processes to occur. Microorganisms/plants are capable to break-down many types of pollutants by a clean, competent & comparatively inexpensive biological process. On completion of course, students will be able to understand the use of basic biotechnological/microbiological and analytical methods, which are extensively used in environmental biotechnology.

1. Student will come up with good understanding of the nature and importance of green remediation.
2. Able to define bioremediation and when each strategy would be most applicable.
3. Student will come up with good knowledge of core engineering design in environmental waste treatment using biological process and bioreactor system.(SDG 6)
4. Student will able to develop the waste to valuables in sustainable way.
5. Demonstrate the use of course concepts to solve problems in real world application and understand the SDG and environmental legislations.
6. The overall outcome of the course is that student worked in diversified manner to deal with environmental problems and provide sustainable way of solutions also worked as environmental biotechnologists/water analyst.

Instructional Method and Pedagogy

1. Preconditioning of the course and its blueprint shall be discussed in the beginning of the course.
2. Various teaching aids are used for smooth conduction of Lectures.
3. 75% attendance in academic sessions is mandatory.
4. Assignments shall be given at the end of each unit/topic. Extempore activity can also be organized on various topics.
5. PPT presentation method is also incorporated in teaching.
6. Case-study based learning will also be used.
7. Promotion of Ex-situ and In-situ learning.
8. Teaching-learning via organizing seminars, guest lectures, invited talks, symposium etc.

Evaluation/Assessment Methodology

	Max. Marks
1) Class tasks/ Sessional Examination	20
2) Tutorial Assessment	10
3) ESE	70
Total:	100

School of Life Science & Technology

ACADEMIC HAND BOOK



Ph.D. Microbiology Coursework

Evaluation Scheme

Evaluation Scheme
Ph.D. Microbiology Coursework

The PhD course for the Research Scholars would consist of five papers. Out of these three papers would be compulsory, one optional (to be chosen from the options given as under) and one Oral/seminar-

S. No.	Subject Code	Subjects	Category	Periods			Marks					Credits
							Internal			External	Total	
				L	T	P	CT	TA	Total			
1	DBTC-113	Research Methodology	CORE	4	0	0	20	10	30	70	100	4
2	DMBC-112	Microbial Techniques	CORE	2	0	1	10	5	15	35	50	2
3	CPE-RPE	Research and Publication Ethics (RPE)	CORE	2	0	1	10	5	15	35	50	2
4	PHD-SP	Seminar/ Oral	DSE	2	0	0	0	0	50	0	50	2
Discipline Specific Elective Courses (Any one)												
1	DDSE -002	Immunology	Elective	4	0	0	20	10	30	70	100	4
2	DDSE-009	Medical Microbiology	Elective	4	0	0	20	10	30	70	100	4
3	DDSE-010	Fermentation Technology	Elective	4	0	0	20	10	30	70	100	4
4	DDSE-011	Current Concepts and Trends in Microbiology	Elective	4	0	0	20	10	30	70	100	4
TOTAL											350	14

Format-3

CORE
DMBC-112: MICROBIAL TECHNIQUES

Programme: Ph.D		Year: I
Class: Microbiology		Semester: I
Credits: 4 Theory: 4 Practical: 0	Subject: MICROBIOLOGY	
Course Code: DMBC-112	Title: MICROBIAL TECHNIQUES	
Course Objectives: 1. To provide the basic knowledge about the isolation and cultivation of microbes 2. To learn different staining and preservation methods. 3. To learn good laboratory practices 4. To provide the knowledge of various separation techniques 5. To provide the knowledge of various molecular techniques. 6. To understand various methods of sterilization		
Nature of Paper: Core/DSE/SEC/GE/AECC [CORE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
Unit	Contents	No. of Lectures Allotted
I	Basic techniques for isolation, cultivation and enumeration of Microorganisms; Staining of microorganisms; Microscopy: (bright field, dark field, fluorescence, phase contrast and electron) Growth limitation and sterilization techniques. Enrichment culture techniques, Principles and methods of preservation of microorganisms, Isolation and cultivation of anaerobes.	06
II	Good laboratory practices: Accuracy in preparation of solutions, media, etc; Qualifications of equipment – design (DQ), installation (IQ), operational (OQ) and performance (PQ) Validation and calibration; Documentation-Concepts, necessity and types; Safety in the laboratory: Commonhazards in the laboratory; Cell disruption methods.	06
III	Biophysical techniques: Principle & application of gel filtration, Ion exchange & hydrophobic interaction chromatography, GC, HPLC, FPLC, Isoelectric-focussing (IEF), Spectrophotometry, GC-MS, LCMS, NMR, MALDITOF, X-ray crystallography,	06
IV	Separation techniques Centrifugation - preparative and analytical, ultra-centrifugation, density gradient centrifugation. Electrophoresis – Principle, types and applications – PAGE, SDS-PAGE, Agarose, Pulsed Field Gel Electrophoresis (PFGE).	06
V	Molecular Biology Techniques: PCR and its types, applications of PCR, Real Time PCR, RT-PCR, Southern, Northern and Western blotting. Library preparation: Genomic DNA, cDNA, EST and reduced representation libraries. DNA microarray, DNA sequencing techniques.	06
References 1. Methods in Microbiology (series) by Norris and Ribbons, Academic Press, NY. 2. Principles and techniques in Practical Biochemistry by Wilson and Walker. 3. Research Methodology for Biological Sciences by N. Gurumani. MJP Publishers, Chennai.		

4. Bioinstrumentation by L. Veerakumari, MJP Publishers, Chennai.
5. Amanual of Laboratory Techniques by N. Raghuramulu and others, NIN, Hyderabad.
6. Microbiological aspects of Anaerobic Digestion–Laboratory Manual by D.R. Ranade and R.V. Gadre, MACS, Agharkar Research Institute, Pune.
7. Isolation Methods for Anaerobes by Shapton, Academic Press.
8. Tools in Biochemistry by D. Cooper.
9. Protein Purification by R.Scopes, Springer Verlag Publications.

If the course is available as Generic Elective, then the students of following departments may opt it. NO

Evaluation/Assessment Methodology	
	Max. Marks:50
1) Class tasks/ Sessional Examination	10
2) Presentations /Seminar	-
3) Assignments	-
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	05
INTERNAL MARKS	15
EXTERNAL MARKS	35
TOTAL	50

Prerequisites for the course:

Course Learning Outcomes:

By the conclusion of this course, the students-

- CO1: Students will be able to isolate, cultivate and identify the microorganisms on the basis of morphological and microscopic examination.
- CO2: Will be able to explain different types of microscopy.
- CO3: Will have good knowledge of laboratory practices.
- CO4: Will be able to elaborate different types of biophysical techniques.
- CO5: Will be able to explain various separation techniques.
- CO6: Will have expand knowledge of molecular techniques.

DISCIPLINE SPECIFIC ELECTIVE COURSES
DDSE 002: IMMUNOLOGY

Programme: Ph.D		Year: I
Class: Microbiology		Semester: I
Credits: 4 Theory: 4 Practical: 0		Subject : MICROBIOLOGY
Course Code: DDSE 002		Title : IMMUNOLOGY
Course Objectives: CO1: To learn about the immune system and immune response of human body. CO2: To study the various classes of antigens and their structure and properties. CO3: To analyze various antigen antibody reactions. CO4: To understand the expression of regulations of immune response. CO5: To analyze the immunity of human body and to learn different immune essay. CO6: To understand the complement system.		
Nature of Paper: Core/DSE/SEC/GE/AECC [ELECTIVE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
Unit	Contents	No. of Lectures Allotted
I	Immune System immune system and immune response. Lymphocytes, their subpopulation, their properties and functions, membrane bound receptors of lymph cells, helper T cells, T cells suppression, lymphocyte trafficking.	06
II	Antigens and Immunoglobulin's Concept of haptens, determinants, conditions of antigen city antigens and immunogenicity, Super antigen. Immunoglobulin's: Structure and properties of immunoglobulin classes. Theories of Antibody formation, hybridoma technology for monoclonal antibodies and designer monoclonal antibodies.	06
III	Antigen- Antibody reaction Antigen-Antibody reaction by precipitation, agglutination and complement fixation. Non-specific immune mechanism:- Surface defences, tissue defenses, opsonisation, inflammatory reaction and hormone balance.	06
IV	Expressions and Regulation of Immune Response Regulation of immune response: antigen processing and presentation, generation of humoral and cell mediated immune response, activation of B and T lymphocytes, cytokines and their role in Immune regulation, T cell regulation, MHC restriction, immunological tolerance. Cell mediated cytotoxicity: Mechanism of T cells and NK mediated lysis, antibody dependent cell mediated cytotoxicity, and macrophage mediated cytotoxicity. Complement system	06
V	Immunity and Immunoassays Defense against bacteria, viruses, fungi and parasites. Immunodiagnostics and Immunotherapy in virology- Serological methods for detection and quantitation of viruses including Hepatitis, Influenza, HIV and others. Immuno-assays: SRID, ELISA, ELISA-PCR, RIA, western blotting.	06
References		

1. Abul Abbas, Andrew H. Lichtman and Shiv Pillai (2023). Basic Immunology 7th Edition. Elsevier
2. Charles A. Janeway, Paul Travers, Mark Walport and Mark J. Schlomchick (2005). Immunobiology 6th edition. Garland Science Publishing.
3. Donal M. Weir and John Steward (2020). Immunology 9th edition. ELBS, London
4. <http://mbbshelp.com/2017/03/31/lange-review-of-medical-microbiology-immunology-13th-edition/>
5. <http://www.immunology.utoronto.ca/online-learning>.
6. Ivan M. Roitt (2004) Essential Immunology 10th edition. Blackwell Scientific Publications, Oxford.
7. Kubly J (2018). Immunology 7th Edition. WH Freeman and Company, New York
8. Peter J. Delves, Seamus J. Martin, Dennis R. Burton and Ivan M. Roitt (2012). Roitt's Essential Immunology, 12th Edition. Wiley-Blackwell
9. Ananthanarayan and Paniker's Textbook of Microbiology (2020), Eleventh Edition Paperback – 3 July 2020 by R Ananthanarayan and CK Jayaram Paniker (Author), Reba Kanungo (Editor).
10. William E. Paul (2012). Fundamental Immunology Seventh edition. Lippincott Williams & Wilkins.

If the course is available as Generic Elective, then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

	Max. Marks:50
1) Class tasks/ Sessional Examination	20
2) Presentations /Seminar	-
3) Assignments	-
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	10
INTERNAL MARKS	30
EXTERNAL MARKS	70
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

- CLO1: Students will be able to explain about the immune system and immune response of human body.
- CLO2: Students will be able to understand various types of antigens and different classes of immunoglobulins.
- CLO3: Students will be able to analyze all types of antigen antibody reactions.
- CLO4: Students will be able to apply the knowledge to understand the complement system.
- CLO5: Students will be able to express the regulation of immune system.
- CLO6: Students will be able to analyze the overall immunity of human body and to explain various immunoassays.

DISCIPLINE SPECIFIC ELECTIVE COURSES
DDSE-009: MEDICAL MICROBIOLOGY

Programme: Ph.D		Year: I
Class: Microbiology		Semester: I
Credits: 4 Theory: 4 Practical: 0	Subject: MICROBIOLOGY	
Course Code:DDSE-009	Title: MEDICAL MICROBIOLOGY	
Course Objectives: CO1: To learn about introduction and history of medical microbiology CO2: To study the various classes of medically important microorganisms. CO3: To analyze various bacterial diseases and to learn the management of various bacterial diseases. CO4: To understand the mechanism of various human viral diseases. CO5: To analyze the mycosis and to study different types of mycoses and to learn some protozoan diseases. CO6: To understand the management prevention, treatment and laboratory diagnosis of various diseases.		
Nature of Paper: Core/DSE/SEC/GE/AECC : [ELECTIVE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
Unit	Contents	No. of Lectures Allotted
I	Introduction of Medical Microbiology History of medical microbiology, Contribution of Louis Pasteur and Robert Koch in medical microbiology, Koch's postulates & River's postulates, Role of Microbiology in Medicine, Classification of medically important microbes, Normal Microbial flora, Infection's Source, Mode of transmission, Prevention of medically important microbes.	06
II	Infectious Bacterial diseases: Causative agents, Pathogenesis, Transmission, Laboratory diagnosis, Clinical symptoms, Prevention and Treatment for bacterial diseases like Pharyngitis, Pyogenic infections, Diphtheria, Plague, Tuberculosis, Cholera, Typhoid, Peptic ulcer, Pneumonia, Tetanus, Leprosy, Meningitis, Gonorrhea,	06
III	Viral diseases: Etiology, prophylaxis, clinical symptoms and treatment for human viral diseases. Smallpox, Chicken pox, Dengue, COVID-19, Rabies, Viral hepatitis, Poliomyelitis, AIDS.	06
IV	Fungal and protozoan diseases: Cutaneous mycoses, systemic mycoses, opportunistic mycoses. Life cycle, diagnosis and treatment of following protozoan diseases – amoebiasis, Giardiasis, malaria, kala-azar.	06
V	Laboratory Diagnosis: Laboratory diagnosis of bacterial diseases, Laboratory diagnosis of mycological and Parasitological diseases, Laboratory diagnosis of viral diseases, Antibiotic sensitivity test. Molecular diagnosis.	06
References: 1. Eduardo A. Groisman (2001). Principles of Bacterial Pathogenesis, Academic Press. 2. Microbiology: A Human Perspective, E.W. Nester, D.G. Anderson, C.E. Roberts,		

3. Microbiology (2023), L.M. Prescott, J. P. Harley, D.A., Klein 12th edition.
4. Microbiology, by M. J. Pelczar, Jr., E.C.S.
5. Chan, Noel R. Kreig (2023), 5th edition.
6. Anantnarayan and Panikar's Text Book of Microbiology 11th Edition, Editor, Reba Kanugo (2020).
7. Major Infectious Diseases, Disease control Properties, 3rd edition, by King K. Holmes, Stefano Bertozzi, Barry R. Bloom and Prabhat Jha.

If the course is available as Generic Elective, then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology	
	Max. Marks:50
1) Class tasks/ Sessional Examination	20
2) Presentations /Seminar	-
3) Assignments	-
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	10
INTERNAL MARKS	30
EXTERNAL MARKS	70
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

- CLO1: Students will be able to explain about the introduction and history of medical microbiology.
- CLO2: Students will be able to understand various types of bacterial diseases, their pathogenesis, diagnosis, prevention and control.
- CLO3: Students will be able to analyze various types of viral infections.
- CLO4: Students will be able to apply the knowledge to understand the different types of fungal and protozoan diseases.
- CLO5: Students will be able to express the laboratory diagnosis of several bacterial, viral, fungal and protozoan diseases.
- CLO6: Students will be able to analyze the various diseases caused by a variety of microorganisms.

DISCIPLINE SPECIFIC ELECTIVE COURSES
DDSE-010: FERMENTATION TECHNOLOGY

Programme: Ph.D		Year: I
Class: Microbiology		Semester: I
Credits: 4 Theory: 4 Practical: 0	Subject: MICROBIOLOGY	
Course Code:DDSE-010	Title: FERMENTATION TECHNOLOGY	
Course Objectives: CO1: To learn about introduction and history and development of fermentation technology. CO2: To study the various types of fermentation processes. CO3: To analyze various types of designs and control of bioreactors. CO4: To understand the mechanism of downstream process. CO5: To understand the industrial production of various antibiotics, alcohol, amino acids etc. CO6: To study upstream bioprocess developments.		
Nature of Paper: Core/DSE/SEC/GE/AECC : [ELECTIVE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
Unit	Contents	No. of Lectures Allotted
I	Introduction: History and development, Microbes for different fermentation processes Isolation, preservation and improvement of microbial strains: Source of microbes, Isolation, selection and culture collection banks, Preservation of industrially important microbes; Sterilization techniques, Strain development.	06
II	Upstream bioprocess development: Growth and product formation Kinetics, processes optimization, Types of fermentation processes: Solid state and submerged fermentation, Batch, fed-batch and continuous fermentation strategies and their application, Types of fermenters (airlift, stirred tank and bubble column fermenter)	06
III	Bioreactor design and control: Basic functions and design (Body construction, agitators, mechanical seal, magnetic drives, baffles, sampling port) reynolds number, power input, fluid dynamics, oxygen transfer and utilization rate, measurements of volumetric mass-transfer coefficient KLa, instrumentation for online monitoring and controls	06
IV	Downstream process development: Membrane filtration, centrifugation and different types of industrial centrifuges designs, sedimentation, flocculation, cell disruption (physico-chemical, mechanical, enzymatic), liquid–liquid extraction, crystallization, spray drying and chromatography-based techniques for product recovery.	06
V	Industrial fermentation processes for production of: Antibiotics (penicillin, streptomycin, cephalosporins) amino acids (glutamic acid, lysine and phenylalanine), industrial alcohol (ethanol, butanol), recombinant enzymes and bio-therapeutic products, products of bioconversion processes.	06
References: 1. Principles of Fermentation Technology (4nd Edition, 2020) by P.F. Stanbury, W. Whitaker & S.J. Hall, Elsevier India Pvt. Ltd. New Delhi-110001.		

2. Bioprocess Engineering Principles (2022) by Academic Press/Elsevier India Pvt. Ltd. New Delhi-110001.
3. Bioprocess Engineering: Basic Concepts (2nd Edition, 2011) by Michael L. Shuler and Fikert Kargi Prentice Hall India learning Pvt. Ltd. New Delhi;
4. Biotechnology: A Text Book of Industrial Microbiology (2022) by W. Crueger & A. Crueger, Panima Publishing Corporation, New Delhi/Bangalore.
5. Modern Industrial Microbiology & Biotechnology (2019) by N. Okafer, Scientific Publishers, Enfield, USA.

If the course is available as Generic Elective, then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology	
	Max. Marks:50
1) Class tasks/ Sessional Examination	20
2) Presentations /Seminar	-
3) Assignments	-
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	10
INTERNAL MARKS	30
EXTERNAL MARKS	70
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

- CLO1: Students will be able to explain about the introduction and history of fermentation technology.
- CLO2: Students will be able to understand various types of bioreactors, their working, functioning and designs.
- CLO3: Students will be able to analyze downstream processing.
- CLO4: Students will be able to apply the knowledge to understand the upstream bioprocess development.
- CLO5: Students will be able to express the isolation, identification and improvement of the microbial strains for fermentation products.
- CLO6: Students will be able to analyze the production of various industrial products like antibiotics, amino acids, enzymes, alcohol etc.

DISCIPLINE SPECIFIC ELECTIVE COURSES
DDSE-011: CURRENT CONCEPTS AND TRENDS IN MICROBIOLOGY

Programme: Ph.D		Year: I
Class: Microbiology		Semester: I
Credits: 4 Theory: 4 Practical: 0	Subject: MICROBIOLOGY	
Course Code:DDSE-011	Title: CURRENT CONCEPTS AND TRENDS IN MICROBIOLOGY	
Course Objectives: CO1: To learn about development of antimicrobial resistance. CO2: To study the various new methods for antimicrobials. CO3: To analyze the microbiome of different parts of human body. CO4: To understand the mechanism of human microbiome in relation to human health and diseases. CO5: To understand the microbiology of food safety and food security. CO6: To study clinical biochemistry.		
Nature of Paper: Core/DSE/SEC/GE/AECC: [ELECTIVE]		
Minimum Passing Marks/Credits: 40% Marks / 4 Credits		
Unit	Contents	No. of Lectures Allotted
I	Antimicrobial resistance: An overview of the history and development of antimicrobials, Introduction and impact of antimicrobial resistance, Antimicrobial agents-Antibiotics, Anti-fungal, Anti-viral, antiprotozoan; Antibiotic classification and mechanisms of their action, Evolution and molecular mechanisms of antimicrobial resistance, multi-drug resistance, Antimicrobial susceptibility testing, Preventive and control strategies to control antimicrobial resistance.	06
II	New methods for antimicrobials: Antimicrobial Discovery and Developments: Antimicrobials and their usage in human medicine, Requirements to novel antimicrobial or alternatives, Screening and development approaches for new microbial natural product, High-content screening methods, antimicrobial in-vitro and in-vivo screening Assays.	06
III	Micro biome: An introduction of human micro biome, Human gut/oral/skin micro biota, current research methods of micro biome analysis including culture-dependent and culture-independent tools, whole genome vs. 16srRNA gene analysis of micro biome, role of human micro biome in health and communicable or non-communicable diseases (Cancer, Diabetes, Malnutrition etc), human gut micro biota and immunity, Role of micro biome in therapeutic and diagnostic. A brief overview of plant and animal micro biome.	06
IV	Food Safety and Security: Microbiology of food of animal and plant origin, Major Food borne diseases, Biological, chemical, and physical hazards of food, Microbiological testing of food, Hazard analysis and critical control points (HACCP), , Food and Drug Administration (FDA), Food Safety and Standards Authority of India (FSSAI), Basic concept & issues food security, genetically modified foods, climate change and food security, Nutrition and	06

	food security, Nutrition and infectious/non-communicable diseases.	
V	Clinical Biochemistry: Use of enzymes in the diagnosis and monitoring of myocardial infarction, liver diseases and pancreatic diseases. Normal and abnormal serum values of the enzymes and their significance, acid and alkaline phosphatase, SGOT, SGPT, α -amylase, LDH, creatine kinase, troponin T. Cancer: Molecular basis, carcinogenesis, oncogenes, benign and malignant, metastasis, tumor markers and tumor staging. Genetic disorders: Down's, Turner's and Lkintfelter's diseases. Infectious diseases at the outset of 21st century like AIDS, SARS, and Dengue. Inborn errors of metabolism, metabolic disorders, diabetes.	06

References:

1. Stefan Schwarz & Lina Maria Cavaco, Jianzhong Shen (2022). Antimicrobial Resistance in Bacteria from Livestock and Companion Animals, ASM Press.
2. Scott H. Podolsky (2023) The Antibiotic Era: Reform, Resistance, and the Pursuit of a Rational Therapeutics, Johns Hopkins University Press.
3. Susan L. Prescott & Alan C. Logan (2020). The Secret Life of Your Microbiome: Why Nature and Biodiversity are Essential to Health and Happiness, New Society Publishers.
4. Angela E. Douglas (2018) Fundamentals of Microbiome Science: How Microbes Shape Animal Biology, Princeton University Press.
5. Ian C. Shaw (2012). Food Safety: The Science of Keeping Food Safe, Wiley-Blackwell.
6. Hal Kin (2013) Food Safety Management: Implementing a Food Safety Program in a Food Retail Business, Springer.
7. Lewis H Ziska (2017). Agriculture, Climate Change and Food Security in the 21st Century Our Daily Bread, Cambridge Scholars Publishing.
8. Immunology by Roitt. Published by Mosby.
9. Lecture notes on Epidemiology and Community Medicines by Farner and Miller.

If the course is available as Generic Elective, then the students of following departments may opt it.
NO

Evaluation/Assessment Methodology

	Max. Marks:50
1) Class tasks/ Sessional Examination	20
2) Presentations /Seminar	-
3) Assignments	-
4) Research Project Report	-
Seminar On Research Project Report	-
5) ESE/Attendance	10
INTERNAL MARKS	30
EXTERNAL MARKS	70
TOTAL	100

Prerequisites for the course:

Course Learning Outcomes:

- CLO1: Students will be able to explain about the multi drug resistance and its mechanism.
 CLO2: Students will be able to understand discovery and development of new antimicrobials.
 CLO3: Students will be able to analyze the microbiome of different parts and systems of human body.
 CLO4: Students will be able to apply the knowledge to understand the microbiology of food safety and security.
 CLO5: Students will be able to express the use of enzymes in the diagnosis and monitoring of various diseases.
 CLO6: Students will be able to analyze the role of clinical biochemistry to manage various diseases.

School of Life Science & Technology

ACADEMIC HAND BOOK



Ph.D. Zoology Coursework

Evaluation Scheme

Evaluation Scheme

Ph.D. Zoology Coursework

The PhD course for the Research Scholars would consist of five papers. Out of these three papers would be compulsory, one optional (to be chosen from five options given as under) and one Oral/seminar-

S. No.	Subject Code	Subjects	Category	Periods			Marks					Credits
							Internal			External	Total	
				L	T	P	CT	TA	Total			
1	DBTC-113	Research Methodology	CORE	4	0	0	20	10	30	70	100	4
2	DZOC-112	Techniques in Biology	CORE	2	0	1	10	5	15	35	50	2
3	CPE-RPE	Research and Publication Ethics (RPE)	CORE	2	0	1	10	5	15	35	50	2
4	PHD-SP	Seminar/ Oral	DSE	2	0	0	0	0	50	0	50	2
Discipline Specific Elective Courses (Any one)												
1	DDSE -002	Immunology	Elective	4	0	0	20	10	30	70	100	4
2	DDSE -003	Molecular Biology	Elective	4	0	0	20	10	30	70	100	4
3	DDSE -005	Enzyme Technology	Elective	4	0	0	20	10	30	70	100	4
4	DDSE-006	Cell Biology	Elective	4	0	0	20	10	30	70	100	4
5	DDSE-010	General Zoology	Elective	4	0	0	20	10	30	70	100	4
TOTAL											350	14

Format-3

TECHNIQUES IN BIOLOGY (Credit: 2)
(CODE: DZOC-112)

UNIT-I

Analysing the application of techniques in animal sciences research: types of microscopy; microtomy.

NMR and ESR spectroscopy, structure determination using X-ray diffraction and NMR; analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.

UNIT - II

Ultracentrifugation (Velocity and buoyant density); Gel filtration, ion exchange & affinity chromatography; thin layer chromatography; gas chromatography; High pressure liquid chromatography (HPLC)

UNIT – III

Electrophoresis (starch, agarose, PAGE); Electrofocussing. Enzyme technology: Animal protein/enzyme purification; application of biosensor development in different systems

UNIT – IV

Histology and histochemistry: Fixation and sectioning of tissue, embryos and cells. Immunohistochemistry, immunofluorescence, histochemical staining for characterization of cell type.

UNIT – V

Nucleic acid hybridization and cot curves; Polymerase Chain reaction; measuring nucleic acid and protein interaction. Flow cytometry, Karyotyping; FISH & GISH; Spirometry; Animal tissue culture.

REFERENCES:

- Lehninger Principles of Biochemistry 6th Edition by David L. Nelson
- Wilson and Walkers Principles and Techniques Of Biochemistry And Molecular Biology 8Ed (2018) by HOFMANN A
- Research Methodology: A Step-by-Step Guide for Beginners Book by Ranjit Kumar

General Zoology (Credit:4)
(CODE: DDSE-010)

UNIT I

Human Biochemical Genetics : Inborn errors of metabolism – Amino acid metabolism, Phenylketonuria. Disorders of Purine metabolism: Lesh Nyhan syndrome. Disorders of carbohydrate metabolism – Galactosemia

Endocrinology- Structure, metabolism, control and functions of endocrine glands

UNIT II

Fisheries and Aquaculture-Study about breeding, rearing, and harvesting of fish, Importance of Aquaculture – Fish products and by-products.

UNIT III

Insect pest control – Natural control – Biological methods, Microbial methods, Chemical methods, Chemosterilant, Insect attractants, repellents, Antifeedants, Integrated pest control.

UNIT IV

Principle of Nematode management – physical methods (soil solarisation, hot water treatment, seed cleaning), cultural methods (deep ploughing, fallowing, crop rotation), biological control (antagonistic crops), chemical control – soil fumigants and nematode management.

UNIT V

Environmental pollution and their impact on animals – Different types of pollutant – acute and chronic toxicity; Bioassay LC₅₀ and LD₅₀ values Biomagnification, biodegradation and bioremediation.

REFERENCES:

- Fish and Fisheries of India, Jingran, VG. (Ed.), Hindustan Publishing Corporation, New Delhi.
- Human chromosomes – Orlando J. Miller, Eeva Therman – Springer Pub.
- Swarup, G and Dasgupta: Plant Parasitic Nematodes of India, Problems and progress. Indian Agricultural Research Institute, New Delhi-110012.
- Sastry K.V.: Endocrinology and Reproductive Biology. Rastogi Publications.
- Khan, M.R.: Plant Nematode Methodology, Morphology,