School of Life Science & Technology

ACADEMIC HAND BOOK

Ordinance & Academic
Regulations

BACHELOR OF SCIENCE IN CBZ (BIOLOGY)

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"meansatheoryorpracticalsubjectthatisnormallystudiedinasemester.
3. "Vice–Chancellor of IIMT-University" means the Head of the University.
4. "Registrar"istheHeadofallAcademicandGeneralAdministrationoftheUniversity.
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:**

Transformedcurriculumwilldevelopeducatedoutcome-orientedcandidature,fosteredwithdiscovery-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 as pects 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 interaction and increase awareness in judicious 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 worldwide 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 reproduction.
2. Plant disease auingmicrobes, symptoms & control.
3. Economic value of plants and their use in Human Welfare.

C. 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 environ mental conservation without compromising on academic rig our and our rich wealth of knowledge in herited 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 be ltplant 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 together with multi-dimensional and multi-disciplinary approach.

1. Understanding of plant classification systematic, evolution, ecology, developmental biology, physiology, biochemistry, plant inter actions with micro bes 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 bio informatics' tools and data bases and the application of statistics to bio logical data**.**
5. Entrepreneurship Skill Development, Understand the issues of environmental contexts and sustain able development, Inculcation of human values,
6. Strength en 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, bio chemistry, tax onomy 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 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, genitures each, 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 •Palae obotanist •Conservationist •Fruit Grower •Morphologist •Cytologist •Ethno botanist •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 wills inculcators' each aptitude and passion for higher education and scientific research.

8. **Admission:** 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. 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 lastinstructionaldayofthecourseandsubmittotheHoDthroughtheclassteacher.

A regular student shall not be permitted to appear in semester examination, unless he/she has regularly attended not less than 75% classe she ldinag gregate of all subjects. The university however may, condone the shortage 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 then tire 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 exceed1 0%.

- **Additional Condonation:**

  Additional condonation may be considered in rare and genuine cases which includes, approved leavefor 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 reputing 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 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.

ASSESMENT:

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 Filling (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:

Creditsaretheweightages,assignedtothecoursesbasedonthefollowinggeneralpattern:
For theory OneHour = 1credit
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 there commendation 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 there commendation 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 transfers ought needs to be considered. The maximum ber 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 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 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 auto mated:

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 questions ets, question paper generation,

vi. On lined 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 malpractices 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 string entpunishments 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

B.Sc. (CBZ) BIOLOGY Semester-I										
S.No.	**Course Code**	**Subject**	**Course Type**	**Study Scheme**			**Evaluation Scheme**			**Credit**
				L	**T**	**P**	**Internal**	**External**	**Total**	
1	BSBC-NP-111	Microbiology and Plant Pathology	Core 1	4	0	0	25	75	100	4
2	BSZC-NP-112	Cytology, Genetics and Infectious Diseases	Core 2	4	0	0	25	75	100	4
3	BSCC-NP-113	Fundamentals of Chemistry	Core 3	4	0	0	25	75	100	4
4	NHU-N-111	English Communication/ Environment & Ecology	AECC 1	3	0	0	15	35	50	3
5	GENCC-101	NCC	Gen E	2	0	0	0	0	0	2
6	NECC-112	University Social Responsibility	USEC	0	0	0	25	0	NC	0
PRACTICALS										
8	BSBC-NP-111P	Techniquesin Microbiology & PlantPathology Lab	Core 1	0	0	2	20	30	50	2
9	BSZC-NP-112P	Cell Biology & Cytogenetics Lab	Core 2	0	0	2	20	30	50	2
10	BSCC-NP-113P	Quantitative Analysis Lab	Core 3	0	0	2	20	30	50	2
		TOTAL		**0**	**0**	**0**	**150**	**350**	**500**	**0**
11	SPT-111	Sports	USEC	0	0	0	50	0	NC	0
21 (23 including NCC)										

B.Sc. (CBZ) BIOLOGY Semester-II										
S. No.	**Course Code**	**Subject**	**Course Type**	**Study Scheme**			**Evaluation Scheme**			**Credit**
				L	**T**	**P**	**Internal**	**External**	**Total**	
1	BSBC-NP-121	Archegoniates and Plant Architecture	Core 4	4	0	0	25	75	100	4
2	BSZC-NP-122	Biochemistry and Physiology	Core 5	4	0	0	25	75	100	4
3	BSCC-NP-123	Bioorganic and Medicinal Chemistry	Core 6	4	0	0	25	75	100	4
4	NHU-N-121	Environment & Ecology/ English Communication	AECC 2	3	0	0	15	35	50	3
5	CBZGE-NP-124a	Soil Health Assessment	GE 1	4	0	0	25	75	100	4
	CBZGE-NP-124b	Disaster Management System in India								
6	GENCC-201	NCC	Gen E	2	0	0	0	0	0	2
7	NECC-122	University Social Responsibility	USEC	0	0	0	25	0	NC	0
8	NECC-124	MOOCs/ SWAYAM/	SEC 1	2	0	0	50	0	50	2
PRACTICALS										
9	BSBC-NP-121P	Land Plants Architecture Lab	Core 4	0	0	2	20	30	50	2
10	BSZC-NP-122P	Physiological, Biochemical & Haematology Lab	Core 5	0	0	2	20	30	50	2
11	BSCC-NP-123P	Biochemical Analysis Lab	Core 6	0	0	2	20	30	50	2
		TOTAL		**0**	**0**	**0**	**225**	**425**	**650**	
12	SPT-121	Sports	USEC	0	0	0	50	0	NC	0
27 (29 including NCC)										

B.Sc. (CBZ) BIOLOGY Semester-III										
S. No.	Course Code	Subject	Course Type	Study Scheme			Evaluation Scheme			Credit
				L	T	P	Internal	External	Total	
1	BSBC-NP-231	Flowering Plants Identification & Aesthetic Characteristics	Core 7	4	0	0	25	75	100	4
2	BSZC-NP-232	Molecular Biology, Bioinstrumentation & Biotechniques	Core 8	4	0	0	25	75	100	4
3	BSCC-NP-233	Chemical Dynamics & Coordination Chemistry	Core 9	4	0	0	25	75	100	4
4	UPS-301	Professional Skills	AECC 3	3	0	0	15	35	50	3
5	CBZGE-NP-234a	Herbal Technology	GE 2	4	0	0	25	75	100	4
	CBZGE-NP-234b	Biostatistics								
6	GENCC-301	NCC	GenE	2	0	0	0	0	0	2
7	NECC-232	University Social Responsibility	USEC	0	0	0	25	0	NC	0
PRACTICALS										
9	BSBC-NP-231P	Plant Identification technology Lab	Core 7	0	0	2	20	30	50	2
10	BSZC-NP-232P	Bioinstrumentation & Molecular Biology Lab	Core 8	0	0	2	20	30	50	2
11	BSCC-NP-233P	Physical Analysis Lab	Core 9	0	0	2	20	30	50	2
		TOTAL		**0**	**0**	**0**	**175**	**425**	**600**	**0**
12	SPT-231	Sports	USEC	0	0	0	50	0	NC	0
25 (27 including NCC)										

B.Sc. (CBZ) BIOLOGY Semester-IV										
S. No.	**Course Code**	**Subject**	**Course Type**	**Study Scheme**			**Evaluation Scheme**			**Credit**
				L	**T**	**P**	**Internal**	**External**	**Total**	
1	BSBC-NP-241	Economic Botany, Ethnomedicine and Phytochemistry	Core 10	4	0	0	25	75	100	4
2	BSZC-NP-242	Diversity of Non-Chordates, Parasitology and Economic Zoology	Core 11	4	0	0	25	75	100	4
3	BSCC-NP-243	Quantum Mechanics and Analytical Techniques	Core 12	4	0	0	25	75	100	4
4	UVE-401	Human Values	AECC 4	3	0	0	15	35	50	3
5	GENCC-401	NCC	Gen E	2	0	0	0	0	0	2
6	NECC-242	University Social Responsibility	USEC	0	0	0	25	0	NC	0
7	NECC-244	MOOCs/ SWAYAM	SEC 2	2	0	0	50	0	50	2
PRACTICALS										
8	BSBC-NP-241P	Commercial Botany and Phytochemical Analysis Lab	Core 10	0	0	2	20	30	50	2
9	BSZC-NP-242P	Diversity of Non-Chordates, Parasitology and Economic Zoology Lab	Core 11	0	0	2	20	30	50	2
10	BSCC-NP-243P	Instrumental Analysis Lab	Core 12	0	0	2	20	30	50	2
		TOTAL		**0**	**0**	**0**	**200**	**350**	**550**	**0**
11	SPT-241	Sports	USEC	0	0	0	50	0	NC	0
23 (25 including NCC)										

B.Sc. (CBZ) BIOLOGY Semester-V										
S.No.	**Course Code**	**Subject**	**Course Type**	**Study Scheme**			**Evaluation Scheme**			**Credit**
				L	**T**	**P**	**Internal**	**External**	**Total**	
1	BSBC-NP-351	Plant Physiology, Metabolism and Biochemistry	Core 13	4	0	0	25	75	100	4
2	BSZC-NP-352	Diversity of Chordates and Comparative Anatomy	Core 14	4	0	0	25	75	100	4
3	BSCC-NP-353	Organic Synthesis A	Core 15	4	0	0	25	75	100	4
4	CBZ-RP-351	Industrial Training/ Survey/ Research Project	Industrial Training/ Research Project	0	0	0	25	75	100	4
5	GENCC-501	NCC	Gen E	2	0	0	0	0	0	2
6	NECC-352	University Social Responsibility	USEC	0	0	0	25	0	NC	0
PRACTICALS										
7	BSBC-NP-351P	Plant Physiology, Metabolism and Biochemistry Lab	Core 13	0	0	2	20	30	50	2
8	BSZC-NP-352P	Diversity of Chordates and Comparative Anatomy Lab	Core 14	0	0	2	20	30	50	2
9	BSCC-NP-353P	Qualitative Analysis Lab	Core 15	0	0	2	20	30	50	2
		TOTAL		**0**	**0**	**0**	**160**	**390**	**550**	**0**
10	SPT-351	Sports	USEC	0	0	0	50	0	NC	0
22(24 including NCC)										

B.Sc. (CBZ) BIOLOGY Semester-VI										
S. No.	**Course Code**	**Subject**	**Course Type**	**Study Scheme**			**Evaluation Scheme**			**Credit**
				L	**T**	**P**	**Internal**	**External**	**Total**	
1	BSBC-NP-361	Cytogenetics, Plant Breeding and Nanotechnology	Core 16	4	0	0	25	75	100	4
2	BSZC-NP-362	Ethology, Evolutionary and Developmental Biology	Core 17	4	0	0	25	75	100	4
3	BSCC-NP-363	Organic Synthesis B	Core 18	4	0	0	25	75	100	4
4	CBZ-RP-361	Industrial Training/ Survey/ Research Project	Industrial Training /Research Project	0	0	0	25	75	100	4
5	GENCC-601	NCC	Gen E	2	0	0	0	0	0	2
6	NECC-362	University Social Responsibility	USEC	0	0	0	25	0	NC	0
7	NECC-364	MOOCs/ SWAYAM/	SEC 3	2	0	0	50	0	50	2
PRACTICALS										
8	BSBC-NP-361P	Cytogenetics, Plant Breeding and Nanotechnology Lab	Core 16	0	0	2	20	30	50	2
9	BSZC-NP-362P	Ethology, Evolutionary and Developmental Biology Lab	Core 17	0	0	2	20	30	50	2
10	BSCC-NP-363P	Organic Synthetic Lab	Core 18	0	0	2	20	30	50	2
		TOTAL		**0**	**0**	**0**	**210**	**390**	**600**	**0**
11	SPT-361	Sports	USEC	0	0	0	50	0	NC	0
24(26 including NCC)										

Format-1

Format 1

College/ School: Life Science & Technology Programme: B.Sc. CBZ (Biology) Duration: 6 Semester/ 3 Years										Credit range: 120 to 150 (Suggested by CBCS Committee)
COURSE	**CREDIT**	**SEMESTER**	**CORE (Th 4+P 2)**	**DSE (Th 4+P 2)**	**AECC (Th 3)**	**SEC (Th 1+1)**	**GE (Th 4)**	**GENE (2)**	**Industrial Training/ Survey Project (4)**	**Total Credits**
Certificate Course in Microbial Technology and Classical Botany	48	Ist	C1-Microbiology and Plant Pathology C 2-Cytology, Genetics and Infectious Diseases C-3-Fundamentals of Chemistry		AECC 1-English Communication / Environment & Ecology			NCC		21
		2nd	C4-Archegoniates and Plant Architecture C5-Biochemistry and Physiology C-6-Bioorganic and Medicinal		AECC 2-English Communication / Environment & Ecology	SEC 1-MOOCs/ SWAYAM	Soil Health Assessment/ Disaster Management System in India	NCC		27

			Chemistry							
Diploma in Plant Identification, Utilization & Ethnomedicine	96	3rd	C 7-Flowering Plant Identification and Aesthetic characteristics C-8-Molecular Biology, Bio-instrumentation and Biotechniques C-9-Chemical Dynamics and Coordination Chemistry		AECC-3-Professional Skills		Herbal Technology/ Biostatistics	NCC		25
		4th	C-10-Economic Botany, Ethnomedicine and Phytochemistry C-11-Diversity of Non-Chordates, Parasitology and Economic Zoology C-12-Quantum Mechanics and Analytical Techniques		AECC 4-Human Values	SEC 2-MOOCs/ SWAYAM		NCC		23

Bachelor of Science in CBZ	142	5th	C-13-Plant Physiology, Metabolism and Biochemistry C-14-Diversity of Chordates and Comparative Anatomy C-15-Organic Synthesis A					NCC	Industrial Training/ Survey/ Research Project	22
		6th	C-16-Cytogenetics, Plant Breeding and Nanotechnology C-17-Ethology, Evolutionary and Developmental Biology C-18-Organic Synthesis B			SEC 3-MOOCs/ SWAYAM		NCC	Industrial Training/ Survey/ Research Project	24

Format-2

Format-2

1. **After the completion of II, IV and VI Semester**

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-Microbiology and Plant Pathology (Th.4 Cr.+ P 2Cr.) ii) C 2-Cytology, Genetics and Infectious Diseases(Th.4 Cr.+ P 2Cr.) iii)C-3-Fundamentals of Chemistry iv) AECC-1-English Communication/ Environment & Ecology (Th.3 Cr)	4+2 4+2 4+2 3	8 8 8 3	60+60 60+60 60+60 45	i)C1-Microbiology and Plant Pathology ii) C 2-Cytology, Genetics and Infectious Diseases iii)C-3-Fundamentals of Chemistry iv) AECC-1- English Communication	Unit=8/Period=60 Unit=8/Period=60 Unit=8/Period=60 Unit=5/Period=45	40% Marks in 12th with a subject of life Science/ Biology (PCB)	Agriculture/ B. Pharm N/A N/A N/A

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

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

1. PO1: Work in different laboratories of life sciences as technical research assistant.
2. PO2: differentiate between the groups of different plants
3. PO3: Understand the chemical components of life and their importance.
4. PO4: Identify the plant diseases on the basis of their symptoms.
5. PO5: Assess the quality of the soil which is an important aspect 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 has been 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:

PSO1: Diversity of plants and micro best heir habitat, morphology, architecture and reproduction.

PSO2: Plant disease causing microbes, symptoms & control.

PSO3: Economic value of plants and their use in Human Welfare.

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-Flowering plant identification and aesthetic characteristics (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i)C 7-Flowering plant identification and aesthetic characteristics	Unit=8/Period=60	40% Marks in 12th 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	ii) 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.) ii) C-11-Diversity of Non-Chordates, Parasitology and Economic Zoology (Th.4 Cr.+ P 2Cr.) iii) C-12-Quantum Mechanics and Analytical Techniques (Th.4 Cr.+ P 2Cr.) iv) AECC-4-Human Values (Th.3 Cr) iv) SEC-2 MOOCs/Swayam (Th. 2)	4+2 4+2 4+2 3 2	8 8 8 3 2	60+60 60+60 60+60 45 30	i)C-10-Economic Botany, Ethnomedicine and Phytochemistry ii) C-11-Diversity of Non-Chordates, Parasitology and Economic Zoology iii) C-12-Quantum Mechanics and Analytical Techniques iv)AECC-4-Human Values iv) SEC-2 MOOCs/Swayam	Unit=8/Period=60 Unit=8/Period=60 Unit=8/Period=60 Unit=5/Period=45 Unit=5/Period=30	40% Marks in 12th 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 N/A N/A N/A 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 rig our and our rich wealth of knowledge inherited over generations.

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.

PSO2: The course is designed to become a commercial crop grower, florist and 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 12th 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 12th 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.
			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		N/A
			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		N/A
			iv) SEC-3 MOOCs/Swayam (Th.2)	2	2	30	iv) SEC-3 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: CBCS syllabus with a combination of general and specialized education shall introduce the concepts of 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 healthcare 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 interaction, increase awareness in judicious use of plant resources by recognizing the ethical value system.

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 back bone of this framework whereas discipline electives, generic electives and skill enhancement courses would add academic excellence in the subject together with multi-dimensional and multi disciplinary approach.

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

PO4: The training provided to the students will make them competent enough for doing jobs in Govt. and private sectors of academia, research and industry along with graduate preparation for national as well as international competitive examinations, especially UGC-CSIR NET , IFS, FRI, FCI, UPSC Civil Services Examination, BSI, NSC, etc.

PO5: Certificate and diploma courses are framed to generate self- entrepreneurship and self-employability, if multi exit option is opted.

PO6: By drawing attention towards the knowledge of worldwide plants and their domestication, lifelong learning may be achieved.

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

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.

16. Understanding of various life forms of plants, morphology, anatomy, reproduction, genetics, microbiology, molecular biology, recombinant DNA technology, transgenic technology and use of bio informatics tools and databases and the application of statistics to biological data**.**

17. To Entrepreneurship Skill Development, Understand the issues of environmental contexts and sustain able development, Inculcation of human values,

18. To strengthen mathematical and computational skills. Enable students to use ICT & AI effectively.

19. To 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, bio chemistry, 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 equipment 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 bio technology.

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 agri culture or forestry, oil, chemical, bio technology, 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 •Pale botanist •Conservationist •Fruit Grower •Morphologist •Cytologist •Ethno botanist •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.

Format-3

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: 06 Theory: 04 Practical: 02	**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, Bio fertilizers, 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	
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	8

	and Quorum sensing, Bacterial Growth curve, Factors affecting growth of 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- *Nostoc, Chlorella, Volvox, Oedogonium, Chara; Sargassum.* 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 Synchytrium: **Zygomycotina**: *Rhizopus,* **Ascomycotina:** *Saccharomyces, Penicillium.* **Basidiomycotina**: *Ustilago, Puccinia, Agaricus;* **Deuteromycotina**: *Fusarium, Alternaria. Heterothallism, Heterokaryosis &Parasexuality.*	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 IIndary 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, *Alternaria* 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 bio fertilizers, blue green algae, Azolla and mycorrhiza. Introduction to: Plant growth promoting rhizobacteria & bio pesticides-Trichoderma sp. and Pseudomonas, Single cell proteins (Spirulina), Organic farming inputs, Microbiology of water, Biopolymers, Bio indicators, Biosensors, Bioremediation, Production of bio fuels, Biodegradation of	8

	Pollutants and bio deterioration of materials & cultural property. Microbial bio factories (*E. coli* 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: 06 Theory: 04 Practical: 02	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: 40% Marks

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, Gelatinlique faction test, Urease test, Nitratereduction test, Catalase test, Oxidase test, Starch hydrolysis, Case in hydrolysis. 8. Antibacterial potential of natural products 9. Replica plating 10. Bacterial transformation 11. Bacterial gene induction 12. Bacterio phage 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-*Spirulina, Nostoc, Chlorophyceae-Chlorella, Volvox, Oedoganium, Cladophora and Chara;* *Xanthophyceae- Vaucheria;* Bacillariophyceae-*Pinnularia,* Phaeophyceae-*Sargassum,* Rhodophyceae-*Polysiphonia.*	**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, Fewviral 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 *rhizospheretonon- rhizo* sphere population of bacteria. 3. Isolation of antagonistic Pseudomonas from soil. 1. Isolation of *Azospirillum* sp. from the roots of grasses. 2. Microscopic observations of root colonization by VAM fungi. 3. Isolation of phyllosphere microflora. 4. 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 Spirulina & Chlorella in lab for bio fuel. 2. Visit to NBAIM, Mau, Varanasi (Kashi)/IMTECH (Institute of Microbial Technolgy), Chandigarh for viewing culture Repository 3. Visit to biofertilizers and bio pesticide unitto understand about the Unitoperation 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 Microbiolgy, 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: 06 Theory: 04 Practical: 02	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

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 *Rhynia*, Classification (upto family)	**8**
	with examples. Heterospory and seed habitat, Stelar evolution. Economic importance of pteridophytes. Comparative study of morphology, anatomy and reproduction of *Selagenella, Equisetum, Pteris.*	
Unit III	**Gymnosperms** Classification and distribution of Gymnosperms; Salient features of Cycadales, Ginkgoales, Coniferales and Gnetales, their examples with	**8**

	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. IIndary Growth- root and stem- cambium (structure and function), annual rings, periderm, Anomalous IIndary growth- *Bignonia, Boerhaavia, Dracaena, Nyctanthes.*	**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 $12^{th}$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: 06 Theory: 04 Practical: 02	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: 40% Marks

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, Archaegoniophore, 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:** *Lycopodium*: Habit, stem, T.S. Strobilus, V.S. *Selaginella*: Habit, rhizophore T.S. Stem, T.S. axis of strobilus, V.S. Strobilus, Megasporophyll and	**7**

	microsporophyll. *Equisetum*: Habit, rhizome and T.S. and V.S. of strobilus. *Azolla*: 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: Brach 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 Palaeoscienceorvvirtual 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 IIndary thickening: Bignonia, Dracaena, Boerhaavia and Nyctanthes. Study of primary and IIndary 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, Crotolaria, 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:**	**8**

<table>
<tr><td></td><td>1. Azolla production
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.</td><td></td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="3">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.</td></tr>
</table>

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: 04 Theory: 04	Subject: **Botany**
Course Code: CBZGE-NP-124a	**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 agroeco systems.
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

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, Inter science 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.

Format-3

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: 04 Theory: 04	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

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 manmade 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: 06 Theory: 04 Practical: 02	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

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)**	**7+1=8**

	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.	
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: 1 Year: 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 byO.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 12thfrom 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.

Foramt-3

IIMTU-NEP IMPLEMENTATION
Year: **II** / Semester: **III**

<table>
<tr><td colspan="2">Programme:B.Sc. (CBZ)
Certificate/Diploma/Degree/Diploma In Plant Identification, Utilization & Ethnomedicine
UG(R)/PG/Ph.D.
Class : Diploma</td><td colspan="2">Year: II
Semester: III</td></tr>
<tr><td colspan="2">Credits: 06
Theory: 04
Practical: 02</td><td colspan="2">Subject: Botany</td></tr>
<tr><td colspan="2">Course Code:
BSBC-NP-231P</td><td colspan="2">TITLE: PLANT IDENTIFICATION AND TECHNOLOGY LAB</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 4
T:
P: 4(In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)</td></tr>
<tr><th>Unit</th><th colspan="2">Contents
(Minimum any three from each unit, based on the facilities)</th><th>No. of Lectures Allotted</th></tr>
<tr><td>I</td><td colspan="2">Topic: Herbarium: Plant Collection, Preservation and Documentation:
Stepwise practicing Herbarium techniques: (A) FIELD EQUIPMENTS, Global Positioning System (GPS) instrument and collection ofany 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.</td><td>7</td></tr>
<tr><td>II</td><td colspan="2">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 Bentham and Hooker system of classification in the following families:</td><td>8</td></tr>
</table>

	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.

Foramt-3

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: 06 Theory: 04 Practical: 02	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

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 CARI. Tribal knowledge towards disease diagnosis, treatment, medicinal plants, plant conservation and cultivation.	**8**
VI	**Medicinal aspects** Study of common plants used by tribes (*Aegle marmelos, Ficus religiosa, Emblica officinalis, Eclipta alba,Rauvolfia serpentina, Oxalis and Ocimum sanctum*) 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: *Tinospora,Acorus, Ocimum*, 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 *Adhatodavasica, Andrographis paniculata, Azadirachta indica, Coriandrum sativum, Datura metel, Eclipta alba, Emblica officinalis, Ocimum sanctum, Phyllanthus amarus, Ricinus Communis, Catharanthus roseus* and *Zingiber officinale.*	**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-Pharmocognacy- Nirali Prakashan, New Delhi.
7. Modern Kitchen Garden by Dr. Minu Gupta.

Evaluation/Assessment Methodology	
	Max. Marks
1) Sessional Examination 2) Assignments 3) Attendance 4) ESE	**16** **5** **4** **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.

Format-3

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: 06 Theory: 04 Practical: 02	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 ethno botanical 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: 40% Marks

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 Micro technique:** 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. *Aegle marmelos, Ficus religiosa, Cynodondactylon*. Visit a tribal area and collect information's on their traditional method of treatment using crude drugs. Familiarize with at least 5 folk medicines and study the cultivation, extraction and its medicinal application. Observe the plants of ethno botanical 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. Veinislet Number. E. Palisade Ratio. F. Fibres and vessels (maceration) G. Starch test H. Protein and Lipid test.	**8**
VIII	**Phyto chemistry:** 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 phyto chemical 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.

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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: 06 Theory: 04 Practical: 02	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

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.	**7**

	Photosynthesis: Pigments, Action spectra and enhancement effect, Electron Transport system and Photophosphorylation, C3 and C4 Photosynthesis, CAM reaction and significance. Photorespiration.	
V	**Plant Development, Movements, Dormancy & Responses:** 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.	**8**
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, prostaglandings, Introduction of lipid micelles, Monolayers and bilayers.	**8**
VII	**Proteins:** Structure of Amino acids; Peptide bonds; Levels of protein structure-Primary, IIndary, 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, Allostericenzymes and Abzymes. Elementary phytonutrients, Neutraceuticals, dietary Suppliments 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: 06 Theory: 04 Practical: 02	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: 40% Marks

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.	**8**
	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.**	**8**

	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 HCO3 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.	
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, neutraceuticals & 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 *E. coli* 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** 1. Study of experiments establishing nucleic acid as genetic material (Avery et al, Griffith's, Harshey and Chase's and Fraenkel and Conrat's experiment)	**7**

	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, Flavr Savr 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.

Format-3

IIMTU-NEP IMPLEMENTATION

Year: **III** / Semester: **XI**

Programme:B.Sc. (CBZ) Certificate/Diploma/Degree/ **Bachelor Of Science In CBZ** UG(R)/PG/Ph.D. Class:**DEGREE**	**Year: III** **Semester: VI**
Credits: 06 Theory: 04 Practical: 02	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

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, IIndary 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 abrrations), 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	**7**

	chromosomes; Patterns of sex determination in plants.	
III	**Plant Breeding** Plant introduction. Agencies of plant introduction in India. Procedure of 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.	8
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 tendacy- Arithmatic 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 Bioststistics- 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 IIndary metabolite production	8
VI	**Nanotechnology** Nanoscaleassembly 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, Magentosomes, Nanopesticides, Nano-fertilizers, nano sensors.	7
VII	**Artificial Intelligence in Plant Science** Elementary Idea of Big data Analytics, Block Chain Technology, 3-D Printing, Machine learning, Alogithms 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 use interference. IoT application development or 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 12thfrom 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.

Format-3

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: 06 Theory: 04 Practical: 02	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: 40% Marks

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.	7
	4. Hybridization: Procedure of hybridization 5. heterosis and its exploitation in the plant breeding,	7
IV	**Problems related to Biostatistics** 1. Datasample, 2. Population, 3. Random Sampling, 4. Frequency distribution	8

	5. Arithmatic 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. Nanoscaleassembly 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. Alogithms 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. Pradap Prajanan (Hindi) Hardcover- 1st January 2016 by Chandra Prakash Shuki (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.

Format-3

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: 06 Theory: 04 Practical: 02	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, steriochemistry and major and minor products of any organic reaction.
5. The chapters Steriochemistry 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

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 Borrn-Haber cycle, solvation energy, and solubility of ionic solids.	12
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,C2,B_2,F_2,CO, NO, and their ions)	12

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 engths 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	**Steriochemistry:** 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, disasteromers, meso compounds, inversion, retention and recemization. Relative and absolute configuration, sequence rules, R & S systems of nomenclature. Geometric isomerism – determination of configuration of geometric isomers, E & Z system of nomenclature. Conformational isomerism – conformational analysis of ethane and n-butane; conformations of cyclohexane.	11
VII	**Basic Computer system (in brief):** Hard ware and Software; Input devices, Storage devices, Output devices,CentralProcessingUnit(ControlUnitandArithmeticLogicUnit);Numbers ystem(Binary, Octal and Hexadecimal Operating System); Computer Codes (BCD and ASCII)**;** Numeric/String constants and variables.	05

Reference / Text Books:

1. Lee, J.D. Concise Inorganic Chemistry, Pearson Education2010
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 Mc Daniel, 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 Publications1962.
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., Guiliano, 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,*2ndedition, 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 2) Assignments 3) Attendance 4) ESE	**16** **5** **4** **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:

- 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.

Format-3

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: 06 Theory: 04 Practical: 02	Subject: **Chemistry**	
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: 40% Marks		
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. *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
4. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
5. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Edition

Evaluation/Assessment Methodology

	Max. Marks
1) Lab Performance	10
2) Attendance	5
4) Record	5
3) 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:
1. Potability tests of water samples.
2. Estimation of metal ions in samples
3. Estimation of alkali and acid contents in samples
4. Estimation of inorganic salts and hydrated water in samples

Format-3

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: 06 Theory: 04 Practical: 02	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

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 offructose. Inter conversions of sugars (ascending and descending of sugarseries, 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 amino acids,* 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 specifity), 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; Drug action-receptor theory. Structure–activity relationships of drug molecules, binding role of–OH group,-NH_2 group, double bond and aromatic ring. Synthesis of Aspirin, paracetamol.	10
V	**Solid State:** Definition of space lattice, unit cell. Laws of crystallography. X-ray diffraction by crystals. Derivation of Bragg equation.	05
VI	**Introduction to Polymer:** Monomers, Oligomers, Polymers and their characteristics, Classification of polymers: Natural synthetic, linear, cross linked and network; plastics, elastomers, fibres, Homo polymers and Co-polymers, Bonding in polymers: Primary and secondary bond forces in polymers; cohesive energy, and decomposition of polymers.	10
VII	**Mechanism of Polymerization:** Polymerization techniques, Mechanism 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, phenolphthalein.	05

Reference / Text Books:

1. Davis, B. G., Fairbanks, A. J., *Carbohydrate Chemistry*, Oxford Chemistry Primer, Oxford University Press.
2. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
3. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.,* W. H. Freeman.
4. Berg, J. M., Tymoczko, J. L. & Stryer, L. *Biochemistry 7th Ed.,* W. H. Freeman.
5. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Patrick, G. L. Introduction to Medicinal Chemistry, Oxford University Press, UK,2013.
7. Singh, H. & Kapoor, V.K. Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi, 2012.
8. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13(2006).
9. Ball, D. W. Physical Chemistry Thomson Press, India (2007).

10. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
11. R.B. Seymour & C.E. Carraher: *Polymer Chemistry: An Introduction,* Marcel Dekker, Inc. New York, 1981.
12. G. Odian: *Principles of Polymerization*, 4^{th}Ed.Wiley, 2004.
13. F.W. Billmeyer: *Textbookof Polymer Science*, 2^{nd}Ed. Wiley Interscience, 1971.
14. P. Ghosh: Polymer Science & Technology, 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.

Format-3

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: 06 Theory: 04 Practical: 02	Subject : **Chemistry**
Course Code: BSCC-NP-123P	**Title : Biochemical Analysis Lab**

Course Objectives:
This course will provide basic qualitative and quantitative experimental knowledge of bio molecules 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: 40% Marks

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. To determine the iodine value of anoil/fat Estimation 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 3. Synthesis of propranolol	13

Reference / Text Books: 1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012). 2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education. 3. *Vogel's Qualitative Inorganic Analysis*, Revised by G. Svehla. 4. Vogel, A.I. *A Textbook of Quantitative Analysi*s, ELBS.1986 5. Furniss, B.S.; Hannaford, A.J.; Rogers, V.; Smith, P.W.G.; Tatchell, A.R. *Vogel's Textbook of Practical Organic Chemistry*, ELBS. 6. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,* Universities Pres 7. Cooper, T.G. Tool of Biochemistry. Wiley-Blackwell (1977). 8. Wilson, K. & Walker, J. Practical Biochemistry. Cambridge University Press (2009). 9. Varley, H., Gowenlock, A.H & Bell, M.: Practical Clinical Biochemistry, Heinemann,

Evaluation/Assessment Methodology	
	Max. Marks
1) Lab Performance 2) Attendance 4) Record 3) ESE	10 5 5 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 bio molecules 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.	

Format-3

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: 06 Theory: 04 Practical: 02	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.
   Inorganic spectroscopy and its various factors and usefulness of it in chemistry.

Nature of Paper: **Core**

Minimum Passing Marks/Credits: 40% Marks

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	**Phase Equilibrium**: Statement and meaning of the terms-phase, component and degree of freedom, derivation of Gibbs phase rule, phase equilibriums of one component system– water systems.	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 isotherms of Van der Waals equation, relationship between critical	10

	constants and Van der Waals constants.	
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.	05
VI	**Coordination Chemistry:** **Coordinate bonding:** Double and complex salts. Werner's theory of coordination complexes, classification of ligands, ambidentatelig and, 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** Metal- ligand bonding in transition metal complexes, limitations of valance bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planner complexes, factors affecting the crystal-field parameters.	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 $[Ti(H_2O)_6]^{3+}$ complex ion. **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, Wiley1995
5. Lee, J.D, Concise Inorganic Chemistry 4th EditionELBS,1977
6. Douglas, B, Mc Daniel, D and Alexander, J, Concepts of Models of Inorganic Chemistry, John Wiley & Sons; 3rd edition,1994
7. Shriver, D. EAtkins, P.W and Langford, C. H, Inorganic Chemistry, Oxford University Press,1994.
8. Porterfield ,W.W, Inorganic Chemistry, Addison Wesley1984.
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 2) Assignments 3) Attendance 4) ESE	**16** **5** **4** **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.

Format-3

IIMTU-NEP IMPLEMENTATION
Year: **II** / Semester: **III**

<table>
<tr><td colspan="2">Programme : B.Sc (CBZ)
Certificate/Diploma/Degree/
UG(R)/PG/Ph.D.
Class: Diploma</td><td>Year: II

Semester: III</td></tr>
<tr><td colspan="2">Credits: 06
Theory: 04
Practical: 02</td><td>Subject: Chemistry</td></tr>
<tr><td colspan="2">Course Code:
BSCC-NP-233P</td><td>Title: Physical Analysis Lab</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="3">Nature of Paper: Core</td></tr>
<tr><td colspan="3">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="3">L: 4
T:
P: 4
Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)
Practical- 2 Hrs.=1 Credit (4Hrs./Week=2Credits)</td></tr>
<tr><th>Unit</th><th>Contents</th><th>No. of Lectures Allotted</th></tr>
<tr><td>I</td><td>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</td><td>20</td></tr>
<tr><td>II</td><td>Surface Tension and Viscosity
1. Determination of surface tension of pure liquid or solution.
2. Determination of viscosity of liquid pure liquid or solution.</td><td>06</td></tr>
<tr><td>III</td><td>Boiling point and Transition Temperature
1. Boiling point of common organic liquid compounds n buty l alcohol, cyclohexanol, ethyl methyl ketone, cyclohexanone, acetylacetone, isobutyl methyl ketone, isobutyl alcohol, acetonitrile, benzaldehy dean dace tophenone. [Boiling points of the chosen organic compounds should preferably be within180^0 C].
2. Transition Temperature, Determination of the transition temperature of the given substance by thermometric/dialometric method (e.g. $MnCl_2.4H_2O/SrBr_2.2H_2O$)</td><td>14</td></tr>
</table>

IV	**Phase Equilibrium** 1. To study the effect of a solute (e.g. NaCl, succinic acid) on the critical 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) system by cooling curve method.	**20**

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**

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.

Format-3

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: 06 Theory: 04 Practical: 02	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.
   To develop basic skills required for purification, solvent extraction, TLC and column chromatography.

Nature of Paper: **Core**

Minimum Passing Marks/Credits: 40% Marks

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 hydro genatom (no derivation) and its defects, Compton effect.de-Broglie hypothesis. He is enberg 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.	**10**
III	**Molecular Spectros copy**: Introduction: Electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the	**10**

	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.	
IV	**UV-Visible Spectroscopy:** Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules. Types of electronic transitions, λmax, chromophores and auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; application of Woodward Rules for calculation of λmax 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.	**05**
VI	**^{1}H-NMR Spectroscopy (PMR)** NMRSpectroscopy:introduction;nuclearspin;NMRactivemolecules;basicprinciplesofProton 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. 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, met as table ion, fragmentation process, Mc-Lafferty 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 countercurrent extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metalions from aqueous solution, extra action of organic species from the aqueous and non-aqueous media. Chromatography: Classification, principle and efficiency of	**10**

	the technique. Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods.	

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 ,Wiley1995
5. Lee, J.D, Concise Inorganic Chemistry 4th EditionELBS,1977
6. Clayden, J., Greeves, N., Warren, S., *Organic Chemistry,* Second edition, Oxford University Press2012.
7. Silverstein, R. M., Bassler, G. C., Morrill, T. C. *Spectrometric Identification of Organic Compounds*, John Wiley and Sons, INC, Fifth edition.
8. Pavia, D. L. *et al. Introduction to Spectroscopy,* 5th Ed. Cengage Learning India Ed.
9. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wards worth Publishing Company, Belmont, California, USA,1988.
10. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
11. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
12. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. 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: **Diploma**	Year: **II** Semester: **IV**
Credits: **06** Theory: 04 Practical: 02	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, ata 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: 40% Marks	
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 $KMnO_4$/$K_2Cr_2O_7$ 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 pattern.	10

	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 Rf values 4. TLC separation of a mixture of dyes (fluoresce in and methylene blue)	20

Reference / Text Books:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wards worth Publishing Company, Belmont, California, USA,1988.
3. Christian, G.D. *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C. *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. *Principles of Instrumental Analysis*, C engage Learning India Edition.
7. Mikes, O. & Chalmes, R.A. *Laboratory Handbook of Chromatographic & Allied Methods*, Elles Harwood Ltd. London.
8. Ditts, R.V. *Analytical Chemistry: Methods of separation.* 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

Format-3

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: 06 Theory: 04 Practical: 02	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

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**:Classificationofcarbonatominalkanes,Generalmethodsofpreparation,physicaland 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 forms of cyclohexane with energy diagrams rings train in small rings, theory of strain less rings. The case of cyclopropane ring, banana bonds.	10
II	**Chemistry of Alkenes** Methodsofformationofalkenes,Additionto**C=C:**mechanism(withevidence whereverapplicable), reactivity, regioselectivity (Markownikoff and anti-Markownikoff additions) and stereoselectivity; reactions: hydrogenation, halogenation, hydrohalogenation, hydration, oxymercurationdemercuration, hydroboration-oxidation, epoxidation, *syn*and *anti*-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 benzylicbromination in competition	10

	with bromination across C=C; use of NBS; interconversion of *E*- and *Z*-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, oxymercurationdemercuration, hydroboration-oxidation.	**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 HIO4] and pinacolpinacolone 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 Friesre arrangement, Claisenrearrangement, Gattermansyntheis, 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 organo lithium 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, SN2 and SN1 reactions with energy profile diagrams; Polyhalogen compounds: Chloroform, carbontetrachloride; Methods of formation of ary l halides, nuclear and side chain reactions.	**05**

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., Guiliano, 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. 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.

Course Learning Outcomes:

1. Students will able to understand the concept of introductory and advance knowledge of hydrocarbons.
2. Students will be able to understand aromaticity and arenes.
3. Students will be able to understand alcohols, phenols and epoxides.
4. Students will be able to understand the basics chemistry of organic halides.

Format-3

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: **6** Theory: **4** Practical: **2**	Subject : **Chemistry**
Course Code: BSCC-NP-353	Title : **Qualitative Analysis**

Course Objectives:
Upon completion of this course the students will have the knowledge and skills to: understand the laboratory methods and tests related to inorganic mixtures and organic compounds.

Nature of Paper:**Core**

Minimum Passing Marks/Credits: 40% Marks

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	**Inorganic Qualitative Analysis** Semi micro Analysis – cation analysis, separation and identification of ions from Groups I, II, III, IV, V and VI, Anion analysis. Mixture containing 6 radicals-2 +4 or 4+ or 3+3	16
II	**Elemental analysis and identification of functional groups** Detection of extra elements (N, S and halogens) and functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organic compounds.	14
III	**Separation of Organic Mixture** Analysis of an organic mixture containing two solid components using water, $NaHCO_3$, NaOH for separation and preparation of suitable derivatives	18
IV	**Identification of organic compounds** Identification of anorganic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.	12

Reference / Text Books:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
4. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
5. Harris,D.C.*ExploringChemical Analysis*, 9thEd. New York, W.H. Freeman, 2016.

6. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009.

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 practical chemistry taught in the preceding semester.

Course Learning Outcomes:

- Identification of acidic and basic radicals in inorganic mixtures
- Separation of organic compounds from mixture
- Elemental analysis in organic compounds
- Identification of functional group in organic compounds
- Identification of organic compound

Format-3

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: 06 Theory: 04 Practical: 02	Subject: **Chemistry**
Course Code: BSCC-NP-36	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, &terpenesetc 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

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 SeO2, mCPBA, Jones Oxidation, PCC, PDC, PFC, Collin's reagent and ruthenium tetraoxide. Reduction with NaBH4, LiAlH4, 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 ket ones with particular reference to the syn thesis of aldehydes from acid chlorides, synthesis of aldehydes and ketonesuses1,3-dithianes,synthesisofketonesfromnitrites and from carboxylic acids, Physical properties. Mechanism of nucleophillic 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,	10

	Wolff-Kishner, LiAlH4 and NaBH4 reductions. Halogenation of enolizable ketones An introduction to α, β unsaturated aldehydes and Ketones.	
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, substitutionin alkyl or aryl group. Preparation and properties of dicarboxylic acid ssuch as oxalic, malonic, succinic, glutaric, adipic and phthalic acids and unsaturated carboxylic acids suchasacrylic, 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-enoltautomerism of ethyl acetoacetate. Alkylationof 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, nitrities), reductive amination of aldehydic and ketonic compounds, Gabriel-phthalimide reaction, Hofmann bromamide reaction. Reactions of amines, electrophilic aromatic substituton 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 Fisher indole synthesis, Skraup synthesis and Bischler-Nepieralski synthesis,Mechanism of electrophilc 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., Guiliano, 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 2. Assignments 3. ESE	10 + 10 5 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, nitrogeneous organic compounds and various heterocyclic compounds.
5. Students will be able to understand natural products such as alkeloids and terpenoids.

Format-3

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 : 06 Theory: 04 Practical : 02	Subject: **Chemistry**	
Course Code: **BSCC-NP-363P**	Title : **Organic Synthesis Lab**	
Course Objectives : Upon successful completion of this course students should be able to quantify the product obtained through gravimetric method; determination of R*f* values and identification of organic compounds through paper and thin layer chromatography laboratory techniques: perform thermo chemical reactions.		
Nature of Paper: DSE		
Minimum Passing Marks/Credits: 40% Marks		
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	**GravimetricAnalysis** 1. Analysis of Cu as CuSCN, 2. Analysis of Ni as Ni(dimethylgloxime) 3. Analysis of Ba as BaSO4.	**30**
II	**Paper Chromatography** Ascending and Circular. Determination of R*f* values and identification of organic compounds: Separation of a mixture of phenylalanine and glycine. Alanine and aspartic acid Leucine and glutamic acid. Spray reagent – ninhydrin. Separation of a mixture of D, L–alanine, glycine, and L-leucineusingnbutanol : acetic acid : water (4:1:5). Sprayreagent– ninhydrin. Separation of monosaccharaides– a mixture of D- galactose and D – fructoseusing n- butanol: acetone: water (4:5:1). Spray reagent – aniline hydrogen phthalate	**8**
III	**Thin Layer Chromatography** Determination of R*f* values and identification of organic compounds: Separation of green leaf pigments (spinach leaves may be used) Preparation of separation of 2,4- di-nitrophenylhydrazones of acetone, 2-butanone, hexan-2, and 3-one using toluene and light petroleum (40:60)Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5)	8

IV	**Thermo chemistry** To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process 1. To determine the enthalpy of neutralization of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionization of the weak acid/weak base 3. To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born-Haber cycle	14

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)

Evaluation/Assessment Methodology

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

Prerequisites for the course: Practical Chemistry taught in the preceding semester.

Course Learning Outcomes:

Upon successful completion of this course students should be able to quantify the product obtained through gravimetric method; determination of Rf values and identification of organic compounds through paper and thin layer chromatography laboratory techniques: perform thermo chemical reactions.

Format-3

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: 04 Theory: 04	Subject : **Botany**
Course Code : CBZGE-NP-124a	**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 agroeco systems.
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: 04

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. Soil Health card preparation Recommendation regarding utility of soil sample for suitable crops.	**12**

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.

Format-3

IIMTU-NEP IMPLEMENTATION
Year : **I** / Semester : **II**

<table>
<tr><td colspan="2">Programme : B.Sc. (CBZ)
Certificate/Diploma/Degree/ Bachelor Of Science IN CBZ UG(R)/PG/Ph.D.
Class : DEGREE</td><td colspan="2">Year : I

Semester: II</td></tr>
<tr><td colspan="2">Credits: 04
Theory: 04</td><td colspan="2">Subject : Botany</td></tr>
<tr><td colspan="2">Course Code:CBZGE-NP-124b</td><td colspan="2">DISASTER MANAGEMENT SYSTEM IN INDIA</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="4">Nature of Paper : Generic Elective</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td>Unit</td><td colspan="2">Topics</td><td>Lectures</td></tr>
<tr><td>I</td><td colspan="2">Overview and understanding of disaster, Definitions of Disasters, Hazard, Vulnerability, Resilience and Risks.</td><td>7</td></tr>
<tr><td>II</td><td colspan="2">Classification of disaster, Natural hazards and man-made disasters, Causes and social impacts, Urban disasters, Pandemics and climatic changes.</td><td>7</td></tr>
<tr><td>III</td><td colspan="2">Panchayati raj Institutions/ Urban local bodies (PRIs/ ULBs), States, centre and other stake holders, CRBN disasters, NDMA, NDRF, NIDM, STATE DM</td><td>8</td></tr>
<tr><td>IV</td><td colspan="2">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.</td><td>8</td></tr>
<tr><td>V</td><td colspan="2">Mitigation, Response and preparedness, DM Act and Policy, Other Related Policies, Plans, Programs and legislations.</td><td>7</td></tr>
<tr><td>VI</td><td colspan="2">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</td><td>8</td></tr>
<tr><td>VII</td><td colspan="2">Equity issues in disasters; Issues of rehabilitation and resettlement of survivors; Stakeholders in disaster relief management.</td><td>7</td></tr>
<tr><td>VIII</td><td colspan="2">Disaster Risk reduction- Strategies, preparedness plans, Action plans and procedures, Early warning system; Factors contributing to vulnerability.
Capacity building</td><td>8</td></tr>
<tr><td colspan="4">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</td></tr>
</table>

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 2) Assignments 3) Attendance 4) ESE	16 5 4 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.

Format-3

IIMTU-NEP IMPLEMENTATION
Year: **II** / Semester: **III**

<table>
<tr><td colspan="2">Programme : B.Sc. (CBZ)
Certificate/Diploma/Degree/ Bachelor Of Science In CBZ UG(R)/PG/Ph.D.
Class : DEGREE</td><td>Year: II

Semester: III</td></tr>
<tr><td colspan="2">Credits: 04
Theory: 04</td><td>Subject :Botany</td></tr>
<tr><td colspan="2">Course Code: CBZGE-NP-234a</td><td>HERBAL TECHNOLOGY</td></tr>
<tr><td colspan="3">Course Objectives:
1. To get the knowledge about the storage, packing and market value of the herbs.
2. Use of some medicinal plants.
3. To get the knowledge about the phytochemistry of some medicinal herbs.
4. To get the knowledge about some secondary metabolites by phytochemical screening of herbs.
5. To know how to propagate some important species of medicinal plants.</td></tr>
<tr><td colspan="3">Nature of Paper:Generic Elective</td></tr>
<tr><td colspan="3">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td>Unit</td><td>Topics</td><td>Lectures</td></tr>
<tr><td>I</td><td>Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants.</td><td>12</td></tr>
<tr><td>II</td><td>Pharmacognosy - systematic position medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka.</td><td>12</td></tr>
<tr><td>III</td><td>Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; Catharanthus roseus (cardiotonic), Withania somnifera (drugs acting on nervous system), Clerodendron phlomoides (anti-rheumatic) and Centella asiatica (memory booster).</td><td>12</td></tr>
<tr><td>IV</td><td>Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds).</td><td>12</td></tr>
<tr><td>V</td><td>Medicinal plant banks micro propagation of important species (Withania somnifera, neem and tulsi- Herbal foods-future of pharmacognosy)</td><td>12</td></tr>
<tr><td colspan="3">Suggested Readings:
1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956.C.S.I.R, New Delhi.
2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984.
3. International Book Distributors.
4. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
5. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994.Oxford IBH publishing Co.
6. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
7. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
8. Pharmacognosy, Dr.C.K. Kokate et al. 1999. Nirali Prakashan.</td></tr>
</table>

Evaluation/Assessment Methodology	
	Max. Marks
1) Sessional Examination 2) Assignments 3) Attendance 4) ESE	16 5 4 75
Total	**100**

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

1. Have the knowledge about the cultivation, storage and market processing of some useful medicinal plants.
2. Cure the various ailments by the use of some plants like tulsi, ginger, fenugreek and many more. He can establish himself in the field of pharmacognosy.
3. Develop drugs like cardiotonic, acting on nervous system, anti-rheumatic and some memory Booster.
4. Establish himself in the field of about the Drug adulteration by knowing the secondary metabolites of medicinal plants.
5. Establish a plant nursery based on medicinal herbs.

IIMTU-NEP IMPLEMENTATION
Year: **II** / Semester: **III**

Programme : B.Sc. (CBZ) Certificate/Diploma/Degree/ **Bachelor Of Science In CBZ** UG(R)/PG/Ph.D. Class : **DEGREE**	**Year: II** **Semester: III**
Credits: 04 Theory: 04	Subject : **Botany**
Course Code: CBZGE-NP-234b	**BIOSTATISTICS**

Course Objectives:
NA

Nature of Paper : **Generic Elective**

Minimum Passing Marks/Credits: 40% Marks

Unit	Topics	Lectures
I	Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.	**12**
II	Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.	**12**
III	Probability classical &axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.	**12**
IV	Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA)	**12**
V	Correlation and Regression. Emphasis on examples from Biological Sciences.	**12**

SUGGESTED READING

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.

Evaluation/Assessment Methodology

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

Course Learning Outcomes:
NA

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)

Indexing

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

PEO 1	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.
PEO 2	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.
PEO 4	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.
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)/Program Specific Outcome

Table 2: Program Outcomes (POs)/Program Specific 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 PSO_1 To teach an ability to apply biotechnology skills in various subjects studied during the course. PSO_2 To provide students with the concepts of Biotechnology to develop interest in science. PSO_3 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: PSO_1 to impart an ability to apply biotechnology skills and its applications in core and allied fields. PSO_2 Students are able to apply the concepts and research approaches. PSO_3 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: PSO_1 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
PSO_2 To provide students with the conceptions from basics to advance research in the field of Biotechnology and enhance their career in higher studies.
PSO_3 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 10^{th} and 12^{th} from recognized Board.
- Candidates must have a core subject such as Physics, Chemistry, Biology, or Mathematics in class 10^{th} and 12^{th} .
- 10+2 PCB/PCM with min. 40 % marks
- PCBandPCMcandidatesareeligibletoapply.
- 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)b Generic Elective (GEC) Course
2)a Discipline Specific Skill Elective (DSE) Course
3) Ability Enhancement Course
3)b Skill Enhancement Courses (SEC)
3)a "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/ NSSCamps.
- Participation in University/ Inter-university/ State-levelGames.
- Participationinotherextra-curricularactivitiesatUniversity/Inter-university/Statelevel.
- ProlongedIllness
- 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 normsset by the University for Day-to-day living. Also, student has to follow the rules and guidelines, set by the University for DifferentActivities.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.Theinternaland externalassessmentmarksshallbebasedonfactorssuchmarks secured in Sessional examinations, submission of written assignments, class room participation and attendance. The weightage given to each of these factors for apaper 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

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 atleast 50% of the papers prescribed in the semester failing which he/she shall bedeclared as fail in that semester and he/she shall be required to get re-admissionin the failed semester and shall have to appear in all the papers currently inforce.

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) 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).

(b) 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.

(c) 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 ≤TM<M+1.75SD
B+	M+0.75 SD ≤TM<M+1.25SD
B	M+0.25 SD ≤ TM < M+0.75 SD
C+	M-0.25 SD ≤ TM < M-0.25 SD
C	M-0.75 SD ≤ TM < M-0.25 SD
D+	M-1.25 SD ≤ TM < M-0.75 SD
D	M-1.75 SD ≤ TM < M-1.25 SD
E+	M-2.0 SD ≤ TM < M-1.75 SD
E	M-2.25 SD ≤ 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 Ci of course "i "and the grade points Pi earned for that course taken over all courses "i" registered and successfully completed by the student to the sum of Ci 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 onall.

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. **StudentDiscipline:** 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: Not withstanding 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 12^{th} 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

B.Sc. BIOTECHNOLOGY Semester-I										
S.No.	**Course Type**	**Course Code**	**Subject**	**Study Scheme**			**Evaluation Scheme**			**Credit**
				L	**T**	**P**	**Internal**	**External**	**Total**	
1	Core 1	BBTC-NP-111	Biotechnology and Human Welfare	4	0	0	25	75	100	4
2	Core 2	BBTC-NP-112	Microbiology	4	0	0	25	75	100	4
3	DSE 1	DSE-NP-113a	Analytical Tools in Biotechnology	4	0	0	25	75	100	4
		DSE-NP-113b	Computational Biology and Design of Experiment							
4	AECC 1	NHU-N-111	English Communication	3	0	0	15	35	50	3
		NHU-N-112	Environment & Ecology							
5	Gen E	GENCC-101	NCC	2						2
6	USEC	NECC-112	University Social Responsibility				25	0	NCC	0
PRACTICALS										
1	Core 1	BBTC-NP-111P	Biotechnology and Human Welfare Lab	0	0	2	20	30	50	2
2	Core 2	BBTC-NP-112P	Microbiology Lab	0	0	2	20	30	50	2
3	DSE 1	DSE-NP-113aP	Analytical Tools in Biotechnology Lab	0	0	2	20	30	50	2
		DSE-NP-113bP	Computational Biology and Design of Experiment lab							
			TOTAL				**150**	**350**	**500**	
4	USEC	SPT-111	Sports	0	0	0	50	0	NC	0
21 (23 including NCC)										

B.Sc. BIOTECHNOLOGY Semester-II										
S.No.	**Course Type**	**Course Code**	**Subject**	**Study Scheme**			**Evaluation Scheme**			**Credit**
				L	**T**	**P**	**Internal**	**External**	**Total**	
1	Core 3	BBTC-NP-121	Biochemistry and Metabolism	4	0	0	25	75	100	4
2	Core 4	BBTC-NP-122	Plant Biotechnology	4	0	0	25	75	100	4
3	DSE 2	DSE-NP-123a	Immunology	4	0	0	25	75	100	4
		DSE-NP-123b	Molecular Diagnostics							
4	AECC-2	NHU-N-121	English Communication	3	0	0	15	35	50	3
		NHU-N-122	Environment & Ecology							
5	GE 1	BBTGE-NP-124	Entrepreneurship Development	4	0	0	25	75	100	4
6	SEC 1	NECC-124	MOOCs/ SWAYAM	2	0	0	50	0	50	2
7	Gen E	GENCC-201	NCC	2						2
8	USEC	NECC-122	University Social Responsibility	0	0	0	25	0	NC	0
PRACTICALS										
1	Core 3	BBTC-NP-121P	Biochemistry and Metabolism Lab	0	0	2	20	30	50	2
2	Core 4	BBTC-NP-122P	Plant Biotechnology lab	0	0	2	20	30	50	2
3..	DSE 2	DSE-NP-123aP	Immunology lab	0	0	2	20	30	50	2
		DSE-NP-123bP	Molecular Diagnostics lab							
			TOTAL				**225**	**425**	**650**	
4	USEC	SPT-121	Sports	0	0	0	50	0	NC	0
27 (29 including NCC)										

B.Sc. BIOTECHNOLOGY Semester-III										
S.No.	**Course Type**	**Course Code**	**Subject**	**Study Scheme**			**Evaluation Scheme**			**Credit**
				L	**T**	**P**	**Internal**	**External**	**Total**	
1	Core 5	BBTC-NP-231	Cell Biology	4	0	2	25	75	100	4
2	Core 6	BBTC-NP-232	Genetics	4	0	2	25	75	100	4
3	DSE 3	DSE-NP-233a	Industrial Fermentation	4	0	2	25	75	100	4
		DSE-NP-233b	Enzyme Technology							
4	AECC 3	UVE-301	Human Values	3	0	0	15	35	50	3
5	GE 2	BBTGE-NP-234a	Food Fermentation Technology	4	0	0	25	75	100	4
		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	25	0	NC	0
PRACTICALS										
1	Core 5	BBTC-NP-231P	Cell Biology Lab	0	0	2	20	30	50	2
2	Core 6	BBTC-NP-232P	Genetics Lab	0	0	2	20	30	50	2
3	DSE 3	DSE-NP-233aP	Industrial Fermentation Lab	0	0	2	20	30	50	2
		DSE-NP-233bP	Enzyme Technology Lab							
			TOTAL				**175**	**425**	**600**	
4	USEC	SPT-231	Sports	0	0	0	50	0	NC	0
							25 (27 including NCC)			

B.Sc. BIOTECHNOLOGY Semester-IV										
S.No.	**Course Type**	**Course Code**	**Subject**	**Study Scheme**			**Evaluation Scheme**			**Credit**
				L	**T**	**P**	**Internal**	**External**	**Total**	
1	Core 7	BBTC-NP-241	Bioprocess Technology	4	0	0	25	75	100	4
2	Core 8	BBTC-NP-242	Nano-Biotechnology	4	0	0	25	75	100	4
3	DSE 4	DSE-NP-243a	Biostatistics and Bioinformatics	4	0	0	25	75	100	4
		DSE-NP-243b	Medical and Forensic Biotechnology							
4	AECC 4	UPS-401	Professional Skills	3	0	0	15	35	50	3
5	SEC 2	NECC-244	MOOCs/ SWAYAM	2	0	0	50	0	50	2
6	Gen E	GENCC-401	NCC	2						2
7	USEC	NECC-242	University Social Responsibility	0	0	0	25	0	NC	0
PRACTICALS										
1	Core 7	BBTC-NP-241P	Bioprocess Technology Lab	0	0	2	20	30	50	2
2	Core 8	BBTC-NP-242P	Nano-Biotechnology Lab	0	0	2	20	30	50	2
3	DSE 4	DSE-NP-243aP	Biostatistics and Bioinformatics Lab	0	0	2	20	30	50	2
		DSE-NP-243bP	Medical and Forensic Biotechnology Lab							
			TOTAL				**200**	**350**	**550**	
4	USEC	SPT-241	Sports	0	0	0	50	0	NC	0
23 (25 including NCC)										

<table>
<tr><th colspan="11">B.Sc. BIOTECHNOLOGY
Semester-V</th></tr>
<tr><th rowspan="2">S.No.</th><th rowspan="2">Course Type</th><th rowspan="2">Course Code</th><th rowspan="2">Subject</th><th colspan="3">Study Scheme</th><th colspan="3">Evaluation Scheme</th><th rowspan="2">Credit</th></tr>
<tr><th>L</th><th>T</th><th>P</th><th>Internal</th><th>External</th><th>Total</th></tr>
<tr><td>1</td><td>Core 9</td><td>BBTC-NP-351</td><td>Environmental Biotechnology</td><td>4</td><td>0</td><td>0</td><td>25</td><td>75</td><td>100</td><td>4</td></tr>
<tr><td>2</td><td>Core 10</td><td>BBTC-NP-352</td><td>Recombinant DNA Technology</td><td>4</td><td>0</td><td>0</td><td>25</td><td>75</td><td>100</td><td>4</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">DSE 5</td><td>DSE-NP-353a</td><td>Genomics and Proteomics</td><td rowspan="2">4</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">25</td><td rowspan="2">75</td><td rowspan="2">100</td><td rowspan="2">4</td></tr>
<tr><td>DSE-NP-353b</td><td>Animal Biotechnology</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">Industrial Training/Research Project</td><td rowspan="2">BBT-RP-351</td><td>Industrial Training/</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">25</td><td rowspan="2">75</td><td rowspan="2">100</td><td rowspan="2">4</td></tr>
<tr><td>Survey/ Research Project</td></tr>
<tr><td>5</td><td>Gen E</td><td>GENCC-501</td><td>NCC</td><td>2</td><td></td><td></td><td></td><td></td><td></td><td>2</td></tr>
<tr><td>6</td><td>USEC</td><td>NECC-352</td><td>University Social Responsibility</td><td>0</td><td>0</td><td>0</td><td>25</td><td>0</td><td>NC</td><td>0</td></tr>
<tr><th colspan="11">PRACTICALS</th></tr>
<tr><td>1</td><td>Core 9</td><td>BBTC-NP-351P</td><td>Environmental Biotechnology Lab</td><td>0</td><td>0</td><td>2</td><td>20</td><td>30</td><td>50</td><td>2</td></tr>
<tr><td>2</td><td>Core 10</td><td>BBTC-NP-352P</td><td>Recombinant DNA Technology Lab</td><td>0</td><td>0</td><td>2</td><td>20</td><td>30</td><td>50</td><td>2</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">DSE 5</td><td>DSE-NP-353aP</td><td>Genomics and Proteomics Lab</td><td rowspan="2">0</td><td rowspan="2">0</td><td rowspan="2">2</td><td rowspan="2">20</td><td rowspan="2">30</td><td rowspan="2">50</td><td rowspan="2">2</td></tr>
<tr><td>DSE-NP-353bP</td><td>Animal Biotechnology Lab</td></tr>
<tr><td></td><td></td><td></td><td>TOTAL</td><td></td><td></td><td></td><td>160</td><td>390</td><td>550</td><td></td></tr>
<tr><td>4</td><td>USEC</td><td>SPT-351</td><td>Sports</td><td>0</td><td>0</td><td>0</td><td>50</td><td>0</td><td>NC</td><td>0</td></tr>
<tr><td colspan="11">22 (24 including NCC)</td></tr>
</table>

B.Sc. BIOTECHNOLOGY Semester-VI										
S.No.	**Course Type**	**Course Code**	**Subject**	**Study Scheme**			**Evaluation Scheme**			**Credit**
				L	**T**	**P**	**Internal**	**External**	**Total**	
1	Core 11	BBTC-NP-361	Industrial Biotechnology and Down Stream Processing	4	0	0	25	75	100	4
2	Core 12	BBTC-NP-362	Intellectual Property Rights, Bioethics and Biohazard Management	4	0	0	25	75	100	4
3	DSE 6	DSE-NP-363a	Green Biotechnology and Pollution Abatement	4	0	0	25	75	100	4
		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				25	75	100	4
5	Gen E	GENCC-601	NCC	2						2
6	USEC	NECC-362	University Social Responsibility	0	0	0	25	0	NC	0
7	SEC 3	NECC-364	MOOCs/ SWAYAM	2	0	0	50	0	50	2
PRACTICALS										
1	Core 11	BBTC-NP-361P	Industrial Biotechnology and Down Stream Processing Lab	0	0	2	20	30	50	2
2	Core 12	BBTC-NP-362P	Intellectual Property Rights, Bioethics and Biohazard Management Lab	0	0	2	20	30	50	2
3	DSE 6	DSE-NP-363aP	Green Biotechnology and Pollution Abatement Lab	0	0	2	20	30	50	2
		DSE-NP-363bP	Biosensors and Drug Design Lab							
			TOTAL				**210**	**390**	**600**	
4	USEC	SPT-361	Sports	0	0	0	50	0	NC	0
24 (26 including NCC)										

Format-1

Format -1

College/School: School of Life Sciences & Technology Programme: Biotechnology Duration: B.Sc. (6 Sem.), M.Sc. (10 Sem.) Annual/Semester: Semester	Credit range: 120 to 150 (Suggested by CBCS Committee)

Course	CREDIT	SEMESTER	CORE (Th 4+P 2)	DSE (Th 4+P 2)	AECC (Th 3)	SEC (Th 1+1)	GE (Th 4)	GEC (2)	Industrial Training/ Survey Project (4)	Total Credits
Certificate Course in Biotechnology	48	Ist	C1- Biotechnology and Human Welfare C 2- Microbiology	DSE 1- Analytical Tools in Biotechnology/ Computational biology and Design of Experiment	AECC 1- English Communication/ Environment & Ecology			NCC		21
		2nd	C3-- Biochemistry and Metabolism C4-Plant Biotechnology	DSE 2- Immunology / Molecular Diagnostics	AECC 2- English communication/ Environment & Ecology	SEC 1- MOOCs/ SWAYAM	GE1- Entrepreneurship development	NCC		27

Diploma in Biotechnology	96	3rd	C5-Cell Biology C6-Genetics	DSE 3- Industrial Fermentation/ Enzyme Technology	AECC 3-Human Values		GE2-Food Fermentation Technology/ Dairy and Agriculture Biotechnology	NCC		25
		4th	C7-Bioprocess Technology C8-Nano-Biotechnology	DSE 4-Biostatistics and Bioinformatics/ Medical and Forensic Biotechnology	AECC 4-Professional Skills	SEC 2-MOOCs/ SWAYAM		NCC		23
Degree in biotechnology	142	5th	C9-Environmental Biotechnology C10-Recombinant DNA Technology	DSE 5-Genomics and Proteomics/Animal Biotechnology				NCC	Industrial Training/ Survey Project	22
		6th	C11-Industrial Biotechnolo	DSE 6-Green Biotechnology and Pollution		SEC 3-MOOCs/		NCC	Industrial Training/ Survey	24

			gy and Down Stream Processing C12-Intellectual Property Rights, Bioethics and Biohazard Management	Control/ Biosensors and Drug Design		SWAY AM			Project/Biot ech In-house Project or Bio-Entreprene urship	
	187	7th	C13-Biochemistr y & Instrumentati on C14-Immunology	DSE 7-Biostatistics & Bioinformatics/Bi ophysics and Structural Biology	AECC 5-English Communic ation			NC C		21
		8th	C15-Industrial Biotechnolo gy C16-Molecular Biology	DSE 8- Plant Biotechnology /Genomics & Proteomics		SEC 4-MOOC s/ SWAY AM	GE3-IPR, Patent, Trademarks & Bioethics/Bio-entrepreneurship development	NC C		24
	235	9th	C17-Bio-separation and	DSE 9-Recombinant DNA			GE4-Nanobiotechnology/Bio energetics and	NC C	Industrial Training/Su rvey/	26

			downstream processing C18- Environmental Biotechnology	Technology/Animal Biotechnology			Metabolomics		Research Project	
		10 th				SEC 5- MOOCs/ SWAYAM		NCC	Industrial Training/ Survey/Research Project (20)	22

Format-2

Format-2

DEPARTMENT OF BIOTECHNOLOGY

B.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)
CERTIFICATE COURSEIN BIOTECHNOGY (48 credits)	FIRST YEAR	SEMESTER -I	i) C1- Biotechnology and Human Welfare (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i)C1- Biotechnology and Human Welfare	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- English Communication /Environment & Ecology (Th.3 Cr)	3	3	45	iii) AECC-1- Environment & Ecology	Unit=5/Period=45	N/A	N/A
			iv) DSE-1- Analytical Tools in Biotechnology / Computational biology and Design of Experiment(Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iv) DSE-1- Analytical Tools in Biotechnology / Computational biology and Design of Experiment	Unit=5/Period=60	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 Biotechnology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C4- Plant Biotechnology	Unit=5/Period=60	N/A	N/A
			iii) AECC-2- English Communication/ Environment & Ecology (Th.3 Cr)	3	3	45	iii) AECC-2- English Communication/ Environment & Ecology	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:

PSO_1 To teach an ability to apply biotechnology skills in various subjects studied during the course.

PSO_2 To provide students with the concepts of Biotechnology to develop interest in science.

PSO_3 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 (96 Credits) IN BIOTECHNOLOGY	SECOND YEAR	SEMESTER -III	i) C5- Cell Biology	4+2	8	60+60	i)C5- 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: Industrial Fermentation / Enzyme Technology	4+2	8	60+60	iv) DSE-3- Industrial Fermentation / Enzyme Technology	Unit=5/Period =60	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 Technology	4+2	8	60+60	i)C 7- Bioprocess 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	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/ Medical and forensic Biotechnology	4+2 4	8 4	60+60 60	v) DSE-4 - Biostatistics and Bioinformatics / Medical and forensic 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.
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 OutcomeB.Sc. BT II year:

PSO$_1$ To impart an ability to apply biotechnology skills and its applications in core and allied fields.
PSO$_2$Students are ale to apply the concepts and research approaches.
PSO$_3$After completions of the two years course students will be awarded with Diploma in Biotechnologyand prepare students for the job after completion of diploma 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)
UNDER GRADUATE DEGREE IN BIOTECHNOLO	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	4+2	8	60+60	ii) C10- Recombinant DNA Technology	Unit=5/Period=60	N/A	N/A
			iii) DSE-5- Genomics and Proteomics/ Animal	4+2	8	60+60	iii) DSE-5- Genomics and Proteomics /	Unit=5/Period=60	N/A	N/A

			Biotechnology				Animal Biotechnology			
			*Research project/ Industry Training/ Internship Survey	4	4	60				
		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- Intellectual Property Rights, Bioethics and Biohazard Management	4+2	8	60+60	ii) C 12- Intellectual Property Rights, Bioethics and Biohazard Management	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+2	8	60+60	iv) DSE-6 Green Biotechnology and Pollution Control / Biosensors and drug design	Unit=6/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:	**Programme Specific Outcome B.Sc. BT III year:**
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.	PSO_1 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 PSO_2To provide students with the conceptions from basics to advance research in the field of Biotechnology and enhance their career in higher studies. PSO_3To 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.

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.	

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) (187 Credits)	FOURTH YEAR	SEMESTER -VII	C13-Biochemistry& Instrumentation	4+2	8	60+60	C13-Biochemistry& Instrumentation	Unit=5/Period=60	N/A	N/A
			C14-Immunology	4+2	8	60+60	C14-Immunology	Unit=5/Period=60	N/A	N/A
			DSE7-Biostatistics & Bioinformatics/ Biophysics and structural biology	4+2	8	60+60	DSE7-Biostatistics & Bioinformatics/ Biophysics and structural biology	Unit=5/Period=60	N/A	N/A
			AECC 5- English Communication	3	3	45	AECC 5- English Communication	Unit=5/Period=45	N/A	N/A

		SEMESTER - VIII	C15 Industrial Biotechnology C16- Molecular Biology DSE8- Plant Biotechnology /Genomics & Proteomics iv) G E 3IPR, Patent, Trademarks &Bioethics/ Bio-Entrepreneurshipdevelopment SEC 4- MOOCs/ SWAYAM	4+2 4+2 4+2 4 1+1	8 8 8 4 2		C15 Industrial Biotechnology C16- Molecular Biology DSE8- Plant Biotechnology /Genomics & Proteomics iv) G E3- IPR, Patent, Trademarks &Bioethics/ Bio-Entrepreneurship development SEC 4- MOOCs/ SWAYAM	Unit=5/Period=60 Unit=5/Period=60 Unit=5/Period=60 Unit=5/Period=60 Unit=5/Period=30	N/A N/A N/A N/A N/A	N/A N/A N/A Yes N/A
			*Research project/ Industry Training/ Internship Survey							

***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

Programme Specific Outcome M.Sc. BT I year:

PSO_1Ability 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.

PSO_2To develop awareness of various ethical issues in terms of IPR, patent human genome RDT etc in biotechnology research.

PSO_3Develop skill to present the work through visual, oral and written presentations, including an original research proposal after studying the bioentrepreneurship development course.

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 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, academician 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
			C18- Environmental Biotechnology	4+2	8	60+60	C18- Environmental Biotechnology	Unit=5/Period=60	N/A	N/A
			DSE9- Recombinant DNATechnology/ Animal Biotechnology	4+2	8	60+60	DSE9- Recombinant DNATechnology/ Animal Biotechnology	Unit=5/Period=60	N/A	N/A
			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	EC 5- MOOCs/ SWAYAM	2			C 5- MOOCs/ SWAYAM	Unit=5/Period=30		
			*Research project/ Industry Training/ Internship Survey	20						

***Research topic is to be selected from main core paper.**

Programme Outcome:	Programme Specific Outcome M.Sc. BT II Year:
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.	PSO_1Ability to enhance the core biotechnology skills in the field of industrial biotechnology environment biotechnology RDT etc.

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 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, academician or industrial person.	PSO_2Students 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. PSO_3 Industry/academia suitable candidates are prepared after completion of Master in Biotechnology program.

Format-3

Format-3

IIMTU-NEP IMPLEMENTATION
Year I / Semester I

Programme: Biotechnology Certificate/Diploma/Degree/UG **Class: B.Sc. Biotechnology**	**Year: I** **Semester: I**	
Credits Theory: 4 Practical: 2	**Subject: Biotechnology**	
Course Code: BBTC-NP-111	**Title: Biotechnology and Human Welfare**	
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 bio products.	
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. The unit aim also put insight on the SDG 6, 7 and 13.	
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		
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 biotechnology:** chronological development of biotechnology, Development of modern biotechnology, inters disciplinary area of biotechnology, applications of biotechnology. **Biotechnology for Industrial application:** bio products development, bioprocess technology, alcohol and antibiotic formation, Industrially important microorganism.	**15**
II	**Biotechnology in Agriculture and food:** Green biotechnology, qualitative improvement of live stock, bio fertilizer, bio	**13**

	pesticides, bio composting, plant tissue culture, drought resistant crop varieties, crop disease resistance, functions of National Dairy Development Board (NDDB), case study on food industry and Zero hunger strategy.	
III	**Biotechnology for Environment issues:** pollution, pollutant degradation; degradation of contaminants and agricultural wastes, wastewater treatment, solid waste management, biodegradation, green energy, bioremediation, phytoremediation, knowledge towards SDG 6, 7 and 13.	**10**
IV	**Application of Biotechnology in medical & forensic science:** disease diagnosis and treatment, stem cell engineering, vaccine development, drug designing, applications of forensic biotechnology in solving violent crimes, claims of paternity and theft, DNA finger printing, modus operendi.	**10**
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, IPR, bio safety.	**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	
3) Assignments	
4) Research Project Report	5
Seminar On Research Project Report	
5) ESE	475
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 bio products 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-111P: Biotechnology and Human Welfare

Marks: 50 **Duration: 60 hours (2 credits)**

1. To perform of ethanolic fermentation using Baker's yeast.
2. To learn the plant part infected through a microbe.
3. To perform the quantitative evaluation of residual chlorine in water samples.
4. To study the Isolation and analysis of deoxyribonucleic acid (DNA) from minimal available biological samples.
5. Case studies about Bioethics (any two).
6. Model preparation of role of Nitrogen cycle in atmosphere.
7. Model preparation of Bio-composting unit.
8. Case study on solving claims of paternity and theft.
9. Enrichment and isolation procedure for *Azotobacter* and *Azomonas.*
10. 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

<table>
<tr><td>Programme: Biotechnology
Certificate/Diploma/Degree/UG(R)
Class: B.Sc. Biotechnology</td><td colspan="2">Year : I

Semester : I</td></tr>
<tr><td>Credits
Theory: 4
Practical: 2</td><td colspan="2">Subject : Biotechnology</td></tr>
<tr><td>Course Code: BBTC-NP-112</td><td colspan="2">Title : Microbiology</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td colspan="3">Nature of Paper: Core</td></tr>
<tr><td colspan="3">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="3">L: 4
T: 0
P:2(In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td>Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I</td><td>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.</td><td>12</td></tr>
<tr><td></td><td>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,</td><td></td></tr>
</table>

II	poring, plating, streaking and spreading of culture media. Maintenance and preservation of pure cultures. **Staining techniques:** Basic principal , applications and types of staining methods	12
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 (coli forms and non coli forms), 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 Daginawal, 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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year-I / Semester-I

Programme: Biotechnology Certificate/Diploma/Degree/UG(R) **Class : B.Sc. Biotechnology**	**Year :** I **Semester :** I	
Credits Theory: 4 Practical:2	**Subject: Biotechnology**	
Course Code:DSE-NP-113a	**Title : Analytical Tools in Biotechnology**	
Course Objectives:		
CO1. To understand about the working rule and application of microscope. CO2. To study about the working principle and application of spectrophotometer and centrifuge. CO3. To learn about the working principle and application of chromatography. CO4. To get the knowledge about the functioning standard and application of electrophoresis. CO5. To aware students about different blotting techniques. CO6. To get basic knowledge of 3-D and 4D printing in biotechnology.		
Nature of Paper: DSE-1a		
Minimum Passing Marks/Credits: 40% Marks		
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, principle and application of simple microscope, Atomic force microscopy, compound microscope, TEM phase contrast microscope, florescence, confocal scanning laser microscopy Differential interference electron microscope: and SEM, and contrast microscopy.	12
II	Electromagnetic radiation (EMW) and Atomic absorption and emission spectroscopy, spectrum, Principle, working and applications of UV-VIS, IR NMR, and ESR spectrometer, Principle and applications of Positron Emission Tomography(PET), Principle and applications of Mass Spectroscopy, Basics of X-Ray diffraction analysis and applications Circular Dichorism (CD) principles.	14
III	Introduction to the principle and application of chromatography. Different Types of chromatography such as paper thin layer chromatography, HPLC, ion exchange, column chromatography, gel filtration, affinity chromatography, gas chromatography.	12
	Introduction to electrophoresis and factors affecting electrophoresis. Polyacrylamide gel electrophoresis (Native and	10

IV	SDS-PAGE), pulse field gel electrophoresis, agarose gel electrophoresis, immune electrophoresis, iso-electric focusing. Blotting techniques: Northern, Southern and Western blotting.	
V	Introduction of centrifugation and sedimentation. Types of centrifuges, Density gradient centrifugation, analytical and preparative centrifugation;. Application of centrifugation. Principles of 3-D printing, Ideal material properties for bioprinting. 3-D Bioprinting of tissues, bacteria and organs, Introduction to 4D printing in biotechnology	12

Reference / Text Books:

1. Wilson and Walker. Principles and Techniques in Practical Biochemistry. 5th Edition Cambridge University Press (2000).
2. Murphy D. B. Fundamental of Light Microscopy & Electron Imaging.1st Edition. Wiley - Liss. (2001).
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 spectrophoto meter and centrifuge.
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.
CLO5: Student will get the basic knowledge of 3-D and 4-D printing in biotechnology.
CLO6: Student will understand the blotting and different blotting techniques used for detections.

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-113aP: Analytical Tools in Biotechnology Lab

Marks: 50 **Duration: 60 hours (2 credits)**

1. To study instrumentation and principle and of microscope.
2. Native gel electrophoresis of proteins purification.
3. SDS-PAGE of proteins under reducing conditions.
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 HPLC.
8. To Study and demonstration of 3-D printing in biotechnology
9. 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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year I / Semester I

Programme: Biotechnology Certificate/Diploma/Degree/UG(R) **Class: B.Sc. Biotechnology**	Year : I Semester : I
Credits Theory:4 Practical: 2	**Subject: Biotechnology**
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

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-Black well.
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 Pair wise 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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year-I / Semester-II

Programme: Biotechnology Certificate/Diploma/Degree/UG(R) **Class: B.Sc. Biotechnology**	**Year : I** **Semester : II**
Credits Theory:4 Practical:2	**Subject: Biochemistry**
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

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	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, Km value, Vmax 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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year-I / Semester-II

Programme : Biotechnology Certificate/Diploma/Degree/UG(R) **Class: B.Sc. Biotechnology**	**Year: I** **Semester: II**
Credits Theory: 4 Practical: 2	**Subject : Biotechnology**
Course Code : BBTC-NP-122	**Title : Plant Biotechnology**

Course Objectives:
CO1. To study the plant tissue culture, scope and its applications as 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 PGPRs and its bio control mechanisms also aware students about significance of nitrogen fixation.
CO6. To study about Bio control of pathogens and plant growth promotion through free-living bacteria.

Nature of Paper : Core

Minimum Passing Marks/Credits : 40% Marks

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 plant tissue culture, laboratory organization of an ideal plant tissue culture, scopes and applications in India, media preparations, types of tissue culture media, Cyto and organogenic differentiation, Cell suspension culture.	12
II	Axillary bud culture, Meristem and shoot tip culture Clonal, Development of improved organisms (Micropopagation) and its applications, organogenesis, factors effecting organogenesis. Embryogenesis,Weed culture.	12
III	Anther proliferation, Pollen culture, Tissue and Organ culture, Methods of haploid plant culture, Significance and applications of Haploid plant culture, Ovary and ovule 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	Plant biotech and microorganism/ associations of microbes with plant biotechnology, Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion byfree-livingbacteria.	12

Reference / Text Books:

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8 edition Principles of Genetics. Wiley India.
4. Raven, P.H., Johnson, GB. Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rd edition. Benjamin Co.
7. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3edition)
8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.
9. 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
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 learn about the PGPRs and its biocontrol mechanisms.
CLO6: Student will get knowledge about the 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-122P: Plant Biotechnology

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 Micro propagation.
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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year I /Semester II

<table>
<tr><td colspan="2">Programme: Biotechnology
Certificate/Diploma/Degree/UG(R)
Class: B.Sc. Biotechnology</td><td colspan="2">Year: I

Semester: II</td></tr>
<tr><td colspan="2">Credits
Theory: 4
Practical: 2</td><td colspan="2">Subject : Biotechnology</td></tr>
<tr><td colspan="2">Course Code:DSE-NP-123a</td><td colspan="2">Title : Immunology</td></tr>
<tr><td colspan="4">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 His to compatibility 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.</td></tr>
<tr><td colspan="4">Nature of Paper:DSE-2a</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits : 40% Marks</td></tr>
<tr><td colspan="4">L:4
T:
P:2(In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1Credit(4Hrs./Week=4Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I</td><td colspan="2">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)</td><td>14</td></tr>
<tr><td>II</td><td colspan="2">Immunoglobulin gene, expression of antigen, antibody diversity, epitope, paratope, adjuvant, all types & idiotypes,
allelic exclusion, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation)</td><td>12</td></tr>
<tr><td>III</td><td colspan="2">Major His to compatibility 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</td><td>10</td></tr>
<tr><td>IV</td><td colspan="2">Immunity against different organisms, pathogen defense mechanism, evasion of recognition. Autoimmune diseases, Immunodeficiency-AIDS, various types of allergy, hypersensitivity,</td><td>12</td></tr>
</table>

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, Edinberg.
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 His to compatibility 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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year I/Semester II

Programme : Biotechnology Certificate/Diploma/Degree/UG(R) **Class: B.Sc. Biotechnology**	**Year: I** **Semester : II**
Credits Theory:4 Practical:2	**Subject: Biotechnology**
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

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-idio types 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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year : I / Semester II

<table>
<tr><td colspan="2">Programme : Biotechnology
Certificate/Diploma/Degree/UG
Class : B.Sc. Biotechnology</td><td colspan="2">Year: I

Semester : II</td></tr>
<tr><td colspan="2">Credits
Theory:4
Practical:0</td><td colspan="2">Subject : Biotechnology</td></tr>
<tr><td colspan="2">Course Code:BBTGE-NP-124</td><td colspan="2">Title : Entrepreneurship Development</td></tr>
<tr><td colspan="4">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.
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.</td></tr>
<tr><td colspan="4">Nature of Paper: GE-1</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits : 40% Marks</td></tr>
<tr><td colspan="4">L: 4
Theory - 1 Hr. = 1 Credit</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I</td><td colspan="2">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</td><td>12</td></tr>
<tr><td>II</td><td colspan="2">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</td><td>12</td></tr>
</table>

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,TissueCell 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 entrepreneurships. 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.

Format-3

IIMTU-NEP IMPLEMENTATION
Year-II /Semester-III

Programme : Biotechnology Certificate/Diploma/Degree/UG(R) **Class : B.Sc. Biotechnology**	**Year : II** **Semester : III**
Credits Theory:4 Practical:2	**Subject : Biotechnology**
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

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, Genomes, biogenesis. Chloroplasts: biogenesis, Structure, function and genomes organization.	12

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	4
Seminar On Research Project Report	
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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year-II / Semester-III

Programme : Biotechnology Certificate/Diploma/Degree/ UG(R) **Class: B.Sc. Biotechnology**	**Year : II** **Semester : III**
Credits Theory:4 Practical:2	**Subject: Biotechnology**
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

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 bytest 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 organi zation:** 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, non coding DNA. Genetic organization of prokaryotic and viral genome. Structure and morphology and characteristics of bacterial and eukaryotic chromosome, genetic code, and gene	15

	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

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to
6. Genetic Analysis, W. H. Freeman & Co.
7. 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

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-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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year II /Semester III

Programme : Biotechnology Certificate/Diploma/Degree/ UG(R) **Class: B.Sc. Biotechnology**	Year: Second Semester: Third
Credits Theory:4 Practical:2	**Subject: Biotechnology**
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

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 industrial processing, enzymes in organic synthesis, proteolytic	12

	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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year-II / Semester-III

Programme : Biotechnology Certificate/Diploma/Degree/ UG(R) **Class: B.Sc. Biotechnology**	Year : II Semester : III
Credits Theory:4 Practical:2	**Subject: Biotechnology**
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

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 &Vmax.	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 - definition and importance.	12

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 Univerity 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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year II / Semester III

Programme: Biotechnology Certificate/Diploma/Degree/ UG(R) **Class: B.Sc. Biotechnology**	Year: Second Semester: Third
Credits Theory:4 Practical:	**Subject : Biotechnology**
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

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 *Clostridium botulinum.* 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, Woodhead 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. 2 nd 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., Westhoff, 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. 1st 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.

Format-3

IIMTU-NEP IMPLEMENTATION
Year-II / Semester-III

Programme: Biotechnology Certificate/Diploma/Degree/UG(R) **Class: B.Sc. Biotechnology**	Year : II Semester : III
Credits Theory:4 Practical: 0	**Subject: 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	
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	10

	livestock and their consequences, Pasture management, Importance of scientific Feeding, etc.	

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 2) Presentations /Seminar/Attendance	16
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.

Format-3

IIMTU-NEP IMPLEMENTATION
Year II / Semester IV

Programme : Biotechnology Certificate/Diploma/Degree/UG **Class: B.Sc. Biotechnology**	Year: II Semester : IV
Credits Theory: 4 Practical: 2	**Subject : Biotechnology**
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 controleffluent treatment and specific types of bioreactors.

Nature of Paper: Core

Minimum Passing Marks/Credits : 40% Marks

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 O2, 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 2^{nd} 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. 2^{nd} 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
7. Genetic Analysis, W. H. Freeman & Co.
8. Shuler M L, Kargi F, " Bioprocess Engineering- Basic Concepts" , 2nd ed, Prentice Hall of India Ltd. (2002)
9. Aiba S, Humphrey A E and Millis N F ,"Biochemical Engineering" , Academic Press (1973)
10. Bailey J E and Ollis D F, "Biochemical Engineering Fundamentals" , McGraw Hill (1986)
11. Harvey W. Blanch and Douglas S. Clark, "Biochemical Engineering", Marcel Dekker (1996).
12. 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 vesselsand production for bioprocess.
CLO3: Student will study the media preparation; inoculate development and sterilization and types of microbialculture 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.
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-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 Bioadsorbent for bioadsorption process
9. Demonstration of waste water treatment plant
10. Studies on the kinetics of immobilized cell with bioadsorbents.

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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year II / Semester IV

Programme: Biotechnology Certificate/Diploma/Degree/UG(R) **Class: B.Sc. Biotechnology**	Year : II Semester : IV
Credits Theory:4 Practical: 2	**Subject: 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 Nano particle 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

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 / nano materials / bionano materials, 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

BOS

V	Biosensors and nano biotechnology principles used in construction of microelectronic devices sensors and macro mechanical structures and their functioning, immune-nano technology.	12

Reference / Text Books:

1. Nano biotechnology: Concepts, Applications and Perspectives, Christof 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. Bionanotechnology 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. Bionanotechnology towards Green Energy: Innovative and Sustainable Approach by ShubhaDwivedi 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 variousphysical 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 bioconjugates 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 Immunosensor.
9. Preparation of PEG based liposome.
10. Immobilization of antibody over the nanoporous 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 Theory: 4 Practical: 2	**Subject: Biostatistics**
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

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, Pair wise 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
8. Edition. Benjamin Cummings.
9. 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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year: II /Semester: IV

Programme: Biotechnology Certificate/Diploma/Degree/UG(R) **Class: B.Sc.**	Year: II Semester: IV
Credits Theory:4 Practical:2	**Subject: 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

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, GeneticsCounseling andHuman 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 & lymphaticsystem, 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 anatomy &	12

	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 visionfor 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 etermination of λ max by color imetric method.
2. Determination of blood glucose by GOD/POD method.
3. To prepare the Trisbuffer 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 inhuman beings.
6. To isolate plasmid DNA through bacteria and perform the agarose gelelectrophoresis.
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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year-III / Semester-V

Programme: Biotechnology Certificate/Diploma/Degree/UG(R) **Class: B.Sc. Biotechnology**		Year : III Semester : V
Credits Theory:4 Practical:2	**Subject : Biotechnology**	
Course Code:BBTC-NP-351	**Title:** Environmental Biotechnology	

Course Objectives:

- CO 1 To teach different types of environmental pollution due to various anthropogenic activities.
- CO 2 To build up understanding of environment biotechnology in treating various kind of waste to produce valuable products.
- CO 3 To convey knowledge of core designing principle of bioreactor for waste management and treatment uses biological process.
- CO 4 To build up statistical and analytical skills requisite for designing and operation of source-based waste treatment.
- CO 5 To aware students about waste to wealth technology in terms of treatment and green energy production.
- CO 6 To aware students about various national/international environmental legislative framework, Working of EIA.

Nature of Paper: Core

Minimum Passing Marks/Credits : 40% Marks

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 Bio energy, 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. Bio nano technology towards Green Energy: Innovative and Sustainable Approach by ShubhaDwivedi and Naveen DwivediCRC 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, Blue rose 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, Blue rose publishers, 2023. (ISBN: 978-93-5819-020-5)
9. Essentials of Ecology & Environmental Science, S.V.S. Rana, Prentic Hall India, 2006.
10. 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	4
Seminar On Research Project Report	
5) ESE	75
Total:	100

Prerequisites for the course: Basic knowledge of bioreactors, environment science is required.

BOS

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 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 Theory:4 Practical:2	**Subject: Biotechnology**	
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 cellsand its applications.
CO6. To study the plant viruses used as episomal expression vectors.

Nature of Paper: Core

Minimum Passing Marks/Credits: 40% Marks

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,T herapeutic 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 directedmutagenesis, Random mutagenesis, Gene	12

	shuffling, production of chimeric proteins, Protein engineering concepts and examples	
V	Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *A. rhizogenes*, Tiplasmids, 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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year III /Semester V

Programme: Biotechnology Certificate/Diploma/Degree/UG(R) **Class: B.Sc. Biotechnology**	Year: III Semester: V
Credits Theory: 4 Practical: 2	**Subject: Biotechnology**
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, Transcript to me 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

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, Transcript to me abundance 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, Prediction of protein function.	12

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 optit.
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: 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, Trascripto me 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 bar coding 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 Entrez with 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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year III / Semester V

Programme: Biotechnology Certificate/Diploma/Degree/UG(R) **Class: B.Sc. Biotechnology**	Year: III Semester: V
Credits Theory:4 Practical:2	**Subject: 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

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, Coccidios is, 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 Labfax II: Gene analysis. II Edition. Academic Press, California, USA.
2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers.
3. Prof.P.K. Gupta Animal Biotechnology 2017, Rastogi Publications
4. 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.
5. 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
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-353bP: Animal Biotechnology Lab

Marks: 50 | **Duration: 60 hours (2 credits)**

1. Packing and sterilization of glass and plastic wares for cell culture.
2. Study of effect of toxic chemicals on cultured mammalian cells.
3. 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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year III/ Semester VI

Programme: Biotechnology Certificate/Diploma/Degree/UG(R) **Class: B. Sc. Biotechnology**	Year: III Semester: VI
Credits Theory:4 Practical:2	**Subject: Biotechnology**
Course Code:BBTC-NP-361	**Title:** Industrial Biotechnology and Down Stream Processing

Course Objectives:

CO 1	To study about the history of industrial biotechnology, basic of fermentation, microbial strain improvement and different types of bioreactors
CO 2	To get the understanding of SCP, wine, beer and vinegar; bio-preservatives cheese, vitamins production from microbes.
CO 3	To learn about Cell disruption and Removal of insoluble biomass and cell debris methods.
CO 4	To get knowledge about Purification by Precipitation Methods with salts - organic solvents.
CO 5	To aware students about unit operation procedures of production.
CO 6	To aware students about cost-effective downstream processing and provide industry efficient technology.

Nature of Paper: Core

Minimum Passing Marks/Credits: 40% Marks

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-Freeze 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& oils, 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 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 sizebased 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: Third Semester: Six
Credits Theory:4 Practical:2	**Subject : Biotechnology**
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.

CO 1	To study the introduction on Intellectual Property, Patents, GI its protection, Remedies Licensing and its types.
CO 2	To study the International Scenario of intellectual property rights and Indian Patent Act.
CO 3	To study the Patents, Requirement of patentable novelty, Procedure for applying for patent and Biological Patentability.
CO 4	To study the Biosafety, Good Lab Practices, Biosafety Levels GMOs, their environmental impact and agriculture Risk analysis.
CO 5	To study the IPR in Biotechnology, Bioethical issues and agriculture genetic engineering.
CO 6	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% Mark

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. The Paris Convention TRIPS, The World	14

	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 there **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. CLO 6: 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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year-III / Semester-VI

Programme: Biotechnology Certificate/Diploma/Degree/UG(R) **Class: B.Sc. Biotechnology**	Year : III Semester : VI
Credits Theory:4 Practical: 2	**Subject: Biotechnology**
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, Bio restoration 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

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 Bionanotechnology 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, Biorestoration and phytoremediation: Introduction and types.Restoration of coal mines a case study. Biorestoration: reforestation through micropropagation, use of *mycorrhizae* in reforestation, use of microbes for improving soil fertility, reforestation of soils contaminated with heavy metals, Biotransformations.	12

IV	Eco-Friendly Bioproducts from Renewable Sources: Bioinspired material, Fundamentals of composting process: scientific aspects and prospects of green energy; biofertilizers and biopesticides. 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. Bionanotechnology towards Green Energy: Innovative and Sustainable Approach by Shubha Dwivedi and Naveen Dwivedi CRC Press 2023.
2. Bionanotechnology 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)Environmental Processes I-III, J. Winter, 2nd ed., Wiley Publications
7. Introduction to Wastewater Treatment- R. S. Ramalho, Academic Press.
8. Elements of Water Pollution Control Engineering – O.P. Gupta, Khannabooks.
9. Energy Technology – O.P. Gupta, Khannabooks, 2018.
10. 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 eco friendly 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 knownwastewater 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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year III /Semester VI

Programme: Biotechnology Certificate/Diploma/Degree/UG(R) **Class: B.Sc. Biotechnology**	Year : III Semester : VI
Credits Theory:4 Practical:2	**Subject: Biotechnology**
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 indrug 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	
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, nano structured biosensor, Assembly and production of a nano biosensor, Ampero metric Biosensors, Potentio metric Biosensors, Optical Biosensors	12
II	Immobilization of the Receptor Component in Biosensors, Methods of Immobilization: Adsorption, Gel Entrapment, Covalent Coupling, Cross linking. 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, sub acute 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 Drug Leads, Modern "Rational Approach" to Drug	12

	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 DESIGNLAB

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**

School of Life Science & Technology

ACADEMIC HAND BOOK

DEPARTMENT OF BIOTECHNOLOGY
ORDINANCE M.Sc. Biotechnology
(As per New Education Policy 2020 & UGC Regulation)

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4.	Program Educational objectives
5.	Program outcome/ Program Specific outcome
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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:
PSO_1Ability 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. PSO_2To develop awareness of various ethical issues in terms of IPR, patent human genome RDT etc in biotechnology research. PSO_3Develop 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: PSO_1Ability to enhance the core biotechnology skills in the field of industrial biotechnology environment biotechnology RDT etc. PSO_2Students 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. PSO_3 Industry/academia suitable candidates are prepared after completion of Master in Biotechnology program.

6. Admission:

a) The number of seats shall be in accordance with the directives by the university.

b) B.Sc. Biology/ Biotechnology/Microbiology or BMLT with 6 months Internship with min. 40 % marks

c) 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.

d) 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

- IIb. Generic Elective (GEC) Course
- IIa. Discipline Specific Skill Elective (DSE) Course

c) Ability Enhancement Course

- IIIb. Skill Enhancement Courses (SEC)
- IIIa. "AECC" courses

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 atleast 50% of the papers prescribed in the semester failing which he/she shall bedeclared as fail in that semester and he/she shall be required to get re-admissionin the failed semester and shall have to appear in all the papers currently inforce.

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 a 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 **Masterin 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) Thosewhopassallsemesterexaminationsinthefirstattemptobtaining75%ormoremarksinthe 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: Not withstanding 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

M.Sc. BIOTECHNOLOGY Semester-I										
S.No.	**Course Type**	**Course Code**	**Subject**	**Study Scheme**			**Evaluation Scheme**			**Credit**
				L	**T**	**P**	**Internal**	**External**	**Total**	
1	Core 13	MBTC-NP-111	Biochemistry and Instrumentation	4	0	0	25	75	100	4
2	Core 14	MBTC-NP-112	Immunology	4	0	0	25	75	100	4
3	DSE 7	MBTDSE-NP-113a	Biostatistics and Bioinformatics	4	0	0	25	75	100	4
		MBTDSE-NP-113b	Biophysics and Structural Biology							
4	AECC 5	NHU-N-111	English Communication	3	0	0	15	35	50	3
5	Gen E	GENCC-701	NCC	2						2
6	USEC	NECC-472	University Social Responsibility				25	0	NC	0
PRACTICALS										
1	Core 13	MBTC-NP-111P	Biochemistry and Instrumentation Lab	0	0	2	20	30	50	2
2	Core 14	MBTC-NP-112P	Immunology Lab	0	0	2	20	30	50	2
3	DSE 7	MBTDSE-NP-113aP	Biostatistics and Bioinformatics Lab	0	0	2	20	30	50	2
		MBTDSE-NP-113bP	Biophysics and Structural Biology Lab							
			TOTAL				**150**	**350**	**500**	
4	USEC	SPT-471	Sports	0	0	0	50	0	NC	0
21 (23including NCC)										

M.Sc. BIOTECHNOLOGY Semester-II										
S.No.	**Course Type**	**Course Code**	**Subject**	**Study Scheme**			**Evaluation Scheme**			**Credit**
				L	**T**	**P**	**Internal**	**External**	**Total**	
1	Core 15	MBTC-NP-121	Industrial Biotechnology	4	0	0	25	75	100	4
2	Core 16	MBTC-NP-122	Molecular Biology	4	0	0	25	75	100	4
3	DSE 8	MBTDSE-NP-123a	Plant Biotechnology	4	0	0	25	75	100	4
		MBTDSE-NP-123b	Genomics & Proteomics							
4	GE 3	MBTGE- NP-124a	IPR, Patent, Trademarks & Bioethics	4	0	0	25	75	100	4
		MBTGE- NP-124b	Bio- entrepreneurship Development							
5	Gen E	GENCC-801	NCC	2						2
6	USEC	NECC-482	University Social Responsibility				25	0	NC	0
7	SEC 4(2 Cr.)	NECC-484	MOOCs/ SWAYAM	2	0	0	50	0	50	2
PRACTICALS										
1	Core 15	MBTC-NP-121P	Industrial Biotechnology Lab	0	0	2	20	30	50	2
2	Core 16	MBTC-NP-122P	Molecular Biology Lab	0	0	2	20	30	50	2
3	DSE 8	MBTDSE-NP-123aP	Plant Biotechnology Lab	0	0	2	20	30	50	2
		MBTDSE-NP-123bP	Genomics & Proteomics Lab							
			TOTAL				**210**	**390**	**600**	
4	USEC	SPT-481	Sports	0	0	0	50	0	NC	0
24 (26 including NCC)										

M.Sc. BIOTECHNOLOGY Semester-III										
S.No.	**Course Type**	**Course Code**	**Subject**	**Study Scheme**			**Evaluation Scheme**			**Credit**
				L	**T**	**P**	**Internal**	**External**	**Total**	
1	Core 17	MBTC-NP-231	Bio-separation and Downstream Processing	4	0	0	25	75	100	4
2	Core 18	MBTC-NP-232	Environmental Biotechnology	4	0	0	25	75	100	4
3	DSE 9	MBTDSE-NP-233a	Recombinant DNA Technology	4	0	0	25	75	100	4
		MBTDSE-NP-233b	Animal Biotechnology							
4	GE 4	MBTGE- NP-234a	Nanobiotechnology	4	0	0	25	75	100	4
		MBTGE- NP-234b	Bioenergetics and Metabolomics							
5	Industrial Training/Research Project	MBT-RP-231	Industrial Training/ Survey/Research Project				25	75	100	4
6	Gen E	GENCC-901	NCC	2						2
7	USEC	NECC-592	University Social Responsibility				25	0	NC	0
PRACTICALS										
1	Core 17	MBTC-NP-231P	Bio-separation and Downstream Processing Lab	0	0	2	20	30	50	2
2	Core 18	MBTC-NP-232P	Environmental Biotechnology Lab	0	0	2	20	30	50	2
3	DSE 9	MBTDSE-NP-233aP	Recombinant DNA Technology Lab	0	0	2	20	30	50	2
		MBTDSE-NP-233bP	Animal Biotechnology lab							
			TOTAL				**160**	**390**	**550**	
4	USEC	SPT-591	**Sports**	**0**	**0**	**0**	**50**	**0**	**NC**	0
26 (28 including NCC)										

M.Sc. BIOTECHNOLOGY Semester-IV										
S.No.	**Course Type**	**Course Code**	**Subject**	**Study Scheme**			**Evaluation Scheme**			**Credit**
				L	**T**	**P**	**Internal**	**External**	**Total**	
1	Industrial Training/Research Project	MBT-RP-241	Industrial Training Survey/ Research Project				75	225	300	20
2	Gen E	GENCC-X01	NCC	2						2
3	USEC	NECC-5X2	University Social Responsibility				25	0	NC	0
4	SEC 5 (2 Cr.)	NECC-5X4	MOOCs/ SWAYAM	2	0	0	50	0	50	2
			TOTAL				**125**	**225**	**350**	
5	USEC	SPT-5X1	Sports	0	0	0	50	0	NC	0
22 (24 including NCC)										

Format-1

Format -1

College/School: School of Life Sciences & Technology Programme: Biotechnology Duration: B.Sc. (6 Sem.), M.Sc. (10 Sem.) Annual/Semester: Semester	Credit range: 120 to 150 (Suggested by CBCS Committee)

Course	CREDIT	SEMESTER	CORE (Th 4+P 2)	DSE (Th 4+P 2)	AECC (Th 3)	SEC (Th 1+1)	GE (Th 4)	GEC (2)	Industrial Training/ Survey Project (4)	Total Credits
Certificate Course in Biotechnology	48	Ist	C1-Biotechnology and Human Welfare C 2-Microbiology	DSE 1-Analytical Tools in Biotechnology/ Computational biology and Design of Experiment	AECC 1-English Communication/ Environment & Ecology			NCC		21
		2nd	C3--Biochemistry and Metabolism C4-Plant Biotechnology	DSE 2-Immunology / Molecular Diagnostics	AECC 2-English communication/ Environment & Ecology	SEC 1-MOOCs/ SWAYAM	GE1- Entrepreneurship development	NCC		27

Diploma in Biotechnology	96	3rd	C5-Cell Biology C6-Genetics	DSE 3- Industrial Fermentation/ Enzyme Technology	AECC 3- Human Values		GE2-Food Fermentation Technology/ Dairy and Agriculture Biotechnology	NCC		25
		4th	C7-Bioprocess Technology C8-Nano-Biotechnology	DSE 4-Biostatistics and Bioinformatics/ Medical and Forensic Biotechnology	AECC 4-Professional Skills	SEC 2-MOOCs/ SWAYAM		NCC		23
Degree in biotechnology	142	5th	C9-Environmental Biotechnology C10-Recombinant DNA Technology	DSE 5-Genomics and Proteomics/Animal Biotechnology				NCC	Industrial Training/ Survey Project	22
		6th	C11-Industrial Biotechnolo	DSE 6-Green Biotechnology and Pollution		SEC 3-MOOCs/		NCC	Industrial Training/ Survey	24

			gy and Down Stream Processing C12-Intellectual Property Rights, Bioethics and Biohazard Management	Control/ Biosensors and Drug Design		SWAYAM			Project/Biotech In-house Project or Bio-Entrepreneurship	
	187	7th	C13-Biochemistry & Instrumentation C14-Immunology	DSE 7-Biostatistics & Bioinformatics/Biophysics and Structural Biology	AECC 5-English Communication			NCC		21
		8th	C15-Industrial Biotechnology C16-Molecular Biology	DSE 8- Plant Biotechnology /Genomics & Proteomics		SEC 4-MOOCs/ SWAYAM	GE3-IPR, Patent, Trademarks & Bioethics/Bio-entrepreneurship development	NCC		24
	235	9th	C17-Bio-separation and	DSE 9-Recombinant DNA			GE4-Nanobiotechnology/Bioenergetics and	NCC	Industrial Training/Survey/	26

			downstream processing C18- Environmental Biotechnology	Technology/Animal Biotechnology			Metabolomics		Research Project	
		10 th				SEC 5- MOOCs/ SWAYAM		NCC	Industrial Training/ Survey/Research Project (20)	22

Format-2

DEPARTMENT OF BIOTECHNOLOGY

B.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)
CERTIFICATE COURSEIN BIOTECHNOLOGY (48 credits)	FIRST YEAR	SEMESTER -I	i) C1- Biotechnology and Human Welfare (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	i)C1- Biotechnology and Human Welfare	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- English Communication /Environment & Ecology (Th.3 Cr)	3	3	45	iii) AECC-1- Environment & Ecology	Unit=5/Period=45	N/A	N/A
			iv) DSE-1- Analytical Tools in Biotechnology / Computational biology and Design of Experiment(Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	iv) DSE-1- Analytical Tools in Biotechnology / Computational biology and Design of Experiment	Unit=5/Period=60	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 Biotechnology (Th.4 Cr.+ P 2Cr.)	4+2	8	60+60	ii) C4- Plant Biotechnology	Unit=5/Period=60	N/A	N/A
			iii) AECC-2- English Communication/ Environment & Ecology (Th.3 Cr)	3	3	45	iii) AECC-2- English Communication/ Environment & Ecology	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:

PSO_1 To teach an ability to apply biotechnology skills in various subjects studied during the course.
PSO_2 To provide students with the concepts of Biotechnology to develop interest in science.
PSO_3 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 (96 Credits) IN BIOTECHNOLOGY	SECOND YEAR	SEMESTER -III	i) C5- Cell Biology	4+2	8	60+60	i)C5- 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: Industrial Fermentation / Enzyme Technology	4+2	8	60+60	iv) DSE-3- Industrial Fermentation / Enzyme Technology	Unit=5/Period =60	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 Technology	4+2	8	60+60	i)C 7- Bioprocess 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	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/ Medical and forensic Biotechnology	4+2 4	8 4	60+60 60	v) DSE-4 - Biostatistics and Bioinformatics / Medical and forensic 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.
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 OutcomeB.Sc. BT II year:

PSO_1 To impart an ability to apply biotechnology skills and its applications in core and allied fields.
PSO_2Students are ale to apply the concepts and research approaches.
PSO_3After completions of the two years course students will be awarded with Diploma in Biotechnologyand prepare students for the job after completion of diploma 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)
UNDER GRADUATE DEGREE IN BIOTECHNOLOGY (142Credits)	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	4+2	8	60+60	ii) C10- Recombinant DNA Technology	Unit=5/Period=60	N/A	N/A
			iii) DSE-5- Genomics and Proteomics/ Animal Biotechnology	4+2	8	60+60	iii) DSE-5- Genomics and Proteomics / Animal Biotechnology	Unit=5/Period=60	N/A	N/A
			*Research project/ Industry Training/ Internship Survey	4	4	60				
		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- Intellectual Property Rights, Bioethics and Biohazard Management	4+2	8	60+60	ii) C 12- Intellectual Property Rights, Bioethics and Biohazard Management	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+2	8	60+60	iv) DSE-6 Green Biotechnology and Pollution Control / Biosensors and drug design	Unit=6/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:	Programme Specific Outcome B.Sc. BT III year:
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.	PSO_1 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 PSO_2To provide students with the conceptions from basics to advance research in the field of Biotechnology and enhance their career in higher studies. PSO_3To 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) (187 Credits)	FOURTH YEAR	SEMESTER -VII	i) C13-Biochemistry& Instrumentation	4+2	8	60+60	i) C13-Biochemistry& Instrumentation	Unit=5/Period=60	N/A	N/A
			ii)C14-Immunology	4+2	8	60+60	ii)C14-Immunology	Unit=5/Period=60	N/A	N/A
			iii) DSE7-Biostatistics & Bioinformatics/ Biophysics and structural biology	4+2	8	60+60	iii) DSE7-Biostatistics & Bioinformatics/ 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

		SEMESTER - VIII	C15 Industrial Biotechnology C16- Molecular Biology DSE8- Plant Biotechnology /Genomics & Proteomics iv) G E 3IPR, Patent, Trademarks &Bioethics/ Bio-Entrepreneurshipdevelopment SEC 4- MOOCs/ SWAYAM	4+2 4+2 4+2 4 1+1	8 8 8 4 2		C15 Industrial Biotechnology C16- Molecular Biology DSE8- Plant Biotechnology /Genomics & Proteomics iv) G E3- IPR, Patent, Trademarks &Bioethics/ Bio-Entrepreneurship development SEC 4- MOOCs/ SWAYAM	Unit=5/Period=60 Unit=5/Period=60 Unit=5/Period=60 Unit=5/Period=60 Unit=5/Period=30	N/A N/A N/A N/A N/A	N/A N/A N/A Yes N/A
			*Research project/ Industry Training/ Internship Survey							

***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

Programme Specific Outcome M.Sc. BT I year:

PSO_1Ability 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.

PSO_2To develop awareness of various ethical issues in terms of IPR, patent human genome RDT etc in biotechnology research.

PSO_3Develop skill to present the work through visual, oral and written presentations, including an original research proposal after studying the bioentrepreneurship development course.

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 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, academician 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-Recombinant DNATechnology/ Animal Biotechnology	4+2	8	60+60	iii) DSE9-Recombinant DNATechnology/ 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	20						
***Research topic is to be selected from main core paper.**										

Programme Outcome:	Programme Specific Outcome M.Sc. BT II Year:
Programme Outcome:	PSO_1Ability to enhance the core biotechnology skills in the field of

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 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, academician or industrial person.	industrial biotechnology environment biotechnology RDT etc. PSO_2Students 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. PSO_3 Industry/academia suitable candidates are prepared after completion of Master in Biotechnology program.

Format-3

Format-3

IIMTU-NEP IMPLEMENTATION
Year I/ Semester I

Programme: Biotechnology Certificate/Diploma/Degree/PG **Class: M.Sc. Biotechnology**	Year: First Semester: Semester
Credits Theory: 4 Practical:2	**Subject:** Biochemistry and Instrumentation
Course Code:MBTC-NP-111	**Title: Biochemistry and Instrumentation**

Course Objectives:

CO 1	To aware students about the biomolecule, forces, structure, classifications of biomolecules and transport mechanisms.
CO 2	To aware students about enzymes, classification, factors affecting, Enzyme kinetics, inhibition and its regulations, Enzymes purifications process and various methods involved in enzyme 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% Mark

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, Hydrogen bonds, hydrophobic interactions, Van-der Waal's forces, ionic bond, Principle of thermodynamics, pH and buffers, Transport mechanism, Structure of macromolecules (Carbohydrates, Proteins: Amino acid structure, primary, secondary, tertiary and quaternary structure, Ramchandran's plot, Lipids, Nucleic acids), Introduction to Enzymes: classification, nature and activity, Factors affecting enzyme activity, Enzyme kinetics MichaelisMenten Equation, EadieHofstee plot, Hanes-Woolf plot, Enzyme inhibition and activation of enzymes, Vitamins and coenzymes, Immobilized enzymes and their uses	14
II	**Metabolic pathway:** Glycolysis, pentose phosphate and its regulation gluconeogenesis. Citric acid cycle & its regulation,	12

	conversion of ammonia into urea, electron transport and oxidative phosphorylation, energy field by oxidative-phosphate. Fatty acid oxidation, biosynthesis of fatty acids, triaglycerol and cholesterol, inborn errors of metabolism	
III	**Techniques to separate the biomolecule:** Metabolite purification, Filtration (Microfiltration, Ultrafiltration, Nano-filtration), Ultra-centrifugation, Differential Centrifugation, Chromatography, types, Paper chromatography, Thin Layer Chromatography, column chromatography, affinity chromatography, gel filtration, ion exchange chromatography, HPLC, gas chromatography, Electrophoresis- SDS, immune-electrophoresis, SDS-PAGE	12
IV	**Microscopy and diagnostic techniques:** Microscopy-types and role in biotechnology, compound microscope, and phase contrast microscope, fluorescence microscopy, SEM, TEM, CT- scan, digital microscopy and its role in biotechnology, Spectrophotometry, Lambert Beers law, Autoradiography, NMR, mass spectrometry, radioisotope technique, X-ray crystallography.	12
V	**Molecular technique and Cytochemistry:** principles and application, quantitative chemistry, Molecular diagnostic techniques, PCR, modifications in PCR, real-time PCR, southern, northern and western blotting, metabolic engineering, different nodes of metabolic pathways	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. Upadhay 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
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 themetabolic pathways, regulations and inborn errors associated with metabolic pathways.

CLO3: Students acquired knowledge of various separation techniques, Enzymes purifications process and various methods involved in enzyme 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-111P: Biochemistry and Instrumentation Lab

Marks: 50 **Duration: 60 hours (2 credits)**

1. Amino acids separation and identification through paper chromatography.
2. Demonstration of Microscopy: Light and Electron microscope.
3. Antibiotic's MIC Determination using bacteria and Vitamin assay.
4. Estimation and Quantification of reducing sugars by anthrone method.
5. Identification and Separation of sugars/lipids by TLC.
6. To determine the concentration of Proteins by Lowry's method.
7. Microbial amylase: Identification and estimation
8. Estimation of DNA by Diphenylamine Method
9. To determine the concentration of Reducing Sugars Benedict's Method
10. Specific tests for carbohydrates; Polysaccharide iodine test, Fehling's test, Barfoed's Test and Seliwanoff's Test

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 Theory:4 Practical:2	**Subject: Immunology**
Course Code:MBTC-NP-112	**Title: 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% Mark

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 vs Immunogenicity, 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 types and 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	12

	pathway of complement activation, biological consequence of complement 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 (Immunoelectrophorectic and Immunodiffusion method), Immuno-blotting, fluorescence immunosorbent assay, ELISA, immuno-electronmicroscopy, RIA, latest advancement in immunology research.	14

Reference / Text Books:

1. Janeway'sImmunobiology 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 InvestigAllergolClinImmunol 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 ClinInvestig 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, immunoglobulin's its type, structure and factors influencing immunogenicity.

CLO3 Student will study the diversity in Immune system, Major his to compatibility 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-112P: 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 H_2O 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 Semester : II
Credits Theory:4 Practical:2	**Subject:** Biostatistics and Bioinformatics
Course Code:MBTDSE-NP-113a	**Title:** Biostatistics and Bioinformatics

Course Objectives:
CO1. To study the elementary Statistics, data types, frequency curves, standard deviation, median, quartiles and various types of test.
CO2. To study the Probability, probability laws, probability rules and Introduction of statistical sampling.
CO3. To study the history, scope of bioinformatics, databases and BLAST.
CO4. To study the Sequence and Phylogeny analysis, sequence alignment, its various types.
CO5. To study the Databases, Data Submission tools and Genome Annotation.
CO6. To study the *in silico* tools for *r DNA* technology.

Nature of Paper: DSE-7a

Minimum Passing Marks/Credits : 40% Mark

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	**Elementary Statistics:** Elementary Statistics, Representation of data- discrete data, frequency curves, histogram, polygons, continuous data. The mean variability of data, median, skewness, standard deviation, quartiles, Test of goodness of fit, Small sample test- chi-square test, student t-test.	12
II	**Probability:** Experimental Probability, probability rules for combined events, subjective probabilities, probability when outcomes are equally likely, probability laws, Bayer's Theorem, conditional probability and independent events, Probability theorem, Introduction of statistical sampling from a population, Probability sampling	12
III	**Bioinformatics:** History, scope and Applications. Sequence Alignment Tools, FASTA and BLAST, Directionality of sequence, Types of Databases, EST, Genome informatics: transcription factor regulation and motif finding, Genome sequencing technologies & analysis methods; Artificial Neural Networks.	12
IV	**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	12

	amino acid composition, codon usage and statistics.	
V	**Nucleic acid and protein databases:** Types of Databases, SWISS PROT, Gen Bank, DDBJ, INTERPRO, EMBL, UNIPROT. Resources at NCBI, derived databases, PUBMED, genome databases, MEDLINE, Patent database, structural databases, *in silico* tools for rDNA technology.	12

Reference / Text Books:

1. Gupta S.P, Statistical Method, Sultan Chand & Sons Publications,2005
2. Khan I.A., Statistics, Ukaaz Publications,2009
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 *in silico* tools for *rDNA* 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-113aP : BIOSTATISTICS AND BIOINFORMATICS 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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year I / Semester I

Programme: Master of Science in Biotechnology Certificate/Diploma/Degree/PG **Class: M.Sc. Biotechnology**	Year: I Semester: I
Credits 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

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, structure of myoglobin and hemoglobin, Quaternary structure, protein	10

	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.*200727440-444
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
4) Research Project Report / 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 toaware 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 BIOLOGYLAB

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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year I / Semester II

Programme:Master of Science in Biotechnology Certificate/Diploma/Degree/PG **Class:M.Sc. Biotechnology**		Year: I Semester: II
Credits Theory:4 Practical:2	**Subject :** Industrial Biotechnology	
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

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 bioproduct development	15
II	**Microbes in food industry and agriculture:** Beneficial soil microorganisms, biofertilizers and biopesticides, SCP, microbial production of wine, beer and vinegar; biopreservatives (Nisin), cheese, biopolymers, vitamins; Bioflavours and biopigments; 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,	10

	Production of industrial enzymes such as proteases, amylases, lipases, cellulases, whole cell biocatalysis, Applications of bioconversion, transformation of steroids and sterols	
IV	**Microbial production of pharmaceuticals and other bioproducts**: 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 bionanotechnology 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	4
Seminar On Research Project Report	
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 bio products from industrial biotechnology.
CLO5	Understand the concept of bio fuels 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 microorganismsthat isvital 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 bio products including ethanol, citric acid, and amylase are produced. 3. Isolate microorganisms. 4. Purify the proteins and enzymes that are crucial to industry. 5. Conductand 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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year I / Semester II

Programme: Biotechnology Certificate/Diploma/Degree/PG **Class: M.Sc. Biotechnology**	Year: I Semester: II
Credits 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

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, *Ex-vivo*immunocapture 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 *lac operon* and *trp operon*), 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 thespecific 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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year-I / Semester-II

Programme : Biotechnology Certificate/Diploma/Degree/PG **Class : M.Sc. Biotechnology**	Year : I Semester : II
Credits Theory:4 Practical:2	**Subject: Plant Biotechnology**
Course Code:MBTDSE-NP-123a	**Title : Plant Biotechnology**

Course Objectives:
CO1. To study about plant biotechnology history, scope, and application.
CO2. To study about Cell suspension culture, callus culture, protoplast culture, Somatic hybridization.
CO3. To get knowledge about Haploid production by distant hybridization, Androgenesis (anther and Pollen culture), Gynogenesis (ovule and ovary culture).
CO4. To learn about the production scale- up through bioreactors, secondary metabolite production, bioinsecticides, biopesticides.
CO5. To study about micropropagation from Callus to plant and somatic embryogenesis.
CO6. The overall objectives of the course are to provide advance and in-depth knowledge in the field of plant biotechnology.

Nature of Paper: DSE-8a

Minimum Passing Marks/Credits: 40% Marks

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 of plant biotechnology, laboratory organization of plant tissue culture, chronological development of plant biotechnology, Plant tissue culture media, Plant growth regulators and their use.Cellular totipotency, cyto-differentiation and morphogenesis.	12
II	Types of plant tissue culture: Cell suspensionculture, call us culture, protoplastculture, Somatic hybrid and cybrid , In vivo and in vitro pollination and fertilization, embryo culture and embryo rescue and synthetic seeds.	12
III	Haploid production by distant hybridization, Androgenesis (anther and Pollen culture), Gynogenesis (ovule and ovary culture), clonal propagation and production by micropropagation – meristem tip culture, shoot tip culture and shoot tip grafting.	13
IV	Production scale- up through bioreactors, secondary metabolite production, bioinsecticides, biopesticides and biofertilizers, transgenic plants (production and uses). Preservation of plantgenetics resources germplasm collection and conservation.	13

V	Plant Tissue Culture applications – micro propagation, from Callus to plant, somatic embryogenesis, soma-clonal variation, and chemicals from plants, genetically engineered plants, Banana tissue culture, pineapple tissue culture.	10

Reference / Text Books:

1. Plant Tissue Culture: Techniques and Experiments by Roberta H. Smith. Academic Press, 3rd edition (August , 2012)
2. Plant Biotechnology: An Introduction to Genetic Engineering by Adrian Slater, Nigel W. Scott, Mark R. Fowler. Oxford University Press, 2nd edition (2008)
3. An Introduction to Plant Tissue culture by M K Razdan. Science publication, 2003.
4. Plant tissue culture by Bhojwani. S S and Razdan. M.K 2004.
5. Plant Propagation by Tissue Culture by E F George, M A. Hall, G D Klerk. Springer; 3rd edition (2008).
6. Introduction to Plant Biotechnology by H. S. Chawla, CRC Press, 3rd edition (January 2009)
7. 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 Haploid production by distant hybridization, Androgen sis (anther and Pollen culture), Gynogenesis (ovule and ovary culture),

CLO4: Students will learn about the production scale- up through bioreactors, secondary metabolite production, bioinsecticides, biopesticides.

CLO5: Students will learn about micropropagation 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-123aP: PLANT BIOTECHNOLOGY LAB

Marks: 50 **Duration: 60 hours (2 credits)**

1. Demonstration on to set up a plant tissue culture laboratory.
2. Preparation and formulation of Murashige & Skoog's medium.
3. Explant selection, preparation and surface sterilization.
4. Aseptic handling of numerous explants.
5. To perform the isolation of protoplast from plants.
6. Demonstration of culturing, sub culturing and maintenance using selected explants.
7. Development of the process for synthetic seed production and Somatic embryogenesis
8. To reveal various steps of Micro propagation through practical protocol.
9. Callus production from peripheral layers on explants *in-vitro*.
10. Aseptic isolation from of shoots from floral meristem.

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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year I / Semester II

Programme : Biotechnology Certificate/Diploma/Degree/PG **Class : M.Sc. Biotechnology**	Year: I Semester: II
Credits 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

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, *Arabidopsis*, Yeast. The Human Genome Project, Structural genomics- Assembly of a contiguous DNA sequence-shotgun method, Whole genome sequencing, clone *contig* 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 chromatography, Gel filtration, 2D electrophoresis, Ion exchange chromatography. Applications of proteomics.	12

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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year I / Semester II

Programme : Biotechnology Certificate/Diploma/Degree/PG **Class: M.Sc. Biotechnology**	Year : I Semester : II
Credits 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, bio safety levels, Bio safety 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

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	12

	protocol.	
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.

Format-3

IIMTU-NEP IMPLEMENTATION
Year I / Semester II

Programme : Biotechnology Certificate/Diploma/Degree/PG **Class : M.Sc. Biotechnology**	Year: I Semester: II
Credits Theory:4 Practical:0	**Subject:** Bio-entrepreneurship Development
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 entrepreneurships.
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 bio start-ups.

Nature of Paper: GE- 3b

Minimum Passing Marks/Credits : 40% Marks

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	Healthpreneurs, Molecular Diagnostics, Agri Biotech: Biocontrol agents, Biofertilizers, 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.

Format-3

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 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 proficientso 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

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 andimportance of bioseparation in biotechnological processes: Problems and requirements of bioproducts purification - Properties ofBiomolecules - Characteristics of fermentation broth - Biological activity, Analysis of purity-Process economics: Capital and operating cost analysis.	12
II	**REMOVAL OF INSOUBLES**: Cell disruption methods for intracellularproducts: 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, Extraction: Principle, Batch and continuous, Precipitation: Methods of precipitation,Filtration: Principle and methods, Membrane based	12

	separations: Micro and ultra-filtration, Centrifugation: Principle and methods	
IV	**PURIFICATION OF BIOPRODUCTS:** Basic principles of Chromatographicseparations: ion- exchange, affinity, Electrophoreticseparation techniques: capillary - isoelectric focusing-2D gel electrophoresis -Hybrid separation technologies: GC-MS and LC-MS.	12
V	**PRODUCT POLISHING:** Crystallization: Principles-Nucleation-CrystalBatch crystallizers: Scale-up and design, Drying: Principles-Water in biological solids, Drying equipmentsdescription and operation-Vacuum shelf - rotary dryer-Freeze dryer-Spraydryer, 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	4
Seminar On Research Project Report	
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 ofprimary 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

CLO 6. 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**

Format-3

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 Theory:4 Practical:2	**Subject: Environmental Biotechnology**	
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 To develop understanding of different biological remediation technology with case studies also aware students about nature based solutions of different environmental issues.
- CO 3 To convey information related with core engineering design of bioreactor/bio-digester for solid waste treatment using biological process.
- CO 4 To 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 To aware students about waste to wealth technology in terms of treatment and waste to energy production technology (WTE) (SDG 7).
- CO 6 To aware students about bioenergy and its production technology by various types of bioreactors.

Nature of Paper: Core

Minimum Passing Marks/Credits:40% Marks

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
	UNIT II: Bioremediation: Phytoremediation, microbial bioremediation, microbial desulphurization, biodegradation of xenobiotics, Bioremediation	13

II	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 biomethanation; 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 biorefinary, Different Case studies: Photobioreactor 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. Bionano technology towards Sustainable Management of Environmental Pollution by Naveen Dwivediand Shubha Dwivedi, CRC Press 2022.
4. Environmental Biotechnology B.C. Bhattacharya & Ritu Banerjee, Oxford Press 2007.
5. Bionanotechnologytowards Green Energy: Innovative and Sustainable Approach by ShubhaDwivedi 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, SabeelaBeeviUmmalyma, 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) Research Project Report	4
Seminar On Research Project Report	
5) ESE	75
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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year II /Semester III

Programme: Biotechnology Certificate/Diploma/Degree/PG **Class: M.Sc. Biotechnology**	Year: II Semester: III
Credits 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 andDiagnosis, 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% Mark

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-	12

	TOF.	
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 andDiagnosis, 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-Applying 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 biotherapeutics, 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 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

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 gene therapy, vector used in gene therapy, Animal biotechnology lab requirement and structuring.	12

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.Publiser- 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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year II/ Semester III

Programme: Biotechnology Certificate/Diploma/Degree/PG **Class:M.Sc. Biotechnology**	Year:II Semester: III
Credits Theory:4 Practical:0	**Subject:** Nanobiotechnology
Course Code: MBTGE- NP-234a	**Title:**Nanobiotechnology

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 bionanomaterials.
CO3. To discover more about Microbial Nanoparticle Production.
CO4. For comprehension about DNA-Protein Nanostructures and various technologies associated with Nanobiotechnology.
CO5. To impart knowledge of Nanobiotechnology in various advanced the biotechnology sector.
CO6. The course's fundamental objective is to create Nanobiotechnology as potential tools in providing advance applications towards environmental solutions.

Nature of Paper: GE-4a

Minimum Passing Marks/Credits:40% Marks

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	**UNITI**: **Introduction to Nanoscience and Nanotechnology/nanobiotechnology:** Basic idea of quantum mechanics, History of Nanotechnology, Nanoscience in nature, Nanobiotechnology and Bionanotechnology, history of nanobiotechnology, Biological production of metal nano particles/ nanomaterials, macro molecular assemblies and nanocomposites.	12
II	**UNIT II: Biomolecules as Nanomaterials:** Artificial, Natural and Bionanomaterials, DNA, RNA, lipids and carbohydrates as Nanomaterials, Nanobiomotors, Nanobiomachines 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 techniques- FTIR, SEM, TEM, AFM, X-ray diffraction, Fabrication of nanomaterials, Surface modification techniques.	12
V	**UNIT V: Application of Bionanotechnology:** Preparation of nanodrug, liposome as drug vesicle, General idea of drug delivery, Bionanotechnology 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. Nanobiotechnology: Concepts, Applications and Perspectives, Christof 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. Bionanotechnologytowards Sustainable Management of Environmental Pollution by Naveen Dwivedi and ShubhaDwivedi, CRC Press 2022.
4. Nanotechnology, William Illsey Atkinson, JAICO Publishing House, Second Impression-2008.
5. Bionanotechnologytowards Green Energy: Innovative and Sustainable Approach by ShubhaDwivedi 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 Tonycass, Biosensors II edition, Oxford Publication.
10. MansiKarkare (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 2) Presentations /Seminar/ Attendance 3)Assignments 4)Research Project Report Seminar On Research Project Report 5) ESE	16 5 4 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 nanobiotechnology 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: Thebasic outcome of the course is to create Nanobiotechnology as potential tools in providing advance applications. CLO 6: The course's overall outcome is to create Nanobiotechnology 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.

Format-3

IIMTU-NEP IMPLEMENTATION
Year II/ Semester III

Programme: Biotechnology Certificate/Diploma/Degree/PG **Class:M.Sc. Biotechnology**	Year: II Semester:III
Credits 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

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; Chemiosmotichypothesis of oxidative phosphorylation; Mechanism of ATP synthesis, Control of oxidative phosphorylation. Metabolites and metabolite profiling, Metabolomics - applications and its role in systems biology with case studies.	12
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
4) Research Project Report 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 Sciences 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, sericulrure, 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 candidate spursuing 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 exceed10%.

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 reputing 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.

ASSESMENT:

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 programfor 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 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, 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 then 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 sub stantiated. 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-bail able 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

IIMT UNIVERSITY MEERUT (U.P.)

Transforming Education System, Transforming Lives

UGC Approved Section 2f & 12B

M.Sc. ZOOLOGY Semester-I										
S.No.	**Course Code**	**Subject**	**Course Type**	**Study Scheme**			**Evaluation Scheme**			**Credit**
				L	**T**	**P**	**Internal**	**External**	**Total**	
1	MSZC-NP-111	Biosystematics, Taxonomy & Evolution	Core 1	4	0	0	25	75	100	4
2	MSZC-NP-112	Structure and Function of Invertebrates	Core 2	4	0	0	25	75	100	4
3	MSZDSE-NP-113a	Cell Biology	DSE 1	4	0	0	25	75	100	4
	MSZDSE-NP-113b	Genetics								
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	MSZC-NP-111P	Biosystematics, Taxonomy & Evolution Lab	Core 1	0	0	2	20	30	50	2
2	MSZC-NP-112P	Structure and Function of Invertebrates Lab	Core 2	0	0	2	20	30	50	2
3	MSZDSE-NP-113aP	Cell Biology Lab	DSE 1	0	0	2	20	30	50	2
	MSZDSE-NP-113bP	Genetics Lab								
		TOTAL					**150**	**350**	**500**	
4	SPT-471	Sports	USEC	0	0	0	50	0	NC	0
21 (23 including NCC)										

M.Sc. ZOOLOGY
Semester-II

S.No.	Course Code	Subject	Course Type	Study Scheme			Evaluation Scheme			Credit
				L	T	P	Internal	External	Total	
1	MSZC-NP-121	Structure and Function of Vertebrates	Core 3	4	0	0	25	75	100	4
2	MSZC-NP-122	Molecular Biology	Core 4	4	0	0	25	75	100	4
3	MSZDSE-NP-123a	Environmental Science and Wildlife Management	DSE 2	4	0	0	25	75	100	4
	MSZDSE-NP-123b	Biochemistry and Instrumentation Techniques								
4	MSZGE- NP-124a	Intellectual Property Rights	GE 1	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	MSZC-NP-121P	Structure and Function of Vertebrates Lab	Core 3	0	0	2	20	30	50	2
2	MSZC-NP-122P	Molecular Biology Lab	Core 4	0	0	2	20	30	50	2
3	MSZDSE-NP-123aP	Environmental Science and Wildlife Management 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. ZOOLOGY
Semester-III

S.No.	Course Code	Subject	Course Type	Study Scheme			Evaluation Scheme			Credit
				L	T	P	Internal	External	Total	
1	MSZC-NP-231	Animal Physiology	Core 5	4	0	0	25	75	100	4
2	MSZC-NP-232	Animal Behavior	Core 6	4	0	0	25	75	100	4
3	MSZDSE-NP-233a	Fish Biology	DSE 3	4	0	0	25	75	100	4
	MSZDSE-NP-233b	Entomology								
4	MSZGE-NP-234a	Biostatistics and Bioinformatics	GE-2	4	0	0	25	75	100	4
	MSZGE-NP-234b	Recombinant DNA Technology								
5	GENCC-901	NCC	Gen E	2						2
6	NECC-592	University Social Responsibility	USEC				25	0	NC	0
		PRACTICALS								
1	MSZC-NP-231P	Animal Physiology Lab	Core 5	0	0	2	20	30	50	2
2	MSZC-NP-232P	Animal Behavior Lab	Core 6	0	0	2	20	30	50	2
3	MSZDSE-NP-233aP	Fish Biology Lab	DSE 3	0	0	2	20	30	50	2
	MSZDSE-NP-233bP	Entomology Lab								
		TOTAL					**160**	**390**	**550**	
4	SPT-591	Sports	USEC	0	0	0	50	0	NC	0
		22 (24 including NCC)								

M.Sc. ZOOLOGY
Semester-IV

S.No.	Course Code	Subject	Course Type	Study Scheme			Evaluation Scheme			Credit
				L	T	P	Internal	External	Total	
1	MSZC-NP-241F	Fish Physiology	Core 7	4	0	0	25	75	100	4
2	MSZC-NP-242F	Fish Culture and Fisheries Science	Core 8	4	0	0	25	75	100	4
3	MSZDSE-NP-243aF	Applied Fisheries	DSE 4	4	0	0	25	75	100	4
	MSZDSE-NP-243bF	Fish Pathology and Microbiology								
4	MSZ-RP-241	Field Visit/ Survey/ Research Project	Industrial Training/ Research Project				25	75	100	4
5	GENCC-901	NCC	Gen E	2						2
6	NECC-5X2	University Social Responsibility	USEC				25	0	NC	0
7	NECC-5X4	MOOCs/ SWAYAM	SEC- 2	2			50	0	50	2
		PRACTICALS								
1	MSZC-NP-241FP	Fish Physiology Lab	Core 7	0	0	2	20	30	50	2
2	MSZC-NP-242FP	Fish Culture and Fisheries Science Lab	Core 8	0	0	2	20	30	50	2
3	MSZDSE-NP-243aFP	Applied Fisheries Lab	DSE 4	0	0	2	20	30	50	2
	MSZDSE-NP-243bFP	Fish Pathology and Microbiology Lab								
		TOTAL					**210**	**390**	**600**	
4	SPT-5X1	Sports	USEC	0	0	0	50	0	NC	0
		24 (26 including NCC)								

Format-1

Format 1

College/ School: Life Science & Technology Programme: M.Sc. Zoology Duration: 4 Semesters/ 2 Years					Credit range: 80 to 110 (Suggested by CBCS Committee)					
COURSE	**CREDIT**	**SEMESTER**	**CORE (Th 4+P 2)**	**DSE (Th 4+P 2)**	**AECC (Th 3)**	**SEC (Th 1+1)**	**GE (Th 4)**	**GEC (2)**	**Industrial Training/ Survey Project (4)**	**Total Credits**
Master of Science in Zoology	49	Ist	C1-Biosystematics, Taxonomy & Evolution C 2-Structure and Functions of Invertebrates	DSE-1: Cell Biology/Genetics	AECC 5-English Communication			NCC		23
		2nd	C3-Structure and Functions of Vertebrates C4-Molecular Biology	DSE-2: Environmental Science and Wildlife Management/Biochemistry and Instrumentation Techniques		SEC 1-MOOCs/ SWAYAM	GE 1: Intellectual Property Rights/Entrepreneurship Development	NCC		26
Master of Science in Zoology	50	3rd	C5-Animal Physiology C6-Animal Behavior	DSE-3: Fish Biology / Entomology			GE2:Biostatistics and Bioinformatics /Recombinant DNA Technology	NCC		24
		4 th	C7-Fish Physiology C8-Fish Culture and Fisheries Science	DSE- 4:Applied Fisheries/Fish Pathology and Microbiology		SEC 2-MOOCs/ SWAYAM		NCC	Field visit/ Survey/ Research Project	26

Format-2

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 Zoology	FIRST YEAR	SEMESTER –I	i) C1:Biosystematics, Taxonomy & Evolution (Th.4 Cr.+ P 2Cr.) ii) C2:Structure and Functions of Invertebrates (Th.4 Cr.+ P 2Cr.) iii) AECC-1 English Communication iv) DSE-1:Cell biology/Genetics (Th.4 Cr.+ P 2Cr.)	4+2 4+2 3 4+2	8 8 3 8	60+60 60+60 60 60+60	MSZC-NP-111 MSZC-NP-112 NHU-N-111 MSZDSE-NP-113a/ MSZDSE-NP-113b	V V V V	B.Sc(CBZ)/ B.Sc. (Zool) Hons.	

		SEMESTER – II	i) C3: Structure and Functions of Vertebrates (Th.4 Cr.+ P 2Cr.) ii) C4:Molecular Biology (Th.4 Cr.+ P 2Cr.) iii) SEC-1:MOOCs/ SWAYAM iv) DSE2: (Th.4 Cr.+ P 2Cr.) Environmental Science and Wildlife Management/ Biochemistry and Instrumentation Techniques v) GE 1:Intellectual Property Rights/Entrepreneurship Development	4+2 4+2 2 4+2 4	8 8 2 8 4	60+60 60+60 30 60+60 60	MSZC-NP-121 MSZC-NP-122 NECC-484 MSZDSE-NP-123a/ MSZDSE-NP-123b MSZGE-NP-124a/ MSZGE-NP-124b	V V V V		

Programme Outcome:	Programme Specific 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, vermiculture, fisheries ,poultry, dairy farms etc PO-6: Expertise in handling various laboratory equipment and	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: 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.

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	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) 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.) ii) C8: Fish Culture and Fisheries Science (Th. 4 Cr. + P 2Cr.) iii)SEC-2: MOOCs/ SWAYAM iv) DSE-4: Applied Fisheries/Fish Pathology and Microbiology (Th.4 Cr.+ P 2Cr.)	4+2 4+2 2 4+2	8 8 2 8	60+60 60+60 30 60+60	MSZC-NP-241F MSZC-NP-242F NECC-5X4 MSZDSE-NP-243aF/MSZDSE-NP-243bF	V V V		
			Field Visit / Survey /Research Project	4	-	-	MSZ-RP-241			

Programme Outcome:	Programme Specific 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	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, sericulrure, aquaculture, agriculture and

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, 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.	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

Format-3

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 Semester: I	
Credits Theory:4 Practical:2	**Subject: Zoology**		
Course Code:MSZC-NP-111	**Title: Biosystematics, Taxonomy and Evolution**		
Course Objectives: CO1: To develop the understanding on biosystematics and taxonomic importance in the biological science. CO2: To develop the basic understanding on speciation, species concepts and origin of reproductive isolation. CO3: To understand the International Code of Zoological Nomenclature, Its operative principle and scientific nomenclature. CO4: To develop the concept of evolution and theories of organic evolution, Natural selection, Mutation, Genetic drift, Migration. CO5: To analyses of quantitative traits, and construction of a phylogenetic tree.			
Nature of Paper: Core/DSE/SEC/GE/AECC: Core			
Minimum Passing Marks/Credits:40% Marks			
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	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, cytotaxonomy, 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 principles, interpretation and applications of important rules.	12
IV	Concept of evolution and theories of organic evaluation with an emphasis	12

	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	
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 Lyal, 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.NA

Evaluation/Assessment Methodology	
	Max. Marks:100
1) Sessional Examination 2) Assignments 3) Presentations /Seminar /Attendance 4) ESE	**16** **5** **4** **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.

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** **Semester: I**
Credits: 06 Theory: 04 Practical: 02	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

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.	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**

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 Semester : I
Credits Theory:4 Practical:2	**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% Mark	
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, skeletoncanal 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 Nemathelminthes	12
III	Annelida: General characters, outline classification,segementation, 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, water vascular system and regeneration	12

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.

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 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 hemichor data.

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** **Semester: I**
Credits: 06 Theory : 04 Practical : 02		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: 40% Marks		
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.	Identification, classification & study of distinguishing features of representatives from various groups.	**5**
2.	Phylum Protozoa- *Polystomella, Formanifera, Opalina, Paramecium* (Fission & conjugation) *Vorticella, Euglena, Trypanosoma, Monocytsis, Plasmodium*	**5**
3.	Phylum Porifera- *Sycon* L.S & T.S, *Spicules, Sponginfibres, Leucosolenia, Euplectella*	**5**
4.	Phylum Cnidaria- *Obelia*, (polyp& Medusa), *Millepora, Physalia, Pennatula, Metridium, Madrepora, Alcyonium, Gorgonia, Aurelia.*	**5**
5.	Phylum Helminthes- *Ascaris, Taenia, Planaria*	**5**
6.	Phylum Annelida - *Pontobdella, Aphrodite, Leech Polygordius, Chaetopterus, Neries, Heteroneries, Arenicola.*	**5**
7.	Phylum Arthropoda- *Cyclops, Peripatus, Balanus, Lepas, Hippa, Belostoma, Limulus, Eupagurus, Julus, Scolopendra, Praying mantis*.	**5**
8.	Phylum Mollusca- *Murex, Bulla, Cardium, Arca, Turritella, Pinctada, Cypraea, Octopus, Nautilus. Phylum Echinodermata- Echinus, Holothuria, Antedon, Asterias*	**5**
9.	Minor Phyla- *Bugula, Plumatella, Crestatella, Pectinella,Phoronis, Dendrostoma*	**5**
10.	Larval Stages: *Planula, Redia, Miracidium, Sporocyst, Cercaria, Metacercaria Trochophore, Nauplius, Zoea*	**5**

11.	*Mysis, Phyllosoma, Trilobite larva of Limulus, Velligar, Bipinnaria, Echinopluteus, Auricularia, Tornaria*	**5**
12.	*Dissections: Cockroach: General anatomy, Reproductive system, Nervous system Mouthparts: Cockroach & Mosquito* (Through models and virtual lab)	**5**

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 Semester: I
Credits Theory:4 Practical:2	**Subject: Zoology**
Course Code: MSZDSE-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

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. 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: 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.

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** **Semester : I**
Credits: 06 Theory: 04 Practical: 02	Subject : **Zoology**
Course Code : MSZDSE-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 of salivery 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: 40% Marks

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.	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**

Format-3

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 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

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	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

<table>
<tr><th colspan="2">Evaluation/Assessment Methodology</th></tr>
<tr><td colspan="2" align="right">Max. Marks:100</td></tr>
<tr><td>1. Sessional Examination
2. Assignments
3. Presentations /Seminar /Attendance
4. ESE</td><td align="center">16
5
4
75</td></tr>
<tr><td align="right">Total:</td><td align="center">100</td></tr>
<tr><td colspan="2">Prerequisites for the course:</td></tr>
<tr><td colspan="2">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 Protochordates and Marsupiails.
CLO6: Student will be able to explain anatomy of the major vertebrate taxa.</td></tr>
</table>

Format-3

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: 06 Theory: 04 Practical: 02	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: 40% Marks

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.	**Class- Ascidiaceae**: *Herdmania, Botryllus, Pyrosoma,Doliolum, Salpa, Oikopleura*	**10**
2.	**Class-Pisces:***Rhinobatus, Chimaera, Acipensor, Amia,Notopterus, Notopterus, Echeneis, Diodon, Triacanthus, Trichurius*	**10**
3.	**Class Amphibia**: *Ichythophis, Ambyostoma, Rhacophorus, Rana*	**7**
4.	**Class- Reptilia**: *Chelone, Chameleon, Draco, Naja, Bungarus, Viper, Alligator*	**7**
5.	**Class – Aves**: Koel , Indian tailor bird,Fowl, Peacock, Emu, Ostrich, Penguin	**7**
6.	**Class- Mammalia:***Loris, Indian Otter, Bat, Pangolin, Ornithorhyncus, Kangaroo, Whale Rhesus monkey, Lion*	**7**
7.	**Osteology Osteology :** Bones of frog, varanus, fowl, rabbit (Skull, Vertebrae, Pectoral & pelvic girdle, Limb bones)	**6**
8.	**DISSECTION :** *Channa punctata* (Demonstration Only) - Afferent, Efferent Blood vessel, Cranial nerves. Rat/ Mice - Digestive System, Reproductive system. (Through models and virtual lab)	**6**

Format-3

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 Theory:4 Practical:2	**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

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 tRNA, factors, elongation and termination, Post-translational processes	12

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 andRegulation. 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.

Format-3

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: 06 Theory: 04 Practical: 02	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: 40% Marks	
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.	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**

Format-3

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 Theory:4 Practical:2	**Subject: Zoology**
Course Code:MSZDSE-NP-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

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	Environmental pollution –air, water, soil, noise and radioactive pollution, global warming and green house effect, Concept of sustainable development	12
II	Biogeochemical cycles(C, O, N, P, S) Population ecology: Natality and mortality, Population age, distribution, population growth curves, Factors affecting population growth, population regulation.	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	Habitat diversity, Indian wildlife sanctuaries, national parks and biosphere reserves, Wildlife (protection) Act of1972. 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	12

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.

Format-3

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: 06 Theory: 04 Practical: 02	Subject : **Zoology**
Course Code:MSZDSE-NP-123aP	**TITLE : Environmental Science and Wildlife Managemen**t
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: 40% Marks	
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 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 II / Semester III

Programme:Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D. **Class: M.Sc. Zoology**		Year : II Semester : III	
Credits Theory:4 Practical:2	**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			
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, energybalance, 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.

Format-3

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: 06 Theory: 04 Practical: 02	Subject : **Zoology**
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: 40% Marks	
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 haemoglobin 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**

Format-3

IIMTU-NEP IMPLEMENTATION
Year: I / Semester : III

Programme:Master of Science in Zoology Certificate/Diploma/Degree//PG/Ph.D. **Class: M.Sc. Zoology**	Year: II Semester: III
Credits Theory:4 Practical:2	**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	
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 2. Assignments 3. Presentations /Seminar /Attendance 4. ESE	**16** **5** **4** **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 thical 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.	

Format-3

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: 06 Theory: 04 Practical: 02	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: 40% Marks

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.**

Format-3

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 Theory:4 Practical:2	**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 locomotion and 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	
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- Vertibral 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-receptors and electric organs. Luminescent organs in fishes - Location, structure and control of	12

	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.

Format-3

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: 06 Theory: 04 Practical: 02	Subject : **Zoology**
Course Code: MSZDSE-233aP	**TITLE: Fish Biology**

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: 40% Marks

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: *Clarias Heterropneustes* Internal ear of *Channapunctate*	**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**

Format-3

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 Theory:4 Practical:2	**Subject: Zoology**
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

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 pseudobranch.	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.	

Format-3

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 : 06 Theory : 04 Practical : 02	Subject : **Zoology**
Course Code:MSZC-NP 241FP	**TITLE : Fish Physiology**
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: 40% Marks	
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 (*H. fossilis*) 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 Theory:4 Practical:2	**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 reverine 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

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 (*Heteropneustis*, *Clarias*, *Channa* & *Anabas*).	12
II	**Riverine fisheries** - Ecology and fisheries of the major river systems of India, Production and potential of reverine 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,	12

	Indian Antartic Expedition & relevance to fishing.	

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: 06 Theory: 04 Practical: 02	Subject : **Zoology**
Course Code : MSZC-NP-242FP	**TITLE: Fish Culture and Fisheries Science**

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: 40% Marks

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 *Channamarulius* *Channapunctata* *Channastriata* *Channagachua* *Nandusnandus* *Ompokpabda* *Ailiacoila* *Clariasbatrachus* *Clariasgariepinus* *Bagariusbagarius* *Heteropneustusfossilis* *Sperataaor* *Mystuscavasius* *Mystustengra* *Sperataseenghala* *Mystusvittatus* *Rita rita* *Wallagoattu*	**50**

	Mastacembelusarmatus *Macrognathuspancalus* *Macrognathusaculeatus* *Notopterusnotopterus* *Notopteruschitala* *Labeocalbasu* *Labeovictoriances* *Labeorohita* *Catlacatla* *Puntiussarana* *Cirrhinusmrigala* *Cirrhinusreba* *Cyprinuscarpio* *Hypophthalmichthysnobilis*	

Format-3

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 Theory:4 Practical:2	**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		
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 identiy 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

<table>
<tr><td colspan="2">Programme : Master of Science in Zoology
Certificate/Diploma/Degree//PG/Ph.D.
Class: M.Sc. Zoology</td><td colspan="2">Year: II
Semester: IV</td></tr>
<tr><td colspan="2">Credits : 06
Theory : 04
Practical : 02</td><td colspan="2">Subject: Zoology</td></tr>
<tr><td colspan="2">Course Code:MSZDSE-NP-243aFP</td><td colspan="2">TITLE: Applied Fisheries Lab</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="4">Nature of Paper : DSE</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 4
T:
P: 4(In Hours/Week)
Theory - 1 Hr. = 1 Credit
Practical- 2 Hrs.=1Credit (4Hrs./Week=4Credits)</td></tr>
<tr><td>S.No</td><td colspan="2">List of Experiments</td><td>No. of Lectures Allotted</td></tr>
<tr><td>1.</td><td colspan="2">Induced Breeding with Pituitary Gland Extraction from Fish. (Through virtual lab)</td><td>10</td></tr>
<tr><td>2.</td><td colspan="2">To discuss the technique of Breeding in fishes.</td><td>10</td></tr>
<tr><td>3.</td><td colspan="2">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</td><td>30</td></tr>
<tr><td>4.</td><td colspan="2">Comment upon the different types of nets and gears</td><td>10</td></tr>
</table>

School of Life Science & Technology

ACADEMIC HAND BOOK

Ph.D. Botany Coursework

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: 04 Theory: 04	Subject: **Botany**
Course Code: DBTC-113	Title: **Research Methodology**
Nature of Paper: **Core**	
Minimum Passing Marks/Credits: 40% Marks	
L: 4 Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)	

Unit	Contents	Lectures
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. Date 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 hazards. **Instrumentation**: Description and principles of (i) Electrophoresis (ii) PCR Machine (iii) Laminar Flow (iv) Ultracentrifuge (v) Autoclave and (vi) Light	12

	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). *Understanding research methods and statistics*. (2^{nd} 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.

Format-3

IIMTU-NEP IMPLEMENTATION
COURSE WORK

<table>
<tr><td colspan="2">Programme: Ph.D.
Certificate/Diploma/Degree/UG(R)/PG/Ph.D.
Class: Ph.D</td><td colspan="2">Course Work</td></tr>
<tr><td>Credits: 02
Theory: 02</td><td colspan="3">Subject: Botany</td></tr>
<tr><td>Course Code: DBOC-112</td><td colspan="3">Title: Techniques in Biochemistry</td></tr>
<tr><td colspan="4">Course Objectives: This course provides
1. The theory and knowledge relevant to the plant Biochemistry principles
2. Techniques employed in biomolecules 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.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="4">L: 4
P: 4
Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)
Practical- 2 Hrs.= 1 Credit (4Hrs./Week=2Credits)</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>Lectures</td></tr>
<tr><td>I</td><td colspan="2">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). 16s rRNA sequencing, Metagenomics, Transcriptoms analysis, High thoughput gene sequencing.</td><td>6</td></tr>
<tr><td>II</td><td colspan="2">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;</td><td>6</td></tr>
<tr><td>III</td><td colspan="2">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</td><td>6</td></tr>
<tr><td>IV</td><td colspan="2">Basic Techniques of Protein Chemistry: Protein isolation and purification (including column chromatographies), Polyacrylamide Gel Electrophoresis (PAGE)</td><td>6</td></tr>
<tr><td>V</td><td colspan="2">Microbial biotechnology: Isolation, purification, cultivation and preservation of microbes, identification based on molecular methods.
Basic introduction to Bioinformatics</td><td>6</td></tr>
<tr><td colspan="4">Reference / Text Books:
▪ V S Mathura, 2009, Bioinformatics a concepts based introduction.</td></tr>
</table>

- 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 biomolecules, 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

Format-3

IIMTU-NEP IMPLEMENTATION
COURSE WORK

<table>
<tr><td colspan="2">Programme: Ph.D.
Certificate/Diploma/Degree/
UG(R)/PG/Ph.D.
Class: Ph.D</td><td>Course Work</td></tr>
<tr><td>Credits: 04
Theory: 04</td><td colspan="2">Subject: Botany</td></tr>
<tr><td>Course Code: DDSE-002</td><td colspan="2">Title: IMMUNOLOGY</td></tr>
<tr><td colspan="3">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</td></tr>
<tr><td colspan="3">Nature of Paper: Core</td></tr>
<tr><td colspan="3">Minimum Passing Marks/Credits: 40% Marks</td></tr>
<tr><td colspan="3">L: 4
Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)</td></tr>
</table>

Unit	Contents	Lectures
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 histocompatibility 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 & Amp; Maled, 2007, Immunology. Mosby Edinburgh, NY, USA.
4. E. Benjamini Richard Coico,Geoffery, 2008, Immunology A Short Course. Sunshine A John Wiley & amp; 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

Format-3

IIMTU-NEP IMPLEMENTATION
COURSE WORK

Programme: **Ph.D.** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: **Ph.D.**		**Course Work**
Credits: 04 Theory: 04	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: 04

L: 4
Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)

Unit	Contents	Lectures
I	Introduction to Double helix and chemical structure of DNA and RNA. Organization of prokaryotic and eukaryotic genomes, supercoiling, 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. Gardland Science Taylor & Amp; Francess Group USA &
2. London
3. S Surzycki, 2000, Basic Techniques in Molecular Biology. Springer Science, USA.
4. Helen Kreuzer, 2008, Molecular Biology & 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. Gardland Science Taylor & Francess Group USA &

BOS

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,
2. and malfunctions of these processes in disease.
3. Discuss chromatin structure and how it can be modified to affect gene expression.
4. Explain the mechanisms of DNA replication and repair, RNA synthesis and processing, and protein synthesis.
5. Describe how gene expression is regulated at the transcriptional and post-transcriptional level.

Format-3

IIMTU-NEP IMPLEMENTATION
COURSE WORK

<table>
<tr><td colspan="2">Programme: Ph.D.
Certificate/Diploma/Degree/
UG(R)/PG/Ph.D.
Class: Ph.D</td><td colspan="2">Course Work</td></tr>
<tr><td colspan="2">Credits: 04
Theory: 04</td><td colspan="2">Subject: Botany</td></tr>
<tr><td colspan="2">Course Code: DDSE-005</td><td colspan="2">Title: ENZYME TECHNOLOGY</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="4">Nature of Paper: Core</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 04</td></tr>
<tr><td colspan="4">L: 4
Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)</td></tr>
<tr><th>Unit</th><th colspan="2">Contents</th><th>Lectures</th></tr>
<tr><td>I</td><td colspan="2">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</td><td>10</td></tr>
<tr><td>II</td><td colspan="2">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).</td><td>10</td></tr>
<tr><td>III</td><td colspan="2">Reversible Inhibition- Competitive, Non Competitive, Uncompetitive, Mixed, Substrate, Allosteric and Product Inhibition. Irreversible Inhibition- Suicide inhibition. Examples and Mechanism of various Inhibitions like Penicillin, Iodoacetamide and DIPF.</td><td>10</td></tr>
<tr><td>IV</td><td colspan="2">Enzyme Kinetics</td><td>10</td></tr>
</table>

	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.	
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.

Format-3

IIMTU-NEP IMPLEMENTATION
COURSE WORK

Programme: **Ph.D.** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: **Ph.D**		**Course Work**
Credits: 04 Theory: 04	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

L: 4
Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)

Unit	Contents	Lectures
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 lignification in defence.	**12**
IV	Fungal Biotechnology Fungal protoplast: Isolation, mycolytic enzymes, hyphal organization and protoplast formation, PEG induced and electrofusion 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, 1, and E. Zeiger. 2003. Plant physiology, Vol. 3Sinquer 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 2) TA 3) ESE	**20** **10** **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.	

Format-3

IIMTU-NEP IMPLEMENTATION
COURSE WORK

Programme: **Ph.D.** Certificate/Diploma/Degree/ UG(R)/PG/Ph.D. Class: **Ph.D**	**Course Work**
Credits: 04 Theory: 04	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

L: 4
Theory - 1 Hr. = 1 Credit (4Hrs./Week=4Credits)

Unit	Contents	Lectures
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 Bioproductivity and Photosynthesis, Pergmon Press, Oxford
6. Hall, Sccurlik, Bolhar, Norden Kamf, Leagood and Long (1993) Photosynthesis and production in a Changing Environment. A Field and Laboratory Manual, Chapman and Hall Publication
7. Buchnan, 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**

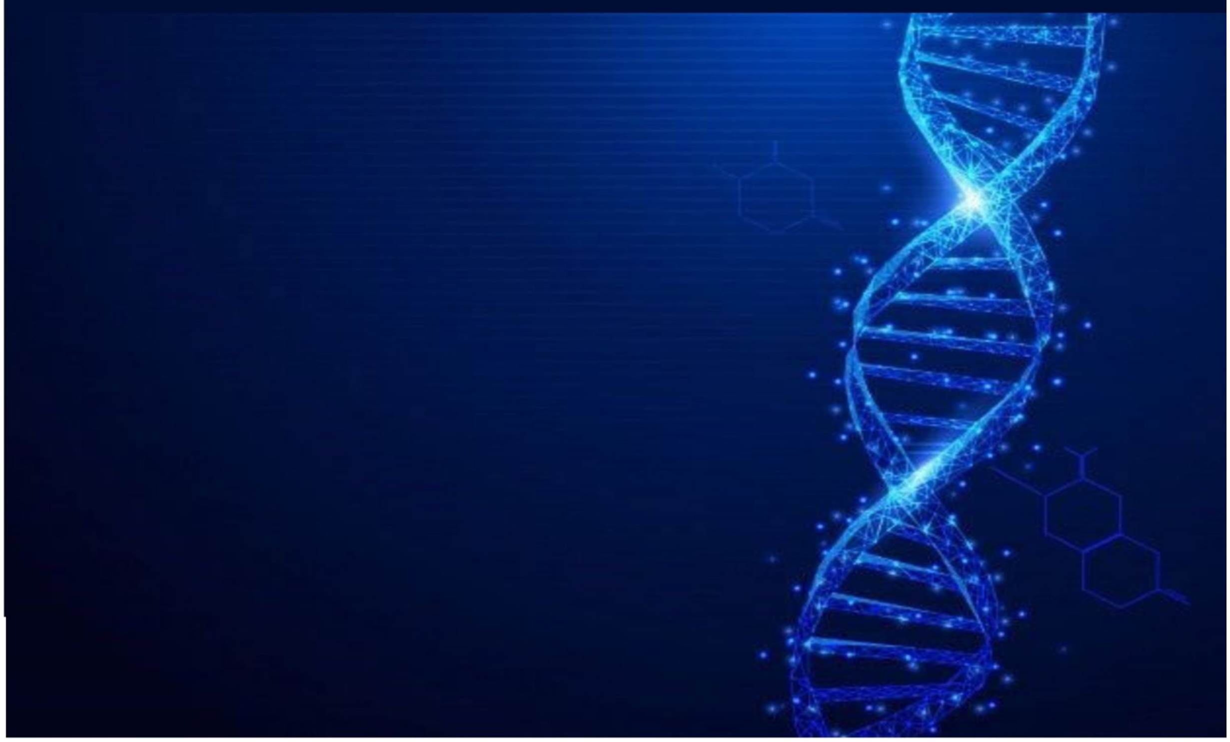
Course Learning Outcomes:

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.

School of Life Science & Technology

ACADEMIC HAND BOOK



Ph.D. Biotechnology Coursework

Evaluation Scheme
Ph.D. Biotechnology Coursework
Session September 2022-23

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

Foramt-3

IIMTU-NEP IMPLEMENTATION
IMMUNOLOGY
(CREDITS: 4) (CODE: DDSE -002)

Programme: Ph.D. in Biotechnology **Class: Ph.D. Biotechnology**	Coursework Semester: I
Credits Theory: 4	**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

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, adjuants 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. 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 OFDISEASE, (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 welll 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 2) Tutorial Assessment 3) ESE	20 10 70
Total:	100

Format-3

IIMTU-NEP IMPLEMENTATION
MOLECULAR BIOLOGY
(CREDITS: 4) (CODE: DDSE -003)

Programme: Ph.D. in Biotechnology **Class: Ph.D. Biotechnology**	Year: Coursework Semester: I
Credits Theory: 4	**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

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 supercoiling, 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, Polyribosomes.	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. McGehee, 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 **Class: Ph.D. Biotechnology**	Coursework Semester: I
Credits Theory: 4	**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

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 expressionprofiling; Whole genome analysis of mRNA and protein expression; Real time PCR andMicroarrays and their applications.	10
IV	Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral mediated delivery, *Agrobacterium* - 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 Bioprocessing 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. Blackwel 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 known 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 **Class: Ph.D. Biotechnology**	Coursework Semester: I
Credits Theory: 4	**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

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	12

	Inhibitions .	
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

Format-3

IIMTU-NEP IMPLEMENTATION
CELL BIOLOGY
(CREDITS: 4) (CODE: DDSE-006)

Programme: Ph.D. in Biotechnology **Class: Ph.D. Biotechnology**	Coursework Semester: I
Credits Theory: 4	**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

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 of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP	13

	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). NewYork: W. H. Freeman ISBN-10: 0-7167-3136-3.
4. Cell Death Techniques: A Laboratory Manual, Edited by Ricky Johnstone, PhD, Peter MacCallum Cancer Centre; John Silke, PhD, The Walter and Eliza HallInstitute 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

Format-3

IIMTU-NEP IMPLEMENTATION
GREEN REMEDIATION AND WASTEWATER TREATMENT
(CREDITS: 4) (CODE: DDSE-007)

Programme: Ph.D. in Biotechnology **Class: Ph.D. Biotechnology**	Coursework Semester: I
Credits Theory: 4	**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

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, *in situ* and *ex situ* 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	15

	interactions with inorganic pollutants. Microbial metal resistance, 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 treatmentsaerobic 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. Phytoremediation. 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 DwivediCRC 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 andApplications. 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

IIMT UNIVERSITY
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Section 2f & 12B

School of Life Science & Technology

ACADEMIC HAND BOOK

Ph.D. Microbiology Coursework

Academic Hand Book (School of Life Sciences & Technology)

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

Format-3

CORE
DMBC-112: MICROBIAL TECHNIQUES

<table>
<tr><td colspan="2">Programme: Ph.D
Class: Microbiology</td><td colspan="2">Year: I
Semester: I</td></tr>
<tr><td colspan="2">Credits
Theory: 4
Practical: 0</td><td colspan="2">Subject: MICROBIOLOGY</td></tr>
<tr><td colspan="2">Course Code:DMBC-112</td><td colspan="2">Title: MICROBIAL TECHNIQUES</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="4">Nature of Paper: Core/DSE/SEC/GE/AECC[CORE]</td></tr>
<tr><td colspan="4">Minimum Passing Marks/Credits: 15% Marks</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>No. of Lectures Allotted</td></tr>
<tr><td>I</td><td colspan="2">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.</td><td>06</td></tr>
<tr><td>II</td><td colspan="2">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.</td><td>06</td></tr>
<tr><td>III</td><td colspan="2">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,</td><td>06</td></tr>
<tr><td>IV</td><td colspan="2">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).</td><td>06</td></tr>
<tr><td>V</td><td colspan="2">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.</td><td>06</td></tr>
</table>

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 2) Presentations /Seminar 3) Assignments 4) Research Project Report Seminar On Research Project Report 5) ESE/Attendance	10 - - - - 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.	

Format-3

DISCIPLINE SPECIFIC ELECTIVE COURSES
DDSE 002: IMMUNOLOGY

Programme: Ph.D **Class: Microbiology**	**Year: I** **Semester: I**
Credits 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

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 Immunoglobulins** Concept of haptens, determinants, conditions of antigenicity antigens and immunogenecity, Superantigen. Immunoglobulins: 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,	06

	Influenza, HIV and others. Immuno-assays: SRID, ELISA, ELISA-PCR, RIA, western blotting.	

References

1. Abul Abbas, Andrew H. Lichtman and ShivPillai (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. Roit (2004) Essential Immunology 10th edition. Blackwell Scientific Publications, Oxford.
7. Kuby 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 2020by 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 immunoglobulin’s.
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 bady and to explain various immunoassays.

Format-3

DISCIPLINE SPECIFIC ELECTIVE COURSES
DDSE-009: MEDICAL MICROBIOLOGY

Programme: Ph.D **Class: Microbiology**		**Year: I** **Semester: I**
Credits 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

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 Microbiology11th 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.

Format-3

DISCIPLINE SPECIFIC ELECTIVE COURSES
DDSE-010: FERMENTATION TECHNOLOGY

Programme: Ph.D **Class: Microbiology**		**Year: I** **Semester: I**
Credits 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		

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.

Format-3

DISCIPLINE SPECIFIC ELECTIVE COURSES
DDSE-011: CURRENT CONCEPTS AND TRENDS IN MICROBIOLOGY

Programme: Ph.D **Class: Microbiology**	**Year: I** **Semester: I**
Credits 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

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	Microbiome: An introduction of human microbiome, Human gut/oral/skin microbiota, current research methods of microbiome analysis including culture-dependent and culture-independent tools, whole genome vs. 16srRNA gene analysis of microbiome, role of human microbiome in health and communicable or non-communicable diseases (Cancer, Diabetes, Malnutrition etc), human gut microbiota and immunity, Role of microbiome in therapeutic and diagnostic. A brief overview of plant and animal microbiome.	06
IV	Food Safety and Security: Microbiology of food of animal and plant origin, Major Foodborne diseases, Biological, chemical, and physical hazards of food, Microbiological testing of food, Hazard analysis and critical control	06

	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 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 2) Presentations /Seminar 3) Assignments 4) Research Project Report Seminar On Research Project Report 5) ESE/Attendance	20 - - - - 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.

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Section 2f & 12B

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

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 filteration, 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, immunoflurosecence, 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, Karoyotyping; 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

BOS

Format-3

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,

BOS