PERIYAR UNIVERSITY

Salem - 636011, Tamil Nadu, India

NAAC A++ Grade – State University- NIRF Rank 73- ARIIA Rank 10

DEPARTMENT OF BIOTECHNOLOGY

M.Sc. BIOTECHNOLOGY Syllabus

(2022-2023 onwards)

Department of Biotechnology syllabus – 2022-23

S. No	Paper code	Subject Title	Credits	Hours/Week		
				L	D	P
		I – SEMESTER				
1	22MBT101	Cell Biology and Biochemistry	4	4	-	-
2	22MBT102	Microbial Technology	4	4	-	-
3	22MBTE103	**Elective-I (5 Courses)**	4	4	-	-
	22MBTEA103	Clinical Biochemistry				
	22MBTEB103	Biodiversity Conservation				
	22MBTEC103	Plant Tissue Culture				
	22MBTED103	Ecotechnology				
	22MBTEE103	Biochemical and Biophysical Techniques				
4.	22MBT104	Practical I: Cell Biology and Biochemistry	4	-	1	5
5.	22MBT105	Practical II: Microbial Technology	4	-	1	5
6.	22MBT106	Team Project	2	-	-	2
7.	22MBT107	MOOC Course	2	-	-	-
		II – SEMESTER				
1.	22MBT201	Genetics and Molecular Biology	4	4	-	-
2.	22MBT202	Plant and Animal Biotechnology	4	4	-	-
3.	22MBT203	rDNA Technology	4	4	-	-
4.	22MBT204	OMICS Concept	4	4	-	-
5.	22MBT205	Practical III: Genetics, Molecular Biology and rDNA Technology	4	-	1	5
6.	22MBT206	Practical IV: Plant and Animal Biotechnology	4	-	1	5
7.	22MBT207	Credit Seminar	1	-	-	1
8.	06PHR04	Human Rights	2	2	-	-
		III- SEMESTER				
1.	22MBT301	Immunotechnology	4	4	-	-
2.	22MBT302	Bioinformatics, Biostatistics and Research Methodology	4	4	-	-
3.	22MBTE303	**Elective-II (6 Courses)**	4	4	-	-
	22MBTEA303	Genotoxicity				
	22MBTEB303	Nano-biotechnology				
	22MBTEC303	Marker Assisted Plant Breeding technology				
	22MBTED303	Bio-pesticide and Integrated Pest Management				
	22MBTEE303	Bioprocess Engineering and Fermentation Technology				
	22MBTEF303	Bioethics, Biosafety and Bioentrepreneurship				
4.	22MBT304	Practical V: Immunotechnology, Bioinformatics and Biostatistics	4	-	1	5
5	22MBTED 305	**Extra Department courses (2 courses)**	4	4	-	-
	22MBTEDA305	Techniques in Biotechnology				
	22MBTEDB305	Basic Biotechnology				
6.	22MBT306	Summer Internship programme				
		IV – SEMESTER				
1.	22MBTE401	**Elective-III (5Courses)**	4	4	-	-
	22MBTEA401	Clinical Neuroscience				
	22MBTEB401	Herbal Technology				
	22MBTEC401	Bio prospecting of Biomolecules				
	22MBTED401	Insect Biotechnology				
	22MBTEE401	Marine Biotechnology				
2.	22MBTE402	**Elective-IV (5 Courses)**	4	4	-	-
	22MBTEA402	Animal Models in Biomedical Research				
	22MBTEB402	Bioremediation Techniques for Polluted Environment				
	22MBTEC402	Commercial Plant Tissue Culture Technology				
	22MBTED402	Insect Toxicology				
	22MBTEE402	Pharmaceutical Biotechnology				
3.	22MBT403	Credit Seminar	1	-	-	1
4.	22MBT404	Project work	14	-	-	14
		Total credits	**94**			
		Total No. of Courses	**25**			

Preamble

This curriculum framework for the M.Sc program in Biotechnology is developed keeping in view of the student centric learning pedagogy, which is entirely outcome-oriented and curiosity-driven. The curriculum framework focuses on pragmatist approach whereby practical application of theoretical concepts is taught with substantial coverage of practical and field based studies. The platform aims at equipping the graduates with necessary skills for biotechnology related careers, in Research, Industry and higher education. Augmented in this framework are master graduate attributes including critical thinking, scientific reasoning, moral ethical reasoning qualification descriptors that are specific outcomes pertinent to the discipline. While designing these frameworks, emphasis is given on the objectively measurable teaching-learning outcomes to ensure employability of the graduates. In line with recent trends in education section, these frameworks foster implementation of modern pedagogical tools and concepts such as MOOCs and other e-learning platforms. The pragmatic core of the framework has been designed such a way to enable the learners implementing the concepts to address the real world problems. Above all, these frameworks are holistic and aim to mould responsible Indian citizen who have adequate skills in reflective thinking, rational skepticism, scientific temper, digital literacy and so on such that they are equipped to fight immediate social issues apropos to Indian milieu, including corruption and inequity.

Aims

- To transform curriculum into outcome-oriented scenario
- To develop the curriculum for fostering discovery-learning
- To equip the students in solving the practical problems pertinent to India
- To adopt recent pedagogical trends in education including e-learning, and MOOCs
- To mold responsible citizen for nation-building and transforming the country towards the future

OBE Regulations and Syllabus

Vision

- Periyar University aims towards excellence in education, research, promoting invention, innovation and preserving culture identity for future generation

Mission

- Provide a vibrant learning environment, fostering innovation and creativity inspired by cutting edge research
- Aspire to be a national leader in developing educated contributors, career ready learners and global citizens
- Provide well equipped facilities for teaching, research, administration and student life
- Have well defined autonomous governance structure
- To make a significant, consistent and sustainable contribution towards social, culture and economic life in Tamil Nadu, India

Values

- Motivation of students to be responsible citizens making them aware of their societal role
- Inculcate scientific temper, honesty, integrity, transparency, empathy, and ethical values amidst student
- Impact a desire for lifelong learning to foster patriotic sensibility, accountability and holistic well being
- Provide conducive and cosmopolitan environment for innovation and free thinking
- Imbibe value based education leading to inclusive growth

Department Vision

The Department of Biotechnology was established in 2008, has offering quality M.Sc; M.Phil and Ph.D programmes in Biotechnology. These programmes have been designed to produce biotechnologists who can address the challenges and needs of the country and the world at large. We aim to become a leading centre of education, research and entrepreneurship in Biotechnology, guided by sound scientific and ethical principles.

Program Educational Objectives

- Competent in applying theoretical and practical hands on approach in Biotechnology
- To apply the knowledge in providing solution to health, environmental and research problems

- Promote Innovation and Research in cutting edge biotechnological research
- To address the problems faced by India and to become a responsible citizen
- Promote a strong sense of team spirit and brotherhood for building a strong India

Program Outcomes / Program Learning Outcome (Department Vision)

The graduates of Biotechnology student must have:

- ✓ Ability to approach, analyze and bring out scientific solution for a given problem
- ✓ Ability to implement multidisciplinary concepts and ideas for the development of innovative technologies.
- ✓ Ability to demonstrate leadership, quality and entrepreneurship.
- ✓ Demonstrate technical skills in operation and maintenance of sophisticated instrumentations.
- ✓ Ability to protect their innovative research through IPR.
- ✓ Innovation for high quality research on par with international laboratories.
- ✓ Ability to explore scientific projects for need based industry.
- ✓ Ability to bring out good quality research proposal as well as research publications.
- ✓ Student would be competent discipline-specific studies, as well as to begin domain-related employment.
- ✓ To mould a responsible citizen who is aware of most basic domain-independent knowledge, including critical thinking and communication.

The student graduating with the Degree of M.Sc Biotechnology should be able to acquire

Core Competency: Students will acquire core competency in the subject Biotechnology

- The student will be able to learn and demonstrate about basic experimental techniques in classical and modern biotechnology
- The students will be able to explain various aspects like Cell and Molecular Biology, Genetic Engineering, Immunology, Biochemistry and Enzymology.
- The students will be able to apply the aforesaid knowledge in Plant, Animal, Microbial Biotechnology, Bioprocess technology, Medical Biotechnology and Environmental Biotechnology.

Analytical Ability: The students will be able to demonstrate the knowledge in understanding research and addressing practical problems

- Application of various scientific methods to address different questions by formulating the hypothesis, data collection and critically analyze the data

Critical thinking and Problem solving ability: An increased understanding of fundamental concepts and their applications of scientific principles is expected at the end of this course. Students will become critical thinker and acquire problem solving capabilities.

Digital knowledge: Students will acquire digital skills and integrate the fundamental concepts with modern tools.

Ethical and Moral Strengthening: Students will also strengthen their ethical and moral values and shall be able to deal with psychological weaknesses.

Team Work: Students will learn team workmanship in order to serve efficiently institutions, industry and society

Course learning outcome

The course learning outcomes are aligned with program learning outcomes. The course level learning shall be reflected as program level learning. The core courses shall be the backbone of this framework whereas discipline electives, electives course and skill enhancement courses would add academic excellence in the subject together with multi-dimensional and multidisciplinary approach. In course learning outcomes, the student will attain subject knowledge in terms of individual course as well as holistically. The example related to core courses and their linkage with each other is stated below:

1. Core courses
2. Elective courses
3. MOOC courses
4. Skill Enhancement Courses

Core Courses (CC)								
Program Outcome	22MBT101	22MBT102	22MBT201	22MBT202	22MBT203	22MBT204	22MBT301	22MBT302
Core competency	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
Critical Thinking	**S**	**M**	**M**	**M**	**M**	**M**	**M**	**M**
Analytical Reasoning	**M**	**S**	**S**	**S**	**M**	**M**	**M**	**M**
Research Skills	**M**	**S**	**S**	**S**	**S**	**S**	**M**	**S**
Team work	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**S**

22MBT101- Cell Biology and Biochemistry 22MBT102- Microbial Technology, 22MBT201- Genetics and Molecular Biology, 22MBT202- Plant and Animal Biotechnology,22MBT203- r DNA Technology, 22MBT204- OMICS Concept, 22MBT301- Immunotechnology, 22MBT302- Bioinformatics, Biostatistics and Research Methodology, S: 'Strong' ; M: 'Medium'

I- SEMESTER (Elective Courses-I)

Discipline Related Elective Courses					
Program Outcome	22MBTEA103	22MBTEB103	22MBTEC103	22MBTED103	22MBTEE103
Additional Academic Knowledge	**S**	**S**	**S**	**S**	**S**
Problem Solving	**S**	**M**	**S**	**M**	**M**
Additional Analytical Skills	**M**	**M**	**M**	**M**	**M**
Additional Research Skills	**M**	**S**	**S**	**S**	**S**

22MBTEA103- Clinical Biochemistry, 22MBTEB103- Biodiversity Conservation, 22MBTEC103- Plant tissue culture, 22MBTED103- Ecotechnology, 22MBTEE103- Biochemical and Biophysical techniques S: 'Strong' ; M: 'Medium'

III- SEMESTER (Elective Courses-II)

Discipline Related Elective Courses						
Program Outcome	22MBTEA303	22MBTEB303	22MBTEC303	22MBTED303	22MBTEE303	22MBTEF303
Additional Academic Knowledge	**S**	**S**	**S**	**S**	**S**	**S**
Problem Solving	**S**	**M**	**S**	**M**	**M**	**M**
Additional Analytical Skills	**M**	**M**	**M**	**M**	**M**	**M**
Additional Research Skills	**M**	**S**	**S**	**S**	**S**	**S**

22MBTEA303- Genotoxicity, 22MBTEB303- Nano-biotechnology, 22MBTEC303- Marker Assisted Plant Breeding technology, 22MBTED304- Bio-pesticide and Integrated Pest Management, 22MBTEE303- Bioprocess Engineering and Fermentation Technology, 22MBTEF303- Bioethics, Biosafety and Bio-entrepreneurship S: 'Strong' ; M: 'Medium'

IV- SEMESTER (Elective Courses-III)

Discipline Related Elective Courses					
Program Outcome	22MBTEA401	22MBTEB401	22MBTEC401	22MBTED401	22MBTEE401
Additional Academic Knowledge	**S**	**S**	**S**	**S**	**S**
Problem Solving	**S**	**M**	**S**	**M**	**M**
Additional Analytical Skills	**M**	**M**	**M**	**M**	**M**
Additional Research Skills	**M**	**S**	**S**	**S**	**S**

22MBTEA401- Clinical NeuroScience, 22MBTEB401- Herbal Technology, 22MBTEC401- Bioprospecting of Biomolecules, 22MBTED401- Insect Biotechnology , 22MBTEE401- Marine Biotechnology S: 'Strong' ; M: 'Medium'

IV- SEMESTER (Elective Courses-IV)

Discipline Related Elective Courses					
Program Outcome	22MBTEA402	22MBTEB402	22MBTEC402	22MBTED402	22MBTEE402
Additional Academic Knowledge	**S**	**S**	**S**	**S**	**S**
Problem Solving	**S**	**M**	**S**	**M**	**M**
Additional Analytical Skills	**M**	**M**	**M**	**M**	**M**
Additional Research Skills	**M**	**S**	**S**	**S**	**S**

22MBTEA402- Animal Models in Biomedical Research,, 22MBTEB402- Bioremediation Techniques for Polluted Environment, 22MBTEC402- Commercial plant tissue culture technology, 22MBTED402- Insect Toxicology, 22MBTEE402- Pharmaceutical Biotechnology S: 'Strong' ; M: 'Medium'

Skill Enhancement Courses (Practicals) + MOOC course									
Program Outcome	22MBT104	22MBT105	22MBT205	22MBT206	22MBT304	22MBT107	22MBT208	22MBT403	22MBT305
Additional Knowledge	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
Exposure beyond discipline	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
Analytical Reasoning	**S**	**M**	**M**	**M**	**M**	**M**	**M**	**S**	**S**
Digital Literacy	**M**	**S**	**S**	**M**	**M**	**S**	**S**	**M**	**M**
Moral and Ethical Awareness	**M**	**S**	**S**	**S**	**S**	**M**	**M**	**S**	**S**

MBT104- Practical- I: Cell Biology and Biochemistry, MBT105- Practical- II: Microbial Technology, MBT205- Practical III Genetics, Molecular Biology, and rDNA Technology , MBT206- Practical- IV Plant and Animal Biotechnology, MBT 304 Practical V: Immunotechnology, Bioinformatics and Biostatistics, MBT107- MOOC Course I , MBT208- Credit seminar, MBT403- Credit seminar, MBT305 – Summer Internship Programme S: 'Strong' ; M: 'Medium'

2. Teaching Learning Outcome

The learning outcomes based course curriculum framework of biotechnology is designed to persuade the subject specific knowledge as well as relevant understanding of the course. The academic and professional skills required for biotechnology-based professions and jobs are also offered by same course in an extraordinary way. In addition, the learning experiences gained from this course is designed and implemented for cognitive development in every student. The practical associated with this course helps to develop an important aspect of the Teaching -Learning process.

- Class Lectures
- Tutorials
- Seminars
- Group discussions and Workshops
- Peer teaching and learning

Question Preparation

- Subjective Type
  - ✓ Analytical based question
  - ✓ Descriptive question
- Objective type
  - ✓ Multiple choice questions
  - ✓ Assertion and reasoning

- **Practicum and project-based learning**
- **Field-based learning**
- **Substantial laboratory-based practical component and experiments**
- **Internship in industry, and research establishments**

The effective teaching strategies are adopted to develop problem-solving skills, higher-order skills of reasoning and analysis. The designed course also encourages fostering the social values for maintaining and protecting the surrounding environment for improved living conditions. A learner centric and active participatory pedagogy is introduced in this framework.

3. Learning outcome based curriculum framework

A. Graduate Attributes

Following the completion of the course the candidate will be proficient in

Core competency: M.Sc graduates will know the fundamental concepts of biotechnology. These concepts would reflect the latest understanding of the field, and therefore, are dynamic in nature and require frequent and time-bound revisions.

Communication Skills: Biotechnology graduates will possess the standards of communication skills that will be applied in read and understand research document with in-depth analyses and logical arguments. Graduates are expected to be well-versed in speaking and communicating their idea, findings and concepts to wider audience

Critical Thinking: Students will have basics of cognitive skills, scientific methodology and constructing cogent scientific arguments.

Problem Solving: the Graduate will have the ability to apply the knowledge and understanding of biotechnology in new contexts and to identify problems and solutions in daily life.

Analytical Reasoning: Graduates will have proficiency in analysing and interpreting the results obtained from experiment.

Research Skills: Graduates will be proficient in designing a scientific experiment through statistical hypothesis testing.

Team Work: Graduates will be team players, with productive co-operations involving members from diverse socio-cultural backgrounds**.**

Leadership Readiness: Graduates will be familiar with decision making process and basic managerial skills to become a better leader.

B. Vision and Mission of the M. Sc Biotechnology Course (Qualification Descriptors)

The qualification descriptors for a Master degree in Biotechnology may include following:

(i) To demonstrate a systematic, extensive and coherent knowledge and understanding of academic fields of study as a whole and its applications and links to disciplinary areas of the study; including critical understanding of the established theories, principles and concepts of a number of advanced and emerging issues in the field of Biotechnology

(ii) To demonstrate procedural knowledge that creates different types of professionals in the field of biotechnology like in research and development, teaching government and public services

(iii) Developing skills and ability to use knowledge efficiently in areas related to specializations and current updates in the subject

(iv) Demonstrate comprehensive knowledge in current research, scholarly and professional literature of advanced learning areas of Biotechnology

(v) Use knowledge understanding and skills for critical assessment of wide range of ideas and problems in the Biotechnology fields.

(vii) Apply one's knowledge and understanding of Biotechnology to new/unfamiliar contexts and to identify problems and solutions in daily life.

C. Distribution of different types of courses with their Credits

Semester	**Core Course** 8 Core Courses 4 credits each All courses are compulsory	**Skill Enhancement Courses** 5 Practical's 4 credits each	**Discipline specific Electives** 21 Elective courses 4 credits each Choose any 1 course per semester	**Generic Elective** 2 Elective courses 4 credits each Choose any 1 course per semester 1 Mandatory Course (Human Rights)	**Seminar, Project, Internship, MOOC course**	**Credit Hour Load**
I	1.Cell Biology and Biochemistry, 2. Microbial Technology	1.Cell Biology and Biochemistry 2. Microbial Technology	Elective I 1.Clinical Biochemistry 2. Biodiversity		1. Team Project 2. MOOC Course	24

			conservation 3. Plant Tissue Culture 4. Ecotechnology 5. Biochemical and Biophysical techniques.			
II	1.Genetics and Molecular Biology, 2.Plant and Animal Biotechnology, 3. rDNA Technology 4.OMICS Concept	1.Genetics, Molecular Biology, and rDNA Technology, 2. Plant and Animal Biotechnology		1. Human Rights	1.Credit Seminar	31
III	1.Immunotechnology 2. Bioinformatics, Biostatistics and Research Methodology	1.Immunotechnology, Bioinformatics and Biostatistics	Elective II 1.Genotoxicity 2.Nano-biotechnology 3. Marker assisted Plant breeding technology 4. Bio-Pesticide and Integrated Pest Management 5. Bioprocess engineering and Fermentation Technology 6. Bioethics, Biosafety and Bio-entrepreneurship	1.Techniques in Biotechnology. 2.Basic Biotechnology	1. Summer Internship Programme	16
IV			Elective III 1.Clinical Neuroscience 2. Herbal Technology 3. Bioprocessing of Bio molecules 4.Insect Biotechnology 5.Marine Biotechnology Elective IV 1.Animal Models in Biomedical Research		1.Credit Seminar 2.Project	23

			2. Bioremediation Techniques for polluted Environment 3.Commercial Plant Tissue Culture Technology 4. Insect Toxicology 5. Pharmaceutical Biotechnology.			
Credits	32	20	16	04	20	94
%Courses	34.04	21.27	17.02	4.2	23.4	100

8. **Courses at a Glance**

CBCS structure of the programme

Course Component	**No of Course**	**Hours of learning/week/Course**	**Marks**	**Credits**
Part A (credit courses)				
Core courses	8	4	800	32
Practicals	5	6	500	20
Elective courses	4	4	400	16
Supportive courses	1	4	100	04
Research Project	1	14	200	14
Team Project	1	2	50	02
Credit Seminar	2	1	50	02
Total(A)	**22**		**2100**	**90**
Part B (Self-learning credit/non-credit courses)				
MOOC Course	**1**	**-**	**-**	**2**
Summer Internship	1	-	50	-
Total (B)	**2**	**-**	**50**	**2**
Total (A+B)	**24**		**2150**	**92**

A. Core Courses

Course Code	Name of the Course	Type of Course	Lecture	Tutorials	Practical	Credits
22MBT101	Cell Biology and Biochemistry	Core Course	4	0	4	8
22MBT102	Microbial Technology	Core Course	4	0	4	8
22MBT201	Genetics and Molecular Biology	Core Course	4	0	2	6
22MBT202	Plant and Animal Biotechnology	Core Course	4	0	4	8
22MBT203	r DNA Technology	Core Course	4	0	2	6
22MBT204	OMICS Concept	Core Course	4	0	3	7
22MBT301	Immunotechnology	Core Course	4	0	2	6
22MBT302	Bioinformatics, Biostatistics and Research Methodology	Core Course	4	0	2	6

B. Discipline Specific Elective Courses

Course Code	Name of the Course	Type of Course	Lecture	Tutorials	Practical's	Credits
22MBTEA103	Clinical Biochemistry	Elective Courses	4	0	0	4
22MBTEB103	Biodiversity Conservation	Elective Courses	4	0	0	4
22MBTEC103	Plant tissue culture	Elective Courses	4	0	0	4
22MBTED103	Ecotechnology	Elective Courses	4	0	0	4
22MBTEE103	Biochemical and Biophysical techniques	Elective Courses	4	0	0	4
22MBTEA303	Genotoxicity	Elective Courses	4	0	0	4
22MBTEB303	Nano-biotechnology	Elective Courses	4	0	0	4
22MBTEC303	Marker Assisted Plant Breeding technology	Elective Courses	4	0	0	4
22MBTED303	Bio-pesticide and Integrated Pest Management	Elective Courses	4	0	0	4
22MBTEE303	Bioprocess Engineering and Fermentation Technology	Elective Courses	4	0	0	4

22MBTEF303	Bioethics, Biosafety and Bio-entrepreneurship	Elective Courses	4	0	0	4
22MBTEA401	Clinical Neuro Science	Elective Courses	4	0	0	4
22MBTEB401	Herbal Technology	Elective Courses	4	0	0	4
22MBTEC401	Bio prospecting of Biomolecules	Elective Courses	4	0	0	4
22MBTED401	Insect Biotechnology	Elective Courses	4	0	0	4
22M2BTEE401	Marine Biotechnology	Elective Courses	4	0	0	4
22MBTEA402	Animal Models in Biomedical Research	Elective Courses	4	0	0	4
22MBTEB402	Bioremediation Techniques for Polluted Environment	Elective Courses	4	0	0	4
22MBTEC402	Commercial plant tissue culture technology	Elective Courses	4	0	0	4
22MBTED402	Insect Toxicology	Elective Courses	4	0	0	4
22MBTEE402	Pharmaceutical Biotechnology	Elective Courses	4	0	0	4

C. Skill Enhancement Courses

Course Code	Name of the Course	Type of Course	Lecture	Tutorials	Practical's	Credits
22MBT104	Cell Biology and Biochemistry	Skill Enhancement Courses	0	0	6	4
22MBT105	Microbial Technology	Skill Enhancement Courses	0	0	6	4
22MBT106	Team Project I	Skill Enhancement Courses	0	0	2	2
22MBT208/22MBT403	Credit Seminar	Skill Enhancement Courses	0	0	0	1
22MBT205	Genetics, Molecular Biology and rDNA Technology	Skill Enhancement Courses	0	0	6	4

22MBT206	Plant and Animal Biotechnology	Skill Enhancement Courses	0	0	6	4
22MBT304	Immunotechnology, Bioinformatics and Biostatistics	Skill Enhancement Courses	0	0	6	4

Assessment Methods (Mention the various methods used for assessment)

Academic performance in various courses i.e. core, electives, skill enhancement courses are to be considered as parameters for assessing the achievement of students in Biotechnology. A number of appropriate assessment methods of Biotechnology will be used to determine the extent to which students demonstrate desired learning outcomes. Following assessment methodology should be adopted.

The oral and written examinations (Scheduled and surprise tests),

- Closed-book and open-book tests,
- Problem-solving exercises,
- Practical assignments and laboratory reports,
- Observation of practical skills,
- Individual and group project reports,
- Efficient delivery using seminar presentations,
- Viva voce interviews are majorly adopted assessment methods for this curriculum.
- The computerized adaptive testing, literature surveys and evaluations, peers and self-assessment, outputs form individual and collaborative work are also other important approaches for assessment purposes.

A continuous assessment method throughout the programme shall inculcate regular reading habit in the students' and continuous observation about weaker aspect of the students'.

Suggested List of Seminar Topics (List of Seminar Topics)

- Molecular Taxonomy; A New Classification system
- RNA interference
- Gene editing
- Plant based drugs

- Functional foods
- DNA barcoding
- Variability in seed development
- Certified seed production in crops
- Strategies for hybrid seed production
- Method of seed production.
- Biodiversity and climate change
- Current Developments in Techniques
- Biotechnology: Past, present and Future
- Role of DNA sequencing in evolutionary history.
- Genetic control of sex determination
- Current trends in DNA sequencing
- DNA markers and Genetic diversity
- Comparative genomics in understanding of gene function

Suggested list for Group Discussion (Topics for group discussion)

- Molecular Taxonomy; A New Classification system
- Biotechnology: Past, present and Future
- Developments in Epigenetics
- Functional Genomics in modern era
- Industrial Production of Antibiotics, Vitamins
- Gene Delivery Systems
- GM crops for food and non-food products
- Biodiversity under changing climate scenario
- Genome editing technology
- Nanotechnology and drug delivery

22MBT101: CELL BIOLOGY AND BIOCHEMISTRY

Credits: 4 **Hours: 4/Wk**

Course Objectives:

The aim of this course is to provide basic knowledge and fundamentals of Cell biology and biochemistry. Students will understand the various topics related to cell biology namely structure and functions of prokaryotic and eukaryotic cells, the cellular mechanism, cell signaling & communication, cell division, cell cycle regulation, cell mobility and microscopy types. The student can understand the biochemical composition of the water and buffers. They can learn the structure of proteins, carbohydrates, lipids, nucleic acids, vitamins, minerals and enzymatic activity.

Unit I

Membrane transport :passive and facilitated diffusion, active transport, symport, antiport, ATPase, ABC transporters, ion channels, and aquaporins.

Unit II

Concept, ligands and receptors. Endocrine, paracrine and autocrine signalling. G protein coupled receptors, receptor kinases. Signal transduction: Cytoplasmic and nuclear receptors. Secondary Messengers: cAMP, Ca+, cGMP and Nitrous oxide

Unit III

Microtubules, Microfilaments, Intermediate filaments, Amyleoid fibers, Cell mobility: Endocytosis and Exocytosis. Proton pumps Cell cycle and its regulation

Unit IV

Carbohydrate metabolism: Glycolysis, citric acid cycle, gluconeogenesis and glycogen metabolism. Lipid metabolism: β-oxidation and biosynthesis of fatty acids .An overview of Metabolic Syndrome

Unit V

Protein denaturation and renaturation; Urea cycle, factors affecting enzyme activity: substrate, pH and Temperature, Michaelis-Mentenequation and L-B plot. Enzyme inhibition.

Recommended Books

- Harper's Illustrated Biochemistry, 27th Edition (2006.) Robert K. Murray, Daryl K. Granner, Victor W. Rodwell. McGraw-Hills.
- David L. Nelson and Michael M. Cox, Lehninger Principles of Biochemistry, 5 th edition, W.H. Freeman and Co., NY, 2008.
- Biochemistry. 5th Edition (1999) Lupert Styrer. W.H.Freeman & Co
- Principles of Biochemistry. 4th Edition (1995). Geoffrey Zubay.
- Bruce Alberts , Alexander Johnson , Julian Lewis, Martin Raff , Keith Roberts, Peter Walter. 2014. Molecular Biology of the Cell, 6th Edn . Academic Press. New York.
- E. D. P. De Robertis, E. M. F. De Robertis Jr. Cell and Molecular Biology 8th Ed., South Asian Edition. Lippincott, Williams and Wilkins.
- Gerald Karp. 2013. Cell and Molecular Biology: Concepts and Experiments, 7th Edn. Wiley.
- Geoffrey Cooper. 2013. The Cell: A molecular approach. 6th Edn. Sinauer Associates Inc.
- Lodish, Baltimore et al. 2007. Molecular Cell Biology. 6th Edn. W.H. Freeman & Co.

Course Outcomes

The overall goal of this course is for the student to gain a fundamental knowledge of biochemical concepts and techniques which will be necessary for future scientific endeavors. Upon completion of the course, the student should achieve knowledge:

- ✓ Understanding the structure and functions of cell organelles
- ✓ Acquiring knowledge of mechanisms of cell membrane transport
- ✓ Getting knowledge for role of ligands and receptors for cell signalling
- ✓ Understanding the internal features of the cell and cell mobility
- ✓ Studying the stages of cell division, cell cycle control and regulation,
- ✓ Getting sound knowledge on principle and applications of various microscopy
- ✓ To understand the basic action of biochemical buffer, vitamins, minerals, and DNA, RNA biosynthesis.
- ✓ To learn classification and functions of monosaccharides, polysaccharides and its molecular metabolism, applications.
- ✓ To study the chemical and biological properties amino acids and their organization into polypeptides and proteins structures and metabolism activity.
- ✓ To understand the structure of different classes of lipids and their roles in biological metabolic disorders.
- ✓ To determine the enzyme catalyze reactions as well as enzyme kinetics and applications.

LECTURE SCHEDULE

S. No.	Lectures
1.	Overview of Membrane transport
2.	Membrane transport - Passive and facilitated diffusion
3.	Membrane transport - Active transport
4.	Membrane transport – Symport
5.	Membrane transport – Antiport
6.	Membrane transport – ATPase
7.	Membrane transport - ABC transporters
8.	Membrane transport - Ion channels
9.	Membrane transport – Aquaporins
10.	Concept, ligands and receptors
11.	Endocrine signaling
12.	Paracrine signaling
13.	Autocrine signaling
14.	G protein coupled receptors
15.	Receptor kinases
16.	Signal transduction: Cytoplasmic and nuclear receptors
17.	Secondary Messengers: cAMP, Ca+,
18.	Secondary Messengers: cGMP and Nitrous oxide
19.	Concept of cytoskeleton – Microtubules
20.	**Internal Test -1**
21.	Microfilaments
22.	Intermediate filaments
23.	Amyleoid fibers

24.	Cell mobility - Endocytosis and Exocytosis
25.	Proton pumps
26.	Cell cycle and its regulation
27.	**Quiz /Group discussion**
28.	**Quiz /Group discussion**
29.	Overview of Carbohydrate metabolism
30.	Carbohydrate metabolism - Glycolysis
31.	Carbohydrate metabolism- citric acid cycle
32.	Carbohydrate metabolism – Gluconeogenesis
33.	Carbohydrate metabolism - glycogen metabolism
34.	Overview of Lipid metabolism
35.	Lipid metabolism - β-oxidation and biosynthesis of fatty acids
36.	An overview of Metabolic Syndrome
37.	Protein denaturation and Renaturation
38.	Urea cycle
39.	Factors affecting enzyme activity
40.	**Internal test –II**
41.	Factors affecting enzyme activity- substrate, pH and Temperature,
42.	Michaelis-Mentenequation and L-B plot
43.	Enzyme inhibition
44.	Signal transduction: Cytoplasmic and nuclear receptors
45.	Concept of cytoskeleton – Microtubules
46.	**Quiz /Group discussion**
47.	**Quiz /Group discussion**
48.	Cell mobility - Endocytosis and Exocytosis
49.	Carbohydrate metabolism - glycogen metabolism
50.	Lipid metabolism - β-oxidation and biosynthesis of fatty acids
51.	Factors affecting enzyme activity- substrate, pH and Temperature,
52.	Michaelis-Mentenequation and L-B plot
53.	Membrane transport - Passive and facilitated diffusion
54.	Carbohydrate metabolism - Gluconeogenesis metabolism
55.	Carbohydrate metabolism- citric acid cycle
56.	Cell cycle and its regulation
57.	**Seminar & Assignment**
58.	**Seminar & Assignment**
59.	**Seminar & Assignment**
60.	**Seminar & Assignment**
61.	**Seminar & Assignment**
62.	**Model Exam**
63.	**Model Exam**
64.	**Model Exam**

22MBT102: MICROBIAL TECHNOLOGY

Credits: 4 **Hours: 4/Wk**

Course Objectives:

The objectives of this course are to introduce the students to the field of microbiology and application of microbes on industry. To train the students on microbial growth, methods for fermentation technology, effluent treatment and enzyme immobilization. To prepare and sensitize the students to scope for research, the increasing for skilled scientific manpower with an understanding of research, industrials applications and microbiology ethics.

Unit I

Introduction to bacteria-Cell wall, cell membrane, flagella and cell inclusions. Staining: principle and types – Bacteria and Fungi. Virus types: bacterial, plant, animal, DNA and RNA viruses: Lytic cycle and lysogeny. Viroids and prions.

Unit II

Microbial growth: Growth curve, factors affecting growth. Culture media. Sterilization. Isolation of pure culture, streak, spread and pour-plate methods. Culture collection and preservation. Microbial metabolism an overview. Photosynthesis in microbes .methanogenesis and acetogenesis.

Unit III

Bioprocess engineering: Isolation and screening of industrially important microbes. Bioreactors types and design. Upstream Processing – media optimization

Unit IV

Fermentation -Downstream processing : Solid-liquid separation, concentration of biological products, purification. Industrial production of ethanol, citric acid, vinegar, penicillin and aminoacids.

Unit V

Immobilization of enzymes: Methods, and applications. Use of enzymes in detergents, textiles, leather food and pharmaceutical industries.Industrial production of wine and beer.

Recommended Books

- Peter F. Stanbury, Allan Whitaker, Stephen J. Hall. 2016. Principles of FermentationTechnology. 3rd Edn. Elsevier Science Ltd
- Joanne Willey, Linda Sherwood, ChristopherJ. Woolverton.2016. Prescott's Microbiology. 10th Edn. McGraw-Hill Education.
- Michael J. Waites, Neil L. Morgan, John S. Rockey Gary Higton. 2001. IndustrialMicrobiology: An Introduction. Blackwell Science Ltd
- Nduka Okafor. 2007. Modern Industrial Biotechnology & Microbiology. Science Publishers, Edenbridge Ltd.,
- Peppler H. J. and Perlman. D. 2012. Microbial Technology. Vol. 1&2. AcademicPress. Casida L. E. and John Jr. 2015. Industrial Microbiology. Wiley and Sons Inc.

Course Outcomes

A student passing this module will be able:

- To show the main microbial processes, methods, cultivation, preservation, metabolism andsynthesis activity.
- To explain about the microorganisms (Bacteria, Fungi, Algae, Protozoa and viruses) type'sspecifics in principals and applications of animal and plants.
- To understand the bioprocess engineering, basic techniques, methods, functions and industrial products.
- To explain the waste water physical, chemical and biological properties, bioremediationand energy sources.
- To know the different microorganisms and their products (enzymes, polymers, metabolites,etc.) that are used in the biotech industry.

LECTURE SCHEDULE

S. No.	Lectures
1.	Introduction to bacteria - Cell wall, cell membrane, flagella and cell inclusions.
2.	Staining techniques - principle and types of stains
3.	staining techniques- simple, negative, differential and structural staining methods
4.	Bacteria and Fungi, types
5.	Different types of viruses
6.	Bacterial, plant, animal, DNA and RNA viruses
7.	Lytic cycle and lysogeny
8.	Difference between lytic and lysogeny
9.	Viroid's -Structure, Characteristic Features and their Disorder
10.	Prions - Structure, Characteristic Features, disease
11.	Microbial growth: Growth curve, factors affecting growth
12.	Culture media- preparation and types
13.	Culture media-classification, types, and relevance
14.	Sterilization and Disinfection- simple and advanced techniques
15.	Isolation of pure culture, streak, spread and pour-plate methods
16.	Culture collection and preservation techniques
17.	Microbial metabolism - an overview
18.	Photosynthesis in microbes-History and classification
19.	Photosynthesis in microbes- definition and examples
20.	**Internal Test -1**
21.	Photosynthesis in microbes an overview
22.	Methanogenesis- introduction, methanogenesis in microbes
23.	The role of methanogenesis
24.	Importance and mechanism of methanogenesis

25.	**Quiz /Group discussion**
26.	**Quiz /Group discussion**
27.	The role of Acetogenesis
28.	Bioprocess engineering: fundamentals and application
29.	Bioprocess engineering: manufacturing products
30.	Isolation of industrially important microbes
31.	screening of industrially important microbes
32.	Bioreactors: definition, principle, parts
33.	Bioreactors types and design
34.	Upstream Processing- fundamentals and manufacture
35.	Upstream Processing – media optimization
36.	Fermentation –basics, methods
37.	Fermentation –Downstream processing
38.	Solid-liquid separation, introduction, priciple
39.	**Internal test –II**
40.	Solid-liquid separation techniques
41.	concentration of biological products
42.	biological products and its purification
43.	Industrial production of ethanol, citric acid.
44.	Industrial production of vinegar, penicillin
45.	**Quiz /Group discussion**
46.	**Quiz /Group discussion**
47.	Industrial production of amino acids.
48.	Enzyme immobilization an over view on techniques
49.	Immobilization of enzymes: fundamentals
50.	Immobilization of enzymes: Methods, and applications.
51.	Enzymes: definition, principle and application
52.	Use of enzymes in detergents, textiles, leather and various purpose.
53.	Application of enzymes in food industries
54.	Application of enzymes in pharmaceutical industries
55.	Industrial production of wine
56.	Industrial production of beer
57.	Seminar & Assignment
58.	Seminar & Assignment
59.	Seminar & Assignment
60.	Seminar & Assignment

61.	Seminar & Assignment
62.	Model Exam
63.	Model Exam
64.	Model Exam

ELECTIVE -I

22MBTEA103: CLINICAL BIOCHEMISTRY

Credits: 4 **Hours: 4/Wk**

Course objectives:

Discuss the fundamental biochemistry knowledge related to health. Explain the clinical significance of the laboratory tests. Diagnosis of clinical disorders are analysed by biological fluid or material analysis. Determine the qualitative and quantitative analysis of body fluids. Evaluate the abnormalities in the lipid profile. To observe abnormalities of hormones for disease diagnosis

UNIT I:

Introduction: Definition and scope of clinical biochemistry in diagnosis. Body Fluids: Biochemistry of urine, blood and cerebrospinal fluid. Haematology: Principle of determination, clinical significance of the following parameters-Total count, differential count, erythrocyte sedimentation rate, packed cell volume, prothrombin time, bleeding time and clotting time.

Unit II

Biological materials- Methods of estimation, normal range in blood serum, plasma and Urine of Glucose, Proteins, Urea, Uric acid, Creatinine. Enzymes: Methods of estimation, principles of assay, normal range of: Serum Glutamic Oxaloacetic Transaminase (SGOT), Serum Glutamate Pyruvate Transaminase (SGPT), Alkaline phosphatase(ALP), Acid phosphatase, Amylase, Creatine Phospho Kinase (CPK).

Unit III

Principle of estimation, normal values and clinical significance of the Lipid profile,- triglycerides, total cholesterol, HDL cholesterol and LDL cholesterol,. Disorders of lipids: lipid mal- absorption and steatorrhea, sphingolipidosis,

Unit IV

Hormones: Methods of estimation, principles of assay, normal range of: Androgens, Pregnonediol, estrogens, corticosteroids, catecholamine, thyroid, prolactin, growth hormones. FSH, LH, testosterone, β-HCG.

UNIT V

Vitamins-Methods of estimation, principles of assay, normal range of: Vitamin A, thiamine, Niacin, Pyridoxine, Ascorbic acid, Vitamin D3. Mineral estimation: principles of assay, normal range of: Na, K, Ca, CI, P, lodine, Zn, Mg, Li.

Books Recommended:

- Abeles RH, Frey PA and Jeneks WP (1992) Biochemistry, Jones and Bartlett Publishers, Boston.
- Berg JM, Tymoczko, JL and Stryer L (2002) Biochemistry, 5th Edition, WH Freeman & Co., New York.
- Cohn EE, Stumph PK, Bruening G and Doi RH (1987) Outlines of Biochemistry.
- Clinical Biochemistry: Metabolic And Clinical Aspects by William J. Marshall, Stephen
- K. Bangert, Elizabeth S.m. Ed. S.m. Ed. Marshall (2008) Publisher: Elsevier Science

Course learning outcome:

1. Learn about the normal constituents of urine, blood and their significance inmaintaining good health.
2. Exposure to the mechanisms of causation of diseases of liver and kidney.
3. The variations in the levels of trigycerides and lipoproteins andtheir relationship with various diseases.
4. Acquainted with the role of enzymes in diagnosis of various diseases.
5. Concept and techniques for various immunological assays for human disease.

LECTURE SCHEDULE

S. No.	Lectures
1	Introduction: Definition and scope of clinical biochemistry in diagnosis
2	Body Fluids: Biochemistry of urine
3	Blood and cerebrospinal fluid
4	Haematology: Principle of determination
5	Clinical significance of the following parameters-Total count, differential count
6	Erythrocyte sedimentation rate
7	Packed cell volume
8	Prothrombin time
9	Bleeding time and clotting time
10	Biological materials- Methods of estimation
11	Normal range in blood serum
12	Plasma and Urine of Glucose
13	Proteins, Urea
14	Uric acid, Creatinine
15	Enzymes: Methods of estimation, principles of assay
16	Normal range of: Serum Glutamic Oxaloacetic Transaminase (SGOT)
17	Serum Glutamate Pyruvate Transaminase (SGPT)
18	Alkaline phosphatase(ALP), Acid phosphatase
19	Amylase, Creatine Phospho Kinase (CPK)
20	**Internal Test -1**
21	Principle of estimation, normal values and clinical significance of the Lipid profile
22	Triglycerides
23	Total cholesterol
24	HDL cholesterol and LDL cholesterol
25	An overview of Disorders of lipids
26	**Quiz /Group discussion**
27	**Quiz /Group discussion**
28	Lipid mal- absorption and steatorrhea
29	Sphingolipidosis
30	An over view of Hormones
31	Methods of estimation of Hormones
32	Hormones Principles of assay
33	Normal range of: Androgens
34	Normal range of : Pregnonediol, estrogens
35	Normal range of : Corticosteroids, catecholamine
36	Normal range of : Thyroid, prolactin and growth hormones
37	Normal range of : FSH, LH
38	Normal range of : Testosterone,

39	Normal range of: β-HCG.
40	**Internal test –II**
41	An over view of Vitamins
42	Vitamins-Methods of estimation
43	Vitamins - principles of assay
44	Normal range of: Vitamin A,
45	Normal range of : Thiamine, Niacin
46	Normal range of : Pyridoxine, Ascorbic acid and Vitamin D3
47	Normal range of : Mineral estimation: principles of assay
48	**Quiz /Group discussion**
49	**Quiz /Group discussion**
50	Normal range of: Na, K, Ca, CI, P, lodine, Zn, Mg, Li
51	Clinical significance of the following parameters-Total count, differential count
52	Biological materials- Methods of estimation
53	Normal range of : Pregnonediol, estrogens
54	HDL cholesterol and LDL cholesterol
55	Normal range of : Thyroid, prolactin and growth hormones
56	Normal range of : Mineral estimation: principles of assay
57	**Seminar & Assignment**
58	**Seminar & Assignment**
59	**Seminar & Assignment**
60	**Seminar & Assignment**
61	**Seminar & Assignment**
62	**Model Exam**
63	**Model Exam**
64	**Model Exam**

22MBTEB103: BIODIVERSITY CONSERVATION

Credits: 4 **Hours:4/Wk**

Course Objectives:

Upon reading the course, the students will be able to:

- Memorize the current status of biodiversity in India and abroad
- How to measure/assess the plant, animal and microbial diversity
- Use of biotechnological tools for access and conserving biological diversity
- Explain the traditional methods for biodiversity conservation
- Describe the rules and regulations of biodiversity protection in world

Unit I:

Biodiversity-definition, levels and types; biodiversity values-evolutionary, economic, social, cultural and intrinsic values, threats to biodiversity-Indian context, Climate change and biodiversity; Biodiversity of Indian subcontinent: biodiversity hotspots and their characteristics. IUCN red listed plants and Exotic plants.

Unit II:

Plant and animal diversity: Techniques for survey and assessment of plant and animal biodiversity-species diversity and stability relationship; Diversity indices, Communities in forests, grassland, desert and mangrove ecosystems. Biotechnology in evaluating genetic diversity: molecular markers and DNA –Protein Profiling. Remote Sensing and GIS tools in biodiversity assessment.

Unit III:

Microbial diversity: Microbes in different environments. Microbial diversity values and roles in ecosystems. Tools for assessing microbial diversity- basic and molecular methods. Techniques for preserving and conserving microbes

Unit IV:

Biodiversity conservation strategies: *in situ* conservation: Biosphere reserve, sanctuaries, national parks, ex situ conservation: botanical garden, zoological garden, *in vitro* conservation: germplasm or gene bank, tissue culture; Global and indigenous approaches to biodiversity conservation

Unit V:

Convention on biological diversity (CBD), CITES, ITTA, UNFCCC, Kyoto Protocol, TRIPS, Ramsar Convention on Wet Lands. Biodiversity Regulatory in India: Indian initiatives in biodiversity conservation-biodiversity act 2002, Biodiversity Rules 2004, national biodiversity strategy and action plan (NBSAP), National biodiversity authority (NBA) etc; protected area network (PAN)-biosphere reserves and community conservation area.

Suggested Books

1. Gaston, K.J and Spicer, J.I. 2004. Biodiversity: An Introduction. Blackwell Publishing Company, USA.
2. Richard. B. Primack. 1998. Essentials of conservation biology. Sinauer Associates, Inc. USA.
3. Ray S. and Ray A.K. 2010. Biodiversity and biotechnology. New central book Agency (P) Ltd. Kolkata
4. Agarwal, S.K. 2002. Biodiversity conservation. Rohini Publishers, Jaipur.
5. Nautiyal, S and Kaul, A.K. 1999. Forest Biodiversity and its conservation Practices in India. Oriental Enterprises, Dehradun.
6. Benson, E.E., 1999. Plant conservation Biotechnology. Taylor and Francis Ltd., London.
7. Sinha, P.C., 1998. Wildlife and forest conservation. Anmol Publication Pvt. Ltd, New Delhi. 13. Edward, O.G., 2004. *Ex situ* plant conservation. Island Press, Washington, DC

Learning outcomes

By the end of the course, the student should be able to

- Explore the biodiversity types, level, uses and its threats.
- Acquired technical knowledge for measure the biodiversity
- Getting knowledge for the use of biotechnological tools for the assess and conserving biodiversity
- Gain knowledge in related to traditional conservation methods for protecting biodiversity.
- Understanding the norms and regulations in global level conservation of biodiversity

S. No.	Lectures

1.	Biodiversity-definition, levels and types.
2.	Classification of biodiversity values
3.	biodiversity values-evolutionary, economic, social.
4.	biodiversity values- cultural and intrinsic values.
5.	Threats to biodiversity--Indian context, Climate change and biodiversity
6.	Biodiversity of Indian subcontinent.
7.	The major biodiversity hotspots in India.
8.	The characteristics of biodiversity hotspots.
9.	IUCN Red List of Threatened Species.
10.	Exotic Plant: Exotic Plant Species as Problems and Solutions
11.	Plant and animal diversity and its importance
12.	Techniques for survey: definition, types and examples
13.	assessment of plant and animal biodiversity
14.	species diversity: definition, importance and examples.
15.	stability relationship; Diversity indices, Communities in forests,
16.	stability relationship: grassland, desert and mangrove ecosystems
17.	Biotechnology in evaluating genetic diversity
18.	Molecular markers and its application
19.	DNA –structure, function, bases
20.	Protein Profiling-expression, Application
21.	Remote Sensing- an overview
22.	GIS tools in biodiversity assessment: fundamendals
23.	GIS tools in biodiversity assessment: importance and application
24.	The importance of microbial diversity
25.	The types of microbial diversity
26.	Microbes in different environments
27.	Microbial diversity: introduction, process, application
28.	Microbial diversity values in ecosystems
29.	Microbial diversity role in ecosystems
30.	Tools for assessing microbial diversity: molecular method
31.	Tools for assessing microbial diversity: basic method
32.	Techniques for preserving microbes
33.	Techniques for conserving microbes

34.	Biodiversity conservation: introduction, process, effects
35.	Biodiversity conservation strategies
36.	*in situ* conservation: Biosphere reserve, sanctuaries, national parks
37.	ex situ conservation: an overview
38.	ex situ conservation: botanical garden, zoological garden,
39.	*in vitro* conservation
40.	**Internal test –II**
41.	germplasm or gene bank
42.	tissue culture: method, requirements, culture condition
43.	Global and indigenous approaches to biodiversity conservation
44.	Convention on biological diversity (CBD)
45.	biodiversity conservation: CITES, ITTA, UNFCCC
46.	**Quiz /Group discussion**
47.	**Quiz /Group discussion**
48.	biodiversity conservation: Kyoto Protocol, TRIPS
49.	Ramsar Convention on Wet Lands
50.	Biodiversity Regulatory in India
51.	Indian initiatives in biodiversity conservation-biodiversity act 2002
52.	Biodiversity Rules 2004
53.	national biodiversity strategy and action plan (NBSAP)
54.	National biodiversity authority (NBA) etc
55.	protected area network (PAN)-biosphere reserves
56.	community conservation area
57.	Seminar & Assignment
58.	Seminar & Assignment
59.	Seminar & Assignment
60.	Seminar & Assignment
61.	Seminar & Assignment
62.	Model Exam
63.	Model Exam
64.	Model Exam

22MBTEC103: PLANT TISSUE CULTURE

Credits: 4 **Hours:4/Wk**

Course Objectives:

This course aims to help the students to gain an advanced level of understanding in the comprehensive components of plant tissue culture. The content of the course contributes for plant tissue culture techniques, food security and human health towards sustainable agriculture. The course will also help student careers in plant related research, government regulatory bodies, education, food industry and other plant based product development and related businesses.

Unit I:

Plant Tissue Culture Introduction- Concepts and principles. History of Plant tissue culture. Sterilization techniques. Nutritional requirements for plant tissue culture - Factors affecting plant tissue culture

Unit II:

Pathways of Plant Regeneration Morphogenesis – direct and indirect, organogenesis and somatic embryogenesis. Callus initiation - establishment and maintenance. Establishment of suspension culture . Synthetic seeds and applications.

Unit III:

Plant Tissue Culture Techniques for Propagation Meristem culture and virus elimination - virus indexing methods. Shoot tip culture and in vitro clonal multiplication-Applications. Micropropagation techniques in roses, banana and advantages

Unit IV:

Plant Tissue Culture Techniques Organ Culture Embryo culture and embryo rescue-applications. In vitro fertilization techniques. Ovule, ovary and endosperm culture. Anther and microspore culture - production of haploids

Unit V:

Plant Tissue Culture Techniques and secondary metabolites – Other Applications Protoplast isolation, culture and protoplast fusion - applications -. Somaclonal variation - applications. In vitro germplasm conservation – Secondary metabolites production through cell culture -bioreactors.

References

1. Bhojwani, S.S and Dantu, P. 2013. Plant Tissue Culture – An Introductory Text. Springer Publications

2. Karl-Hermann Neumann, Ashwani Kumar and JafargholiImani. 2009. Plant Cell and Tissue Culture-A Tool in Biotechnology- Basics and Application. Springer-Verlag, Berlin Heidelberg

3. Acram Taji, Prakash P. Kumar, Prakash Lakshmanan, 2002.In vitro plant breeding. The Haworth Press Inc., New York.

4. Cassells, A. C and Peter B. Gahan. 2006. Dictionary of plant tissue culture. Food Products Press, an

Imprint of the Haworth Press, Inc., New York-London-Oxford

5. Gamborg, O.L and G.C.Philips (eds.). 2013. Plant Cell, Tissue and Organ culture-Lab Manual. Springer Science & Business media.

6. Razdan, M.K. 2003. Introduction to Plant Tissue Culture. (II Edn.). Science Publishers Inc, Enfield (NH) U.S.A.

7. Roberta H. Smith, 2000. Plant tissue culture: Techniques and Experiments. Gulf Professional Publishing.

e- resources

1. PTC Information exchange - www.aggie-horticulture.tamu.edu/tisscult/tcintro.html

2. Applications of Biotech.in Crop Improvement - http://nptel.ac.in/courses/102103016/1

3. e-book: Recent Advances in Plant in vitro Culture - http://www.intechopen.com/books/recent-advances-in-plant-in-vitro-culture

4. e-book: Plant Propagation by Tissue Culture. Vol. I-3rd Edn – pp.504. Springer publications. ISBN 978-1-4020-5005-3 (e-book)

Learning Outcome

- Learning important milestones in the plant tissue culture.
- Understanding the concepts and principles of Plant tissue culture.
- Learning the techniques of sterilization and monitoring method of sterilization
- Learning different pathways of plant regeneration under *in vitro* conditions – organogenesis and somatic embryogenesis.
- Techniques of establishing cell suspension culture. Synthetic seeds and applications.
- Understanding the techniques of virus elimination – methods of virus indexing. Meristem and Shoot tip culture and Applications.
- Performing procedures for Micropropagation techniques in rose and banana.
- Culturing of reproductive structures – anther, microspores, embryos, endosperm, Ovule and ovary cultures and methods to produce haploids.
- Protoplast isolation, culture and protoplast fusion – applications -. Somaclonal variation – applications.
- Learning methods to conserve germplasm under In vitro.
- Production of Secondary metabolites production through cell culture.

LECTURE SCHEDULE

S. No.	Lectures
1.	Introduction-History, scope and concepts of Tissue culture
2.	Sterilization techniques in plant tissue culture-methods, principles and uses
3.	Nutritional requirements
4.	Factors affecting plant tissue culture-explant, medium and other environmental factors
5.	Pathways of plant regeneration- Morphogenesis
6.	Method of plant regeneration
7.	Organogenesis - direct and indirect
8.	Somatic embryogenesis - stages
9.	Somatic embryogenesis - induction, maturation
10.	Plantlet conversion - Synthetic seeds
11.	Callus culture - applications
12.	Suspension culture - applications
13.	Meristem culture
14.	virus elimination-chemotherapy, thermotherapy, cryotherapy and applications
15.	Virus indexing methods-sap transmission, ELISA
16.	Virus indexing methods- Nucleic acid hybridization, dot blot
17.	Virus indexing methods- PCR
18.	Micropropagation-stages and applications-Rose
19.	Micropropagation-stages and applications-Banana
20.	**Internal Test -1**
21.	Embryo culture - technique and applications
22.	Embryo rescue - technique and applications
23.	In vitro fertilization methods-Ovule, ovary - applications
24.	Endosperm culture-applications
25.	Anther and microspore culture – applications
26.	**Quiz /Group discussion**
27.	**Quiz /Group discussion**
28.	pathways of haploid plant regeneration - applications
29.	Doubling of haploids - applications
30.	Protoplast isolation

31.	Protoplast purification
32.	Protoplast fusion
33.	Protoplast fusion
34.	Protoplast culture methods
35.	Protoplast culture methods
36.	Applications of protoplast culture
37.	Applications of protoplast culture
38.	Somaclonal variation-causes, types
39.	Somaclonal variation- applications
40.	**Internal test –II**
41.	In vitro germplasm conservation-slow growth and normal growth
42.	In vitro germplasm conservation-slow growth and normal growth
43.	In vitro germplasm conservation – applications
44.	In vitro germplasm conservation – applications
45.	Secondary metabolites through plant cell cultures
46.	**Quiz /Group discussion**
47.	**Quiz /Group discussion**
48.	Secondary metabolites through plant cell cultures
49.	Secondary metabolites through plant cell cultures - advantages
50.	Secondary metabolites through plant cell cultures - advantages
51.	Secondary metabolites through plant cell cultures
52.	Secondary metabolites through plant cell cultures
53.	Secondary metabolites through plant cell cultures - up scaling procedures
54.	Bioreactors
55.	Bioreactors
56.	Bioreactors
57.	Seminar & Assignment
58.	Seminar & Assignment
59.	Seminar & Assignment
60.	Seminar & Assignment
61.	Seminar & Assignment
62.	Model Exam
63.	Model Exam

64.	Model Exam

22MBTED103: ECOTECHNOLOGY

Credits: 4 **Hours: 4/Wk**

Course objectives:

This course will give the student an understanding of the basic principles of technologies adopted in various aspects of biotechnology. This course will elaborate the latest trends and applications in the field of Biofuels, Eco-friendly polymers, Biofertilizers, Biopesticides and Biostimulants. The student will understand the critical issues in waste management. Student will acquire knowledge about these modern eco technologies as a resource for further technological processing and application.

Unit I

Introduction to Biofuel, Bioenergy sources – Sugar waste, Starch waste, Lignocellulosic waste, livestock waste Categories- Biodiesel: Source & production Biogas: Source & production Bioethanol : Source & production

Unit II

Introduction to Biopolymers ; Sources – natural sources, microbial polysaccharides, poly hydroxyl alkaonates, Biosynthesis of polymers,Production- fermentation, enzymatic synthesis, characterization and analysis of biopolymers, Applications

Unit III

History, Principles & scope of Biological control, Principles of classical Biological control, Microbial control – definition & concept.Role of insect pathogenic Virus, Bacteria, Fungi, nematodes and their mode of action. Mass production and application of biopesticides

Unit IV

Definition & types, Importance of Biofertilizers in Agriculture, Commercial Biofertilizers – Rhizobium, Azatobacter, Acetobacter, Blue Green Algae Organisms for Nitrogen fixation, Phosphate solubilization, sulphur reduction, Mass production and formulation of Biofertilizers, NanoBiofertilizers

Unit V

Definition & categories – Humic Acid, Protein hydrolysate, Sea weed extract, Inorganic compounds, Microbial Innoulants Regulation of Plant Biostimulants Formulation & Applications of Biostimulants in Agriculture and Horticulture

Recommended Books

- John Love. Bryant. A. J. 2017. Biofuels and Bioenergy. Wiley Blackwell. UK.
- Shakeel Ahmed, Suvardhan Kanchi., Gopalakrishnan Kumar. 2019. Handbook of Biopolymers advances and multifaceted applications. Pan Stanford Publishing Pte. Ltd. New York.
- Leo M. L. Nollet., Hamir Singh Rathore. 2015. Biopesticides handbook. CRC Press. USA.
- Arshad Anwer. Md. 2017. Biopesticides and Bioagents: Novel tools for pest

management. Apple Academic press. USA.
- Kaushik. B.D. Deepak Kumar. Shamim. Md. 2019. Biofertilizers and Biopesticides in Sustainable Agriculture. 1st Edition. Apple Academic Press. USA.
- Aneesa Padiniakkara. Aparna Thankappan, Fernando Gomes Souza. Jr. Sabu Thomas. 2018. Biopolymers and Biomaterials. CRC press, USA.
- Damian Price. 2017. Biodiesel Production Processes and Technologies. Larsen and Keller Education. USA.
- Alemayehu Gashaw. Solomon Libsu. 2016. Biodiesel, Bio-Ethanol and Biogas as an Alternative Fuels. American Academic Press. USA.

Web sources

http://agricen.com /agricultural-biostimulants.
https:// www.britannica.com/science/nitrogen-fixation**.**

Course learning outcome:

Completely read this paper student will learn following knowledge:

- This paper provides an in-depth scope and significance of various ecotechnological applications.
- The student will gain knowledge in utilization of the commonly available resources for commercial application.
- The student will get an idea about the exploitation of readily available resources and issues associated with product development, which will be useful for developing entrepreneurship skills.

LECTURE SCHEDULE

S. No.	Lectures
1.	Introduction to Biofuel
2.	Types of biofuels
3.	Economic and environmental considerations of biofuels
4.	Bioenergy sources – Sugar waste
5.	Bioenergy sources – Starch waste
6.	Bioenergy sources- Bioenergy sources
7.	Bioenergy sources- livestock waste
8.	Biodiesel: Source and production
9.	Biogas: Source and production
10.	Bioethanol : Source and production
11.	Introduction to Biopolymers
12.	Biopolymers versus synthetic polymers
13.	Biopolymers ; Sources – natural sources,microbial polysaccharides, poly hydroxyl alkaonates

14.	Biopolymers ; Sources – microbial polysaccharides,
15.	Biopolymers ; poly hydroxyl alkaonates
16.	Biosynthesis of polymers, Production- fermentation process
17.	Biopolymers enzymatic synthesis analysis methods
18.	Biopolymers structural and characterization analysis
19.	Biopolymers applications
20.	**Internal Test -1**
21.	History, Principles and scope of Biological control
22.	Principles of classical Biological control and its types biological control
23.	Microbial control – definition and concept
24.	Microbial control - Mode of action of insect pathogenic Virus, Bacteria,
25.	Microbial control - Mode of action of insect pathogenic Fungi and nematodes
26.	Mass production and application of biopesticides
27.	**Quiz /Group discussion**
28.	**Quiz /Group discussion**
29.	Definition of Biofertilizers
30.	Advantages of Biofertilizers
31.	Types of biofertilizars
32.	Biofertilizers production technology from agro waste materials
33.	Biofertilizers- commericial source Rhizobium, Azatobacter, Acetobacter,
34.	Biofertilizers- commericial source Blue Green Algae Organisms for Nitrogen fixation,
35.	Biofertilizers- commericialsource Phosphate solubilization
36.	Biofertilizers- commericialsource sulphur reduction
37.	Biofertilizer production and their applications in agriculture
38.	Mass production and formulation of Biofertilizers
39.	NanoBiofertilizers preparation methods
40.	**Internal test –II**
41.	NanoBiofertilizers used in agriculture advantages and disadvantages
42.	NanoBiofertilizers used in agriculture field
43.	Definition and categoriesPlant Biostimulants
44.	Definition and Plant Biostimulants
45.	Plant Biostimulants of Humic Acid, Protein hydrolysate

46.	Plant Biostimulants of Sea weed extract
47.	Plant Biostimulants of Sea weed extract
48.	**Quiz /Group discussion**
49.	**Quiz /Group discussion**
50.	Plant Biostimulants of Inorganic compounds
51.	Plant Biostimulants of Microbial Innoulants
52.	Plant Biostimulants of Microbial Innoulants
53.	Regulation of plantBiostimulants Formulation and Applications
54.	Regulation of plantBiostimulants Formulation and Applications
55.	Biostimulants applications in Agriculture and Horticulture
56.	**Seminar & Assignment**
57.	**Seminar & Assignment**
58.	**Seminar & Assignment**
59.	**Seminar & Assignment**
60.	**Seminar & Assignment**
61.	**Seminar & Assignment**
62.	**Model Exam**
63.	**Model Exam**
64.	**Model Exam**

22MBTEE103: BIOCHEMICAL AND BIOPHYSICAL TECHNIQUES

Credits: 4 **Hours: 4/Wk**

Course objective:

After successful completion of this class, students will be able to: Demonstrate an understanding of the biomedical instrumentation principles in aspects of device design and applications. Apply these principles in the context of bioinstrumentation interactions with tissues, organs and human body to explain the measurement results and to develop the instrumentations. Students will demonstrate these abilities and hone the appropriate information gathering, computational and data-handling skills in homework and lab exercises. They will demonstrate their proficiency formally in examinations.

UNIT 1

Bio-chemical measurement: Biochemical sensors - pH, pO2 and pCo2, Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors - Blood gas analyzers, colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description).

UNIT II

Chromatography and Centrifugation: Introduction to chromatography, paper chromatography, gel filtration, ion-exchange chromatography, affinity chromatography, hydroxyapatite chromatography, HPLC & GC: Types, principle and applications. Centrifuge (RCF, sedimentation concept), different types of centrifuges. different rotors, differential and density gradient centrifugation, analytical ultra- centrifugation, determination of molecular weights and other applications.

UNIT III

Analysis of biomolecules: Characterization of proteins and nucleic acids; different electrophoresis like AGE, PAGE, different gel staining methods, auto-radiography, electrophoretic mobility shift assay, chromatin immunoprecipitation.

Unit IV

Microscopes: Concepts - Resolving power. Construction and working principles of the following microscopes– Stereozoom (Dissecting), Compound, Light microscopy, Bright & Dark Field microscopy, Inverted, Phase contrast and electron microscope. An introduction to advance microscopies like fluorescence, confocal, AFM, and cryo-electron microscopy.

UNIT V

Laboratory safety guidelines and regulations, standard operating protocols (SOP), Introduction to bioethics, Introduction to Patent and Process Involved in Patenting. Patenting Living Organisms, Patent of agricultural technology, and their implications for India and other developing countries. Copyright, trademark, trade secret, Traditional Knowledge and Geographical indication. Commercial Exploitation, and Protection of IPR. Participation in Biosafety and Protection of Biodiversity. Indian Biodiversity Act.

Recommended Textbooks and References

1. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 2003.
2. Standard Handbook of Biomedical Engineering & Design – Myer Kutz, McGrawHill Publisher, 2003
3. Biophysics, an introduction. 1st edition. (2002) Cotteril R. John Willey and SonsLtd., USA
4. Biophysics. 1st edition (2002), Pattabhi V and Gautham N. Kluwer AcademicPublisher, USA.
5. Textbook of optics and atomic physics, 8th edition (1989) P.P. Khandelwal,Himlaya Publishing House, India.
6. Instrumentation measurements and analysis – 2nd edition (2003). NakraandChoudhari, Tata McGraw Hill, India.
7. Wilson K, Goulding KH. (2018) Principles and Techniques of Biochemistry and Molecular Biology, Eight Edition , Edited by Hofmann A, Clokie S. Cambridge University Press
8. Plummer DT. (2017) An Introduction to Practical Biochemistry. 3rd Edition McGraw Hill Education
9. Philips, R. Kondev J, Theriot J, Garcia H. (2012). Physical Biology of the Cell. 2nd Edition Garland Science.
10. Bioethics and Biosafety in Biotechnology by Sree Krishna V., New Age International (P) Ltd., Publ., Mumbai. 2007
11. Intellectual Property Rights by Deborah E. Bouchoux., Delmar Cenage Learning. 2005
12. An Advanced textbook on Biodiversity: Principles and Practice by K.V. Krishnamurthy, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2003.
13. The Indian Environmental Protection Act (EPA), 1986
14. Rules for manufacture, use/import/export and storage of hazardous microorganisms or cells Act, 1989
15. Food Safety and Standards act (Government of India), 2006 9. Intellectual Property Rights on Biotechnology by Singh, KC, BCIL, New Delhi

Learning outcomes:

By the end of the course, students will demonstrate:

1. An understanding of biomedical instrumentation principles in aspects of device design and applications.
2. An ability to analyze contemporary bioinstrumentation studies to make connections and decisions based on their scientific merit.
3. An ability to communicate and function effectively on a multi-disciplinary team.
4. An ability to strengthen self-learning methods and organizational skills to enhance problem-solving abilities and efficiency40Bio instrumentation : Introduction, Concepts- Analytical techniques.

LECTURE SCHEDULE

S. No.	Lectures
1.	Fundamental concepts of Biochemical measurements
2.	Biochemical sensors - pH, pO2 and pCo2
3.	Biochemical sensors - Ion selective Field effect Transistor (ISFET)

4.	Biochemical sensors - Immunologically sensitive FET (IMFET),
5.	Biochemical sensors - Blood glucose sensors
6.	Biochemical sensors - Blood gas analyzers
7.	Instrumentation of Colorimeter,
8.	Instrumentation of flame photometer
9.	Instrumentation of Spectrophotometer
10.	Instrumentation of blood cell counter,
11.	Auto analyzer (simplified schematic description).
12.	Introduction of chromatography, and its types
13.	Paper chromatography – Types, principle and applications
14.	Gel filtration chromatography – Types, principle and applications
15.	ion-exchange chromatography – Types, principle and applications
16.	Affinity chromatography– Types, principle and applications
17.	Hydroxyapatite chromatography– Types, principle and applications
18.	High performance liquid chromatography(HPLC)– Types, principle and applications
19.	Gas Chromatography (GC) – Types, principle and applications
20.	**Internal Test – I**
21.	Characterization of proteins and nucleic acids
22.	Different types of electrophoresis, principle and its uses
23.	Electrophoresis technique – Agarose gel electrophoresis
24.	Electrophoresis technique – Polyacrylamide gel electrophoresis
25.	Different gel staining methods
26.	**Quiz /Group discussion**
27.	**Quiz /Group discussion**
28.	Auto-radiography and chromatin immunoprecipitation
29.	Electrophoretic mobility shift assay
30.	Concepts of Microscopy ,Principle and Resolving power
31.	Construction and working principles of Stereo zoom (Dissecting)
32.	Construction and working principles of Compound microsope
33.	Construction and working principles of light microscopy
34.	Construction and working principles of Bright & Dark Field Microscopy
35.	Construction and working principles of Inverted microscope
36.	Construction and working principles of phase contrast microscope
37.	Construction and working principles of electron microscope and its types
38.	An introduction to advance microscopies
39.	Advances of Fluorescence microscopy and its principles
40.	**Internal Test – II**
41.	Advances of Confocal microscopy and its principles
42.	Advances of Atomic force microscopy(AFM) and its principles
43.	Advances of Cryo-electron microscopy and its principles
44.	Laboratory safety guidelines and regulations
45.	Standard operating protocols (SOP) and introduction of bioethics
46.	**Quiz /Group discussion**
47.	**Quiz /Group discussion**
48.	Introduction to Patent and Process Involved in Patenting
49.	Patenting Living Organisms and Patent of agricultural technology
50.	Patenting implications for India and other developing countries
51.	Copyright, trademark, trade secret, Traditional Knowledge and Geographical indication.
52.	Intellectuall Property Rights(IPR)

53.	Commercial Exploitation, and Protection of IPR
54.	Participation in Biosafety and Protection of Biodiversity
55.	Participation in Biosafety and Protection of Biodiversity
56.	Indian Biodiversity Act
57.	**Seminar & Assignment**
58.	**Seminar & Assignment**
59.	**Seminar & Assignment**
60.	**Seminar & Assignment**
61.	**Seminar & Assignment**
62.	**Model Exam**
63.	**Model Exam**
64.	**Model Exam**

22MBT104: PRACTICAL I: CELL BIOLOGY AND BIOCHEMISTRY

Credits: 4 **Hours: 6/Wk**

Course Objectives: Students will gain the sound technical knowledge and having hands on practical skills in various aspects of cell biology and biochemistry

1. Stains and staining techniques : vital and differential staining
2. Study of Stages of Mitosis
3. Study of Stages of Meiosis
4. Sex chromatin(Barr body)
5. Buffer Preparation, Molarity, Molality and Normality
6. Estimation of DNA.
7. Estimation of RNA.
8. Estimation of protein.
9. Extraction and estimation of starch from potato.
10. Separation of aminoacids by paper chromatography/TLC.
11. Analysis of proteins by SDS-PAGE.

Learning outcomes

By the end of the course, the student should be able to

- Find out the stages of Cell division
- Sex chromatin determination by performing a Barr body experiment
- Differentiate the bacterial cells
- Getting knowledge for the preparation of stains, buffers, standard solutions for various biochemical assays
- To train the students for estimation of nucleic acid, protein and starch
- Using chromatography techniques, students will able to separate pigments and amin**o**
- acids from a mixture of samples

22MBT105 Practical- II: MICROBIAL TECHNOLOGY

Credits: 4 **Hours: 6/Wk**

Course Objectives:

The objective of this laboratory course is to introduce students to experiments in general and industrial microbiology. The course is designed to teach students the utility of set of experimental methods and how to handle microbiology experimental problems in industry orientedmanner

1. Preparation of different media, Sterilization methods and streaking methods
2. Enumeration of microorganisms in soil &water.
3. Isolation of microbes from spoiled vegetables.
4. Isolation of amylase producing microorganisms.
5. Microbial production of citric acid using *Aspergillus niger.*
6. Isolation of antibiotic producing microbes and cross streak assay
7. Antibiotic Sensitivity Test by Kirby-Bauer Disk Diffusion method.
8. Wine production (usingYeast).
9. Isolation of nitrogen fixing bacteria.
10. Isolation of carotenoid producing bacteria.
11. Isolation of lipase producing microorganism.

Learning Outcomes

The overall goal of this course is for the student to gain a basic working knowledge of microbiology concepts and techniques which will be necessary for future scientific endeavors.

Upon completion of the course, the student should achieve an understanding of the following:

- To learn media preparation, sterilization, organism details and staining methods.
- Ability to isolate, characterize and identify common bacterial organisms.
- Determine bacterial load of different samples.
- To perform antimicrobial sensitivity test. - Preserve bacterial cultures
- To learn the techniques for isolation and identification of industrially important microbes

22MBT106 TEAM PROJECT

Credit :2 **Hours: 2/wk**

Course Objective: To develop student‘s abilities to transmit technical knowledge and Team work.

22MBT107 MOOC COURSE

Credit :2

Course Objective: Student can select and learn the course of interest from the SWAYAM platform.

22MBT201: GENETICS AND MOLECULAR BIOLOGY

Credits: 4 **Hours: 4/Wk**

Course Objectives

This paper is designed to develop an understanding of fundamental and applied aspects of genetics and molecular biology with the ability to use that knowledge in a wide range of modern science. The content include classical mendalian genetics, microbial and molecular genetics, and various aspects of molecular biology which include replication, transcription, translation, gene regulation, DNA binding motifs, DNA methylation and epigenetic regulation. The paper will be helpful for the students in understanding and applying the core concepts in their project and higher studies.

Unit I : Mendalian Genetics

Mendelian principles: Dominance, Segregation and independent assortment. Mendelian Crosses and Punnett square. Incomplete dominance, Epistasis, Linkage and crossing over. Population genetics: Hardy-Weinberg equilibrium, genetic drift and speciation.

Unit II: Bacterial Genetics

Recombination: Plasmids-origin of replication, incompatibility. Mutations and genetic analysis – auxotrophic, conditional lethal, resistant mutants. Isolation, selection and replica plating of mutants – complementation and recombination test. Transformation, Transduction Conjugation: F-factor and Mating types.

Unit III: DNA structure and Function

DNA: Types and structure. DNA replication in prokaryotes and eukaryotes. DNA Repair Mechanisms: SOS, thymine dimerization, mismatch repair.

Unit IV: RNA structure and Function

RNA: Types of RNA, RNA polymerase, and Promoters: classes and consensus sequences, transcription factors. Transcription in prokaryotes and eukaryotes. Genetic Code. Translation: Steps; protein folding and . Intracellular protein trafficking and targeting

Unit V: Gene Regulation

Regulation of gene expression in prokaryotes: Lactose and tryptophan; epigenetic regulation of gene expression in eukaryotes. DNA methylation – histone modification – acetylation and deacetylation, DNA binding motifs –Zinc finger, Leucine Zipper, HLH, and HTH

Recommended Books

- Benjamin Lewin. Genes XI.2013. Benjamin-Cummings Pub Co.
- Twyman, R.M. 2000. Advanced Molecular Biology: A Concise Reference. Garland/bios Scientific Publishers
- Sandy B Primrose. 1991. Molecular Biotechnology. 2nd Edn. Blackwell Scientific Publishers
- Brown. T.A.2006. Genomes. 3rdEdn. Wiley-Liss (New York).
- Larry Snyder, Wendy Champness.2002.Molecular Genetics of Bacteria. 2nd Edn. Amer Society for Microbiology.
- Sandy B. Primrose, Richard M. Twyman, Robert W. Old, 2002. Principles of Gene Manipulation and genomics. 7th Edn. Blackwell Science

Course learning outcomes

Completely read this course student will learn following knowledge in genetics and molecular biology:

1. Basic concept of Mendalian and non-Mendelian inheritance pattern in plants and animals.
2. Relate modern techniques to the understanding of genetics, and Hardy-Weinberg principle to explain changes in population genetics.
3. Microbial genetic process like generation of mutants for genetic analysis as well as to get an in-depth understanding about the molecular genetics.
4. Describe the principles of gene expression and regulation in prokaryotic and eukaryotic cells.
5. Apprise the importance of epigenetic and methylation systems in gene regulation.
6. Understand the importance of DNA binding motifs in gene regulation

LECTURE SCHEDULE

S. No.	Lectures
1)	Mendelian Genetics – Introduction and Principles .
2)	Mendelian genetics: Dominance, Segregation and independent assortment
3)	Mendelian Crosses and Punnett square.
4)	Incomplete dominance, Epistasis.
5)	Linkage and crossing over.
6)	Population genetics: Hardy-Weinberg equilibrium.
7)	Genetic drift and speciation.
8)	Bacterial Genetics- Introduction.
9)	Recombination: Plasmids-origin of replication, incompatibility.
10)	Mutations and genetic analysis – auxotrophic, conditional lethal, resistant mutants.
11)	Isolation, selection and replica plating of mutants – complementation
12)	Isolation, selection and replica plating of mutants – recombination test.
13)	Transformation
14)	Transduction
15)	Conjugation: F-factor
16)	Conjugation: Mating types.
17)	DNA structure and Function
18)	DNA: Types and structure
19)	DNA replication in prokaryotes

20)	DNA replication in Eukaryotes
21)	**Internal Test -1**
22)	DNA Repair Mechanisms
23)	DNA Repair Mechanisms: SOS
24)	DNA Repair Mechanisms: thymine dimerization
25)	DNA Repair Mechanisms: mismatch repair
26)	Structure of RNA
27)	Functions of RNA
28)	Types of RNA- tRNA
29)	Types of RNA- mRNA
30)	Types of RNA- rRNA
31)	**Quiz /Group discussion**
32)	**Quiz /Group discussion**
33)	RNA polymerase
34)	Promoters: classes and consensus sequences
35)	transcription factors
36)	Transcription in prokaryotes.
37)	Transcription in eukaryotes.
38)	Genetic Code
39)	Translation: Steps; protein folding
40)	Translation: Intracellular protein trafficking
41)	Intracellular protein trafficking
42)	Gene Regulation
43)	Regulation of gene expression in prokaryotes: Lactose
44)	Regulation of gene expression in prokaryotes: tryptophan
45)	**Internal test –II**
46)	epigenetic regulation
47)	epigenetic regulation of gene expression in eukaryotes
48)	DNA methylation
49)	histone modification
50)	acetylation and deacetylation
51)	**Quiz /Group discussion**
52)	**Quiz /Group discussion**

53)	DNA binding motifs –Zinc finger
54)	DNA binding motifs – Leucine Zipper
55)	DNA binding motifs – HLH
56)	DNA binding motifs – HTH
57)	**Seminar & Assignment**
58)	**Seminar & Assignment**
59)	**Seminar & Assignment**
60)	**Seminar & Assignment**
61)	**Seminar & Assignment**
62)	**Model Exam**
63)	**Model Exam**
64)	**Model Exam**

22MBT202: PLANT AND ANIMAL BIOTECHNOLOGY

Credits: 4 **Hours: 4/Wk**

Course Objectives:

This course aims to help the students to gain the basic and advanced level of understanding of plant and animal biotechnology. The content of the course contributes technical insights into plant breeding, tissue culture, plant genes and genetic modification (GM), and plant transformation. They will also gain a good knowledge in animal cell culture facility establishment, stem cell culture, embryo transfer technology and various applications in plant and animal biotechnology arena. The course will also help student careers in plant/animal related research, government regulatory bodies, food industry and other plant/animal based product development and related businesses.

Course Content

Unit I: Plant tissue culture

Totipotency, cytodifferentiation, cell suspension culture, micropropagation, organogenesis, somatic embryogenesis, protoplast culture. Somaclonal variation Production of haploids.

Unit II: Plant Molecular Biology and Plant Transformation

Plant genome organization, Molecular markers: RAPD, AFLP, RFLP, SSR and SNP. Agrobacterium mediated transformation, particle bombardment. Confirmation of transgene expression - PCR, Northern, Southern and Western blot analyses

Unit III: Animal Cell Culture

Nutrient requirements of mammalian cells. Media for culturing cells.

Growth supplements. Primary cultures. Established cell lines. Stationary and Suspension culture techniques. Characterization and maintenance of cells, cryopreservation and revival. Detection of contaminants in cell cultures. Cell viability and cytotoxicity.

Unit IV: Stem cell and Embryo transfer Technology

Stem cells: Types - embryonic and adult, isolation, identification, expansion, differentiation and uses. Manipulation of reproduction in animals: Artificial insemination, embryo transfer, in-vitro fertilization.

Unit V: Biotechnological Applications

Development of Herbicide, insecticide and disease resistant plants. Production of industrial and pharmaceutical products in plants. Gene silencing and Seed terminator technology. Plant breeders and Farmers Right. Production of regulatory proteins, blood products, vaccines, hormones and other therapeutic proteins in transgenic animals. Transgenic Animals knockouts.

Recommended Books

1. Kalyan Kumar De, 1997. Plant Tissue Culture 2nd Edn. New Central Book Agency,Calcutta
2. Robert N. Trigiano, and Dennis J. Gray, 1999. Plant Tissue Culture Concept andLaboratory Exercises, 2nd Edn. CRC Press, London.
3. Srivasta, P.S. 1998. Plant Tissue Culture and Molecular Biology, Narosa PublishingHouse, New Delhi.
4. David W. Galbraith, Hans J. Bohnert and Don P. Bourque, 1995. Methods in Plant CellBiology, Academic Press, New York.
5. John H. Dodds and Lorrin W. Roberts, 2006. Experiments in Plant Tissue Culture, 3rd Edn.Cambridge University Press, USA.
6. Palmiro PoltronieriYiguo Hong, 2015. Applied Plant Genomics and Biotechnology 1stEdition, Elsevier- Woodhead Publishing.
7. John M.Davis, Animal Cell culture, Essential methods, 2011, Wiley Blackwell
8. Robert Lanza and Anthony Atala (editors) 2013. Handbook of stem cells, Volume 1 &2, 2nd edition, Academic Press, Elsevier Inc.
9. Carl Pinkert, 2014. Transgenic animal technology - A laboratory handbook, 3rd edition, Elsevier Inc.

Course Learning Outcomes

Upon successfully completing this course, the students could be able to:

1. Explain the basics, methodology and applications of plant tissue culture
2. Design experiments for functional characterization of plant genes and to identify thosesuitable for creating agronomically important traits

3. Conceptualize plant transformation, selection of desirable genes for crop improvement, design binary vector and procedure for generating GM crops
4. Describe what GM crops and products are in the market and pipeline, and theircontributions towards food security, sustainable environment and medicine
5. Learn basic cell culture, type, subculture media preparation and applications of animal cell
6. Understand the difference between stem cell types and methods for producing transgenicanimals.
7. Improve artificial embryo transfer and nuclear transfer methods and applications.
8. Learn the various type cell morphology, stages, and fertilization and transformationtechniques employed in animal systems.

LECTURE SCHEDULE

S. No.	Lectures
1.	Totipotency- expression and importance
2.	Cytodifferentiation- Tissue culture and protocol
3.	cell suspension culture- an overview, definition, protocol
4.	Micropropagation- uses and methods
5.	Organogenesis- introduction and its development
6.	somatic embryogenesis- Definition, process, stages factors
7.	protoplast culture: importance, isolation. Culture and regeneration
8.	Soma clonal variation Production of haploids
9.	Plant genome organization: in chromosomes, and structures
10.	Molecular markers: RAPD, AFLP: efficiency, comparison, and its types
11.	Molecular markers: RFLP, SSR and SNP
12.	Agrobacterium mediated transformation- an over view, methods
13.	particle bombardment- mediated gene transfer and its application
14.	Confirmation of transgene expression – PCR- techniques and example
15.	Northern blot and Southern blot: introduction and protocol
16.	Western blot analyses- technique, theory and trouble Shooting
17.	Nutrient requirements of mammalian cells- culture condition, types of media
18.	Media for culturing cells- supplements, characteristics
19.	Growth supplements- growth condition in tissue culture
20.	Primary cultures- basics, preparation and management
21.	Established cell lines: definition and example

22.	Stationary phase, cell types and characteristics
23.	Suspension culture techniques- an overview, techniques
24.	Characterization and maintenance of cells
25.	Cryopreservation and its application
26.	**Quiz /Group discussion**
27.	**Quiz /Group discussion**
28.	Revival definition and meaning
29.	Detection of contaminants in cell cultures
30.	Cell viability-assay, cell proliferation
31.	Cytotoxicity-assay, methods
32.	Stem cells: Types - embryonic
33.	Stem cells: adult, isolation, identification, expansion,
34.	Stem cells: differentiation and uses
35.	Manipulation of reproduction in animals
36.	Artificial insemination: infertility, procedure, uses, history
37.	embryo transfer- procedure, an overview
38.	in-vitro fertilization- procedure, preparation and risk
39.	Development of Herbicide, insecticide
40.	**Internal test -II**
41.	Disease resistant plants- horticulture
42.	Production of industrial pharmaceutical products in plants
43.	Gene silencing- mechanism and its role
44.	Seed terminator technology
45.	Plant breeders- definition, objective, types
46.	**Quiz /Group discussion**
47.	**Quiz /Group discussion**
48.	Farmers Right- production of plant varieties
49.	Production of regulatory proteins- process and regulation
50.	blood products- Hematology and oncology
51.	Vaccines-history, preparation, types
52.	Importance of vaccine
53.	Immunization-an overview
54.	Hormones- definition, function

55.	The types of harmones
56.	other therapeutic proteins in transgenic animals. Transgenic Animals knockouts
57.	Seminar & Assignment
58.	Seminar & Assignment
59.	Seminar & Assignment
60.	Seminar & Assignment
61.	Seminar & Assignment
62.	Model Exam
63.	Model Exam
64.	Model Exam

2MBT203: r-DNA Technology

Credits: 4 **Hours: 4/Wk**

Course objectives

Students will able to understand the basics of gene cloning, role of enzymes and vectors for genetic engineering, Gene transfer methods, Techniques and safety measures of genetic engineering, genome mapping and gene therapy.

Unit–I

Introduction: History and recent developments in rDNA technology, Enzymes used in rDNA technology. Restriction enzymes, DNA Ligases, DNA polymerase, Ribonucleases, Reverse transcriptase, Alkaline phosphatase, T4 Polynucleotidekinase, Terminal deoxynucleotidyl transferase, Nucleases-S1Nuclease and DNAase Methods of ligation of insert and vector DNA molecules: cohesive end method, homopolymeric tailing, blunt-end ligation

Unit–II

Cloning Vectors: Cloning Vectors- Plasmids and its types. Bacteriophages-Lambda and M13 vectors, Phagemids, Shuttle vectors- YACs, YEps, BACs. Expression vectors- pBR322, pTZ. Animal viruses-SV40, Baculo and their use as vectors

Unit–III

Gene Transfer Methods: Gene transfer methods: calcium phosphate coprecipitation, electroporation, lipofection, Sperm-mediated transfer, viruses, microinjection. Choice of host organisms for cloning. Cloning strategies- genomic cloning, cDNA cloning Cloning of insulin gene in bacteria

Unit–IV

Gene Cloning Strategies: Gene cloning strategies: DNA cloning. Use of adapters & linkers. Construction of genomic DNA and cDNA libraries. Preparation of radiolabelled/nonradiolabelled DNA & RNA probes. Screening and selection of recombinant clones- Colony Hybridization techniques. lacZ complementation (Blue-white selection), Immuno-screening.

Unit–V

Techniques in rDNA Technology and Applications: PCR –types and its applications. Basic concepts of RT-PCR and real-time qPCR.DNA footprinting, Chromosome walking. Hazards and safety aspects of rDNA . Gene Editing Techniques : CRISPR-Cas9 gene, TALEN. Applications of genetic engineering in agriculture, environment and medicine.

Recommended Books

1. Nicholls DTS. An Introduction to Genetic Engineering. 3rd ed. Cambridge Univ Press. 2008.
2. Glick and Pasternak. Molecular Biotechnology. 4th ed. ASM Press 2009.
3. Reece. Analysis of Genes and Genomes. Wiley 2004.
4. Jain KK. Nanobiotechnology Molecular Diagnostics: Current Techniques and Applications.

Taylor & Francis. 2006.

5. vo-Dinh (ed) Nanotechnology in Biology and Medicine: Methods, devices and applications. CRC Press. 2007.

Learning outcomes

By the end of the course, the student should be able to

- Understanding the basic steps of gene cloning and the role of enzymes and vectors responsible for gene manipulation, transformation and genetic engineering
- Getting detailed knowledge of gene transfer methods and identifying suitable hosts for cloning
- Acquiring theoretical knowledge in the techniques, tools, application and safety measures of genetic engineering.
- Describes the genome mapping and sequencing and methods for gene therapy
- Studying the basics of nanotechnology, synthesis, characterization and applications of various nanoparticles in medicine, agriculture and the environment

LECTURE SCHEDULE

S. No.	Lectures
1.	History and recent developments in rDNA technology
2.	Enzymes used in rDNA technology
3.	Restriction enzymes
4.	DNA Ligases
5.	DNA polymerase
6.	Ribonucleases
7.	Reverse transcriptase
8.	Alkaline phosphatase
9.	T4 Polynucleotidekinase
10.	Terminal deoxynucleotidyl transferase
11.	Nucleases-S1Nuclease and DNAase
12.	Cloning Vectors - Plasmids and its types
13.	Bacteriophages - Lambda and M13 vectors
14.	Phagemids
15.	Shuttle vectors - YACs, YEps, BACs

16.	Shuttle vectors - YACs, YEps, BACs
17.	Expression vectors- pBR322
18.	Expression vectors- pBR322, pTZ
19.	Animal viruses-SV40, Baculo and their use as vectors
20.	**Internal Test -1**
21.	Animal viruses-SV40, Baculo and their use as vectors
22.	Use of adapters & linkers
23.	Use of adapters & linkers
24.	Construction of genomic DNA Libraries
25.	Construction of genomic DNA Libraries
26.	**Quiz /Group discussion**
27.	**Quiz /Group discussion**
28.	Construction of cDNA libraries
29.	Construction of cDNA libraries
30.	Preparation of radiolabelled and nonradiolabelled DNA & RNA probes
31.	Preparation of radiolabelled and nonradiolabelled DNA & RNA probes
32.	Preparation of radiolabelled and nonradiolabelled DNA & RNA probes
33.	Screening and selection of recombinant clones
34.	lacZ complementation (Blue-white selection)
35.	Immuno-screening
36.	PCR applications. DNA footprinting,
37.	Chromosome walking.
38.	Medical and forensic applications of rDNA technology- DNA Profiling,
39.	Medical and forensic applications of rDNA technology- DNA Profiling
40.	**Internal test –II**
41.	Diagnosis of inherited disorders and infectious diseases by PCR.
42.	Gene therapy for ADA and cystic fibrosis.
43.	Gene therapy for ADA and cystic fibrosis.
44.	CRISPR-Cas9 gene editing technology
45.	CRISPR-Cas9 gene editing technology
46.	**Quiz /Group discussion**
47.	**Quiz /Group discussion**
48.	Synthesis and purification of recombinant proteins from cloned genes.

49.	Synthesis and purification of recombinant proteins from cloned genes.
50.	Synthesis and purification of recombinant proteins from cloned genes.
51.	Hazards and safety regulations in rDNA Technology
52.	Hazards and safety regulations in rDNA Technology
53.	Production of recombinant enzymes.
54.	Production of recombinant enzymes.
55.	Therapeutic products for use in human health care- insulin, growth hormones, Hepatitis B vaccine
56.	Therapeutic products for use in human health care- Hepatitis B vaccine
57.	**Seminar & Assignment**
58.	**Seminar & Assignment**
59.	**Seminar & Assignment**
60.	**Seminar & Assignment**
61.	**Seminar & Assignment**
62.	**Model Exam**
63.	**Model Exam**
64.	**Model Exam**

22MBT204: OMICS CONCEPT

Credits: 4 **Hours: 4/Wk**

COURSE OBJECTIVES:

The objective of this course is to give an introduction to Genomics and other global OMICS technologies, the theory and practical aspects of these technologies and the applications of these technologies in biology. The student should be able to gain working knowledge of these technologies and appreciate their ability to impart a global understanding of biological systems and processes in health and disease.

UNIT I: GENOMICS

Structure and organization of prokaryotic and eukaryotic genomes. Major genome sequencing projects, HGP, Tools for genome analysis, DNA fingerprinting, BAC and YAC libraries. Genome mapping, UCSC browser. Applications of genomics using case studies.

UNIT II: GENE SEQUENCING METHODS

Introduction to sequencing, first generation DNA sequencing: Maxam and Gilbert method, Sanger Sequencing techniques; Next Generation sequencing: Ion Torrent, small RNA-sequencing, Whole transcriptome sequencing.

UNIT III: MICROARRAY TECHNOLOGY

Basics of Biochips, Type of DNA microarrays: oligonucleotide and cDNA. Tissue chip, RNA chip, Protein chips, and Comparative Genomic Hybridization (CGH) arrays, Applications of Microarray technology.

UNIT IV: METABOLOMIC

Tools and techniques available for metabolomics analysis, targeted vs non-targeted metabolomics, experimental design and sample preparation, workflow, data analysis tools and repositories, data formats and key challenges, metabolite identification, metabolic fingerprinting, applications of metabolomics.

UNIT V: PROTEOMICS

Basic tools and techniques for protein separation and analysis, 2D analysis. peptide mass fingerprinting (PMF), Protein-protein interactions: surface plasmon resonance technique, pull-down assays (using GST tagged), western blot analysis, Protein interaction maps, Applications: diagnostics, expression profiling.

Recommended Books

- A Beginner's Guide, Helen C. Causton, John Quackenbush, Alvis Brazma. (2003). Microarray Gene Expression Data Analysis: Wiley-Blackwell; 1 edition. ISBN-13: 978-1405106825.
- Bagchi D., Swaroop A., Bagchi M (2015). Genomics, Proteomics and Metabolomics in Nutraceuticals and Functional Foods,. Wiley Blackwell. ISBN:9781118930427
- Barh D., Zambare V., Azevedo V (2013). Omics: Applications in Biomedical, Agricultural, and Environmental Sciences,. CRC Press. Taylor and Francis Group. ISBN 9781138074750.
- Brown, TA. (2006). Genomes (3rd ed.). New York: Garland Science Pub.
- Campbell A. M. & Heyer L. J. (2007). Discovering Genomics, Proteomics and Bioinformatics. Benjamin Cummings
- Mayer, B., (2011) Bioinformatics for omics data: methods and protocols, New York: Humana Press. ISBN 978-1617790270.
- Old, R.W., Primrose, S.B., & Twyman, R.M. (2001). Principles of Gene Manipulation: An Introduction to Genetic Engineering. Oxford: Blackwell Scientific Publications.
- Twyman RM. (2013). Principles of Proteomics Second Edition by Garland Science Taylor & Francis Group New York and London.
- Twyman, R., (2013). Principles of Proteomics, Garland Science, ISBN: 978- 0815344728.
- Wilson and Wilsons. (2014). Applications of Advances Omics Technologies: from Genes to Metabolites, Elsevier. ISBN: 9780444626509.

Course learning Outcomes

1. Gain overview of genome variation in the population including technologies to detect these variations

2. Understand how High-throughput DNA sequencing (HTS) can be used to identify genetic variants

3. Understand how HTS technologies can be used to explore changes in gene expression

4. Endow with application of various OMICS technologies.

LECTURE SCHEDULE

S.No.	Lectures
1.	Prokaryotic genomes' organisation and structure.
2.	Structure and organization of eukaryotic genomes.
3.	Major genome sequencing projects.
4.	Human Genome Project.
5.	Tools for Genome analysis.
6.	DNA fingerprinting/DNA Profiling.
7.	Construction of Bacterial Artificial Chromosome (BAC) libraries
8.	Construction of Yeast Artificial Chromosome (YAC) libraries
9.	Genome mapping
10.	Using UCSC Browser
11.	Applications of genomics analysis using case studies
12.	Overview of Genome sequencing
13.	First generation DNA sequencing.
14.	Maxam and Gilbert DNA sequencing Techniques
15.	Techniques for Sanger DNA Sequencing
16.	Next Generation sequencing Methods
17.	Ion-Torrent DNA sequencing Techniques
18.	small RNA-sequencing Techniques

19.	Whole transcriptome sequencing Methods
20.	**INTERNAL ASSESSMENT-1**
21.	Genome organisation and structure in prokaryotic and eukaryotic organisms.
22.	Human Genome Projects (HGP)
23.	Genomic applications using case studies
24.	First generation DNA sequencing Techniques
25.	**QUIZ /GROUP DISCUSSION**
26.	**QUIZ /GROUP DISCUSSION**
27.	Basic idea behind Biochips.
28.	cDNA and oligonucleotide microarray analysis.
29.	Concepts of RNA chips and protein chips.
30.	Comparative Genomic Hybridization (CGH) arrays.
31.	Applications of Microarray technology.
32.	Tools and methods for analysing metabolomics data.
33.	Targeted vs non-targeted metabolomics.
34.	Metabolomics repository, data analysis tools, and experimental design.
35.	Workflow for preparing samples for metabolomics.
36.	Metabolomic data formats and key challenges.
37.	Identification of metabolites.
38.	Metabolic fingerprinting.
39.	Applications of Metabolomics.
40.	**INTERNAL ASSESSMENT-2**
41.	Basics concepts of Biochips and its advances.
42.	Microarray types and explanations .
43.	Application of microarray technology.

44.	Materials and methods for metabolomics analysis.
45.	Applications of metabolomics.
46.	**QUIZ /GROUP DISCUSSION**
47.	**QUIZ /GROUP DISCUSSION**
48.	Basic equipment and procedures for separating and analysing proteins.
49.	Two-Dimensional (2D) Gel Electrophoresis analysis.
50.	Peptide mass fingerprinting (PMF) analysis.
51.	Surface plasmon resonance technique for protein-protein interactions
52.	Pull-down assays with using GST tag
53.	Western blot analysis.
54.	Mapping of protein interactions.
55.	Applications of proteomics in the field of diagnosis
56.	Applications for protein expression profiling
57.	**SEMINAR & ASSIGNMENT**
58.	**SEMINAR & ASSIGNMENT**
59.	**SEMINAR & ASSIGNMENT**
60.	**SEMINAR & ASSIGNMENT**
61.	**SEMINAR & ASSIGNMENT**
62.	**MODEL EXAM**
63.	**MODEL EXAM**
64.	**MODEL EXAM**

22MBT205: PRACTICAL III: GENETICS, MOLECULAR BIOLOGY AND rDNA TECHNOLOGY

Credits: 4 **Hours: 6/Wk**

Course Objectives

The objectives of this practical course are to provide students with laboratory experimental knowledge of molecular biology, genetic engineering and rDNA Technology aspects. Also this course is aimed to teach students with different approaches to perform molecular biology, genetic engineering, rDNA technology and their practical applications in biotechnological research as well as in pharmaceutical industries. rDNA technology has been developed based on our fundamental understanding of the principles of molecular biology and genetic engineering and this is reflected in the contents of this course.

List of Practical's

1. Isolation of genomic DNA
2. DNA fingerprinting by RAPD
3. Restriction analysis of genomic DNA
4. Southern blotting analysis
5. Determination of molecular size of DNA
6. Amplification of gene by PCR.
7. Isolation of RNA and AGE analysis
8. cDNA synthesis by RT-PCR
9. Isolation of plasmids and Electrophoretic analysis
10. Ligation of DNA into plasmid vectors
11. Transformation of plasmids
12. Selection of recombinant clones by blue – White screening.
13. Identification of gene by Colony PCR.
14. Drosophila Genetics
15. Law of segregation by making monohybrid cross involving sepia eye mutant and red eye
16. Law of independent assortment by making dihybrid crosses involving sepia eye and vestigial wing mutant and red eye and long wing

Course Outcomes

After completion of this course, students should be able

- To gain hands on experience in gene isolation, cloning by PCR approach, DNA on and PCR amplification for DNA fingerprinting analysis via RAPD and restriction digestion.
- To conduct gene amplification experiments by PCR analysis.
- To isolate RNA for cDNA synthesis and perform gene expression analysis by qPCR.
- To learn identification of gene copies as well as integration of transgenes by Southern blot analysis.
- To get expertise in isolation of plasmids, cloning of gene and transformation into suitable bacteria for selection of recombinant clones.

-This practical experience would enable them to begin a career in biotech as well as pharmaceutical

industry that engages in in rDNA research

22MBT206: PRACTICAL IV: PLANT AND ANIMAL BIOTECHNOLOGY

Credits: 4 **Hours: 6/Wk**

Course objectives:

The purpose of the course is to

- Provide a working knowledge of laboratory techniques used in Plant and Animal biotechnology.
- Understand aims of molecular background in Plant and Animal biotechnology techniques to develop new products
- Encourage students to undertake research in this field.

Course Content

1. Basic sterilization techniques and culture media preparation.
2. Shoot tip culture.
3. Root culture.
4. Endosperm culture.
5. Anther culture.
6. Protoplast isolation and culturing
7. Synthetic seed production (Artificial seed)
8. *Agrobacterium* mediated gene transformation
9. Preparation of culture media and sterilization
10. Preparation of single cell suspension from spleen
11. Trypsinization of monolayer and sub culturing
12. Cryopreservation and thawing
13. Cell counting and viability
14. Acrosome reaction

Learning outcomes:

The student is expected to acquire practical skills in basic plant biotechnology techniques. This means that after successful completion of this course students are expected to be able to:

- Become familiar with sterilization techniques, media preparation and plant and animal cell culture methods
- Support methodologies in plant tissue and transformation for crop improvement
- Culture and maintain animal cell cultures, various method of preservation and counting of viable cells

22MBT207 Credit Seminar

Credit-1 **Hours: 1/Wk**

Course Objective: To test the technical skills and the communication skills. The research skill is tested by the student's ability to study the given topic and arrive at potential research topics. The communication skills tested in oral communication.

06PHR04 Human Rights (Offered By Sociology Department)

Credit-2 **Hours: 2/Wk**

22MBT301: IMMUNOTECHNOLOGY

Credits: 4 **Hours: 4/Wk**

Course Objectives

The paper helps to the students to understand about our immune system and the immune response of cells and organs. Immunotechnology is a specialized course, which deals with biotechnological aspects of immunological mechanisms. This paper focuses on gene-re-arrangement of immunoglobulin and T-cell receptor genes, antigen processing and presentation, cellular responses, innate immunity and tolerance in addition immunological techniques like ELISA, Immunoblot, and FACS etc are also focused. This knowledge forms the basis for understanding of the practical aspects for production and engineering of antibodies, the application of (auto) antigens and the design of (recombinant) vaccines. Applications of antibody production, antibody engineering, antigen and vaccine technology in disease diagnostics and molecular medicine.

Unit–I : Cell and Organs of immune system

Innate Immunity. Humoral and cell mediated immunity. Central and peripheral lymphoid organs. Cells of the immune system. Antigens- antigenicity, epitopes, haptens. Immunoglobulins-structure, classification and functions

Unit–II: Organization and Functioning of Immune system

T-cell and B-cell receptors, Antigen recognition- processing and presentation to T-cells. Complement activation. Organization and expression of immunoglobulin genes. Generation of antibody diversity.

Unit–III: Vaccine development

Active and passive immunization. Vaccines - killed, attenuated, Recombinant vaccines, DNA vaccines, synthetic peptide vaccines. mRNA Vaccines. COVID-19 and Malaria Vaccine

development, Vaccine Adjuvants

Unit–IV: Transplantation Immunology and immunodeficiency disorders
Transplantation types: MHC antigens in transplantation. Immunodeficiency disorders: AIDS, SCID, Autoimmunity and hypersensitivity. Cancer immunotherapy

Unit–V: Immunological Methods and Techniques
Knockout and Knock-in technology. Immunoelectrophoresis, Immunoblotting, Immunocytochemistry. RIA, ELISA. Flow cytometry. Hybridoma Technology and Immunodiagnostic Kits

Recommended Books

1. Goldsby et al. Kuby Immunology. WH Freeman & Co. 7th ed 2013.
2. Abbas et al. Cellular and Molecular Immunology. Elsevier 2011.
3. Janeway, C. (Ed), Paul Travers. Immunobiology 8th ed. Garland Publ. 2016.
4. Coico and Sunshine. Immunology: A short course. 7th ed. Wiley, 2015.

Course learning outcomes
Completely study this course, the students able to understand following things:

1. The basic and general concept of immunotechnology. Basic Understanding of various immunological process like innate and adaptive immunity, cells and organs of immune system, antigen and antibody interaction, immunogenicity and antigenicity, epitopes and antibody structure.
2. Describe the organization of Ig genes, class switching in constant regions of genes and expression and regulation of Ig genes.
3. How antigens are processed, presented and immune activation occurs
4. How B-cell and T-cell are activated and differentiate.
5. Immune response during allergic reaction.
6. Cancer, AIDS and other immunodeficiency diseases.
7. Development of vaccines, molecular diagnoses tools.
8. This course helpful to the student at his/her project, higher studies and employment in pharmacological industries.

LECTURE SCHEDULE

S. No.	Lectures
1.	Immunotechnology – Introduction.
2.	Cell and Organs of immune system.
3.	Innate Immunity
4.	Humoral and cell mediated immunity
5.	Central and peripheral lymphoid organs.
6.	Cells of the immune system
7.	Antigens- antigenicity
8.	Epitopes and haptens.
9.	Role of Immunoglobulins.
10.	Structure of Immunoglobulins.
11.	Classification of Immunoglobulins.
12.	Functions of Immunoglobulins.
13.	Organization and Functioning of Immune system.
14.	T- Cell receptor.
15.	B - Cell receptor.
16.	Antigen recognition- processing and presentation to T-cells.
17.	Complement activation.
18.	Organization of immunoglobulin genes.
19.	expression of immunoglobulin genes.
20.	Generation of antibody diversity.
21.	**Internal Test -1**
22.	Overview of vaccine development.
23.	Active immunization.
24.	Passive immunization.
25.	Different types of vaccines.
26.	Killed vaccines.
27.	Attenuated vaccines.
28.	**Quiz /Group discussion**
29.	**Quiz /Group discussion**
30.	Recombinant vaccines.
31.	DNA vaccines
32.	Synthetic peptide vaccines.

33.	mRNA vaccines.
34.	COVID-19 Vaccine development
35.	Malaria Vaccine development
36.	Transplantation Immunology and immunodeficiency disorders
37.	**Internal test –II**
38.	Transplantation types.
39.	MHC antigens in transplantation.
40.	Immunodeficiency disorders: AIDS
41.	Immunodeficiency disorders: SCID
42.	Autoimmunity and hypersensitivity.
43.	Cancer immunotherapy
44.	Immunological Methods and Techniques - Overview
45.	Pathogenecity of entomopathogenic pathogen- Nematode.
46.	**Quiz /Group discussion**
47.	**Quiz /Group discussion**
48.	Knockout technology
49.	Knock-in technology
50.	Immunoelectrophoresis
51.	Immunoblotting
52.	Immunocytochemistry
53.	RIA, ELISA.
54.	Flow cytometry.
55.	Hybridoma Technology
56.	Immunodiagnostic Kits
57.	**Seminar & Assignment**
58.	**Seminar & Assignment**
59.	**Seminar & Assignment**
60.	**Seminar & Assignment**
61.	**Seminar & Assignment**
62.	**Model Exam**
63.	**Model Exam**
64.	**Model Exam**

22MBT302: BIOINFORMATICS, BIOSTATISTICS AND BIOINSTRUMENTATION

Credits:4 **Hours: 4/Wk**

Course objectives:

The aim of this course is to emphasize the integration of computer science, statistics and cellular and molecular instrumentations for developing and applying biological research. This course will make the students to understand basic and advanced principles, concepts, and operations of electrophoresis, spectroscopy and chromatography.

Unit I

Biological databases: Database concepts; Protein and nucleic acid databases; Structural databases. databases and search tools: biological background for sequence analysis; NCBI; publicly available tools; resources at EBI; resources on web; database mining tools PDB: Introduction, Database searching, PDB file retrieval, Protein structure prediction: protein folding and model generation; secondary structure prediction

Unit II

Gene bank sequence database; submitting DNA sequences to databases and database searching; sequence alignment; pairwise alignment techniques; BLAST: BLASTp, BLASTn, tBLASTn, BLASTx, tBLASTx, PHI-BLAST, and PSI-BLAST; motif discovery and gene prediction; assembly of data from genome sequencing; Comparative genomics; Gene prediction: Extrinsic and intrinsic methods

Unit III

Multiple sequence analysis; multiple sequence alignment;flexible sequence similarity searching with the FASTA. program package; use of CLUSTALW and CLUSTALX for multiple sequence alignment; submitting protein sequence to databases: where and how to submit, SEQUIN; methods of phylogenetic analysis.

Unit IV

Collection and classification of data: diagrammatic and graphic representation of data. Measurement of central tendency: standard deviation – parametric and nonparametric hypothesis testing. Student t test. Correlation and regression. Chi square test. ANOVA.

Unit V

Research Ethics, IPR and Publishing: Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); Publishing- design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.

Recommended Books

1. Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

2. Lesk, A. M. (2002). *Introduction to Bioinformatics*. Oxford: Oxford University Press.
3. Campbell A. M. & Heyer L. J. (2007). *Discovering Genomics, Proteomics and Bioinformatics*. Benjamin Cummings
4. Wilson and Walker. Principles and techniques of Biochemistry and Molecular biology.7th Edn. Cambridge University Press 2012.
5. Boyer, Rodney F. Modern Experimental Biochemistry. 3rd Edn. 2000 Prentice Hall. 21
6. Norman T.S. Bailey, 1995. Statistical methods in Biology, 3rd Edn. Cambridge University Press, UK

Course learning Outcome:
Upon successfully completing this course the students could be able to

1. Explain which type of data is available from the most common public databases like (NCBI, EMBI, UniProt, GenBank, Protein Data Bank, CATH).

2. Explain the theories underlying the most common methods for sequence searches and sequence alignments, and in particular knows the principle and main steps for pairwise and multiple sequence alignments.

3. Conceptualize the application of basic statistical concepts, diagrammatic and graphic representation data commonly used in biological research. Using basic analytical techniques to generate results and interpret results of commonly used statistical analyses which demonstrate statistical reasoning skills correctly and contextually.

4. Understand the use of basic biomedical instrumentation, principles and techniques commonly used in biotechnological application.

S. No.	Lectures
1.	Biological Databases: primary and secondary
2.	Biological Databases: primary and secondary
3.	Database similarity search engine – BLAST
4.	Database similarity search engine –FASTA
5.	Database similarity search engine – NCBI, EMBL
6.	Protein Structural Database (PDB)
7.	Multiple sequence alignments: CLUSTAL.
8.	Multiple sequence alignments: CLUSTAL.
9.	Molecular Phylogenetics
10.	Molecular Phylogenetics
11.	Biostatistics Collection, Organization and representation of data
12.	Biostatistics Collection, Organization and representation of data
13.	Measurement of central tendency

14.	Measurement of central tendency
15.	Standard deviations – parametric and nonparametric hypothesis testing
16.	Standard deviations – parametric and nonparametric hypothesis testing
17.	Student t test
18.	Student t test
19.	Correlation and regression
20.	**Internal Test -1**
21.	Correlation and regression
22.	Correlation and regression
23.	Chi square test
24.	Chi square test problems
25.	Chi square test problems
26.	**Quiz /Group discussion**
27.	**Quiz /Group discussion**
28.	Spectroscopy Beer and Lamberts Law, Principle, instrumentation and applications of UV-visible spectrophotometry
29.	Spectroscopy Beer and Lamberts Law, Principle, instrumentation and applications of UV-visible spectrophotometry
30.	Principle, instrumentation and applications of Atomic absorption spectroscopy
31.	Autoradiography
32.	Applications of Radioisotopes in biology
33.	Proteomics Principles and types of centrifugation
34.	Proteomics Principles and types of centrifugation
35.	Subcellular fractionation. Ultracentrifugation
36.	Subcellular fractionation. Ultracentrifugation
37.	Electrophoresis: Principle, technique and applications of Native-PAGE
38.	Agarose gel electrophoresis
39.	Isoelectric focusing
40.	**Internal test –II**
41.	Isoelectric focusing
42.	MALDI-TOF
43.	MALDI-TOF
44.	Principle, and applications of thin layer Chromatography

45.	Principle, and applications of thin layer Chromatography
46.	**Quiz /Group discussion**
47.	**Quiz /Group discussion**
48.	Ion-exchange Types, principle and applications
49.	Ion-exchange Types, principle and applications
50.	molecular exclusion Types, principle and applications
51.	molecular exclusion Types, principle and applications
52.	Affinity chromatography Types, principle and applications
53.	HPLC Types, principle and applications
54.	HPLC Types, principle and applications
55.	GC Types, principle and applications
56.	GC Types, principle and applications
57.	**Seminar & Assignment**
58.	**Seminar & Assignment**
59.	**Seminar & Assignment**
60.	**Seminar & Assignment**
61.	**Seminar & Assignment**
62.	**Model Exam**
63.	**Model Exam**
64.	**Model Exam**

ELECTIVE PAPER
22MBTEA303: GENOTOXICITY

Credits: 4 **Hours: 4/Wk**

Unit I

Principles and mechanisms of toxicity, xenobiotic pathways, process of biotransformation and bioactivation, Dosage and time responserelationships. Biotic and abiotic aspects of toxicity. Toxicity of chemical substances viz hydrocarbons, metals, minerals and their effects on living being, dose response curve.

Unit II

Genotoxicity: Target and non-target organ toxicity, hepatotoxicity, nephrotoxicity, neurotoxicity, respirotoxicity, Immunotoxicity, carcingenecity, mutagenicity, system toxicity, genetic and reproductive toxicity, embryotoxicity, teratogeneticity.

Unit III

Biotoxins: Phyto, Zoo and microbial toxins, metabolism of toxic substances by plants /animals/ microbes. Effect of toxicants at various levels such as sub cellular, cellular, individual, population, ecosystem, biosphere etc.Biomagnification of toxicants, Interaction of toxins with other substances such as vitamins, minerals.Food additives as toxicants.

Unit IV

Evaluation of toxicity tests; short-term genetic toxicology- bacterial reverse mutation assay, in vitrotoxicology testing, In vivo toxicology testing-low dose estimation models; ADI (acceptance daily intake), RfD (Reference dose), BMD (Bone mineral density), comet assay.

Unit IV

Genotoxic Chemotherapy, Risk and different treatment like alkylating agents, intercalating agents, enzyme inhibitors; Computational toxicology, legislation important in toxicology; EPA information databases.

References:

1. Butler JC, Principle of Toxicology, John Wiley & Sons, NY.
2. Duffers JH, Environmental Toxicology, Edwards Arnold Publ. London 24.
3. De Anil Kumar, Environmental Chemistry, Wiley Eastern Ltd., New Delhi.
4. Hays JW and RR Laws, Handbook of Pesticide Toxicology (vol. I), Academic Press, NY.
5. Li A and Heflich RH, Genetic Toxicology, CRC Press, USA.

LECTURE SCHEDULE

S. No.	Lectures
1.	Principles of toxicity
2.	Mechanisms of toxicity
3.	Xenobiotic pathways
4.	Process of biotransformation and bioactivation

5.	Dosage and time response relationships
6.	Biotic and abiotic aspects of toxicity
7.	Overview of toxicity of chemical substances
8.	Toxicity of chemical substances - hydrocarbons, metals
9.	Toxicity of chemical substances - minerals and their effects on living being
10.	Toxicity of chemical substances - dose response curve
11.	Concept of Genotoxicity
12.	Genotoxicity: Target and non-target organ toxicity
13.	Genotoxicity: hepatotoxicity, nephrotoxicity
14.	Genotoxicity: neurotoxicity, respirotoxicity
15.	Genotoxicity: Immunotoxicity, carcingenecity
16.	Genotoxicity: mutagenicity, system toxicity
17.	Genotoxicity: genetic and reproductive toxicity
18.	Genotoxicity: embryotoxicity
19.	Genotoxicity: teratogeneticity
20.	**Internal Test -1**
21.	Overview of Biotoxins
22.	Biotoxins - Phyto, Zoo and microbial toxins
23.	Biotoxins - metabolism of toxic substances by plants
24.	Biotoxins - metabolism of toxic substances by animals/ microbes
25.	Effect of toxicants at various levels such as sub cellular, cellular
26.	**Quiz /Group discussion**
27.	**Quiz /Group discussion**
28.	Effect of toxicants at various levels such as individual, population
29.	Effect of toxicants at various levels such as ecosystem, biosphere
30.	Biomagnification of toxicants
31.	Interaction of toxins with other substances such as vitamins
32.	Interaction of toxins with other substances such as minerals
33.	Food additives as toxicants
34.	Evaluation of toxicity tests
35.	Short-term genetic toxicology
36.	Bacterial reverse mutation assay in vitrotoxicology testing
37.	In vivo toxicology testing-low dose estimation models
38.	In vivo toxicology testing-low dose estimation models; ADI (acceptance daily intake)
39.	In vivo toxicology testing-low dose estimation models; RfD (Reference dose)
40.	**Internal test –II**
41.	In vivo toxicology testing-low dose estimation models; BMD (Bone mineral density)
42.	Comet assay
43.	Genotoxic Chemotherapy
44.	Risk and different treatment of alkylating agents
45.	Risk and different treatment of intercalating agents
46.	**Quiz /Group discussion**

47.	**Quiz /Group discussion**
48.	Risk and different treatment of enzyme inhibitors
49.	Computational toxicology
50.	Legislation important in toxicology
51.	EPA information databases
52.	Toxicity of chemical substances - hydrocarbons, metals
53.	Process of biotransformation and bioactivation
54.	Applications of Biotoxins
55.	Biomagnification of toxicants
56.	Difference between Biotic and abiotic aspects of toxicity
57.	**Seminar & Assignment**
58.	**Seminar & Assignment**
59.	**Seminar & Assignment**
60.	**Seminar & Assignment**
61.	**Seminar & Assignment**
62.	**Model Exam**
63.	**Model Exam**
64.	**Model Exam**

ELECTIVE - II

22MBTEB303: NANO-BIOTECHNOLOGY

Credits: 4 **Hours: 4/Wk**

Course Objectives:

Students will be able to understand the various fields of the Nanobiotechnology:

- Fundamentals of nanotechnology
- Types, properties and structure of Nanomaterials
- Synthesis and characterization of nanomaterials
- Application of nanaomaterial in agriculture, environment, industry and medicine.

Unit I: Basic of Nanobiotechnology

Nanomaterials: Types -metallic, bimetallic and fluorescent. Properties and Biocompatibility. Biomaterial types: NanoCeramics – Nanopolymers – Nano Silica – Carbon based nanomaterials. Nanostructures: Zero, One, Two and Three dimensional structure.

Unit II: Synthesis – chemical, physical and biological

Chemical methods: sol-gel method, micro emulsion technique, reduction of metal salts, organic block copolymers. Physical methods: pulsed laser deposition, Magnetron sputtering. Biological synthesis of nanoparticles.

Unit III: Characterization of nanomaterials

Spectroscopy analysis: UV visible and Infrared spectroscopy, Raman spectroscopy, X-ray diffraction (XRD) and FT-IR, FRET and DLS. Microscopic techniques: Scanning Electron Microscopy (STM) and Transmission Electron Microscopy (TEM) and High resolution Transmission Electron Microscopy (HRTEM).

Unit IV: Application in Agriculture, Industry and Environment

Nanoparticles for crop improvement, food production, detection and control of plant diseases. Environmental applications of nanomaterials: Remediation of aqueous contaminants, photocatalyst degradation; membranes incorporating nanomaterials, Soil remediation. Overview of nanomaterial applications in Food, Textiles, Paints, Cosmetic industries.

Unit V: Application in Drug Delivery and Medicine

Nanomedicine: Diagnosis of diseases, treating and preventing of diseases – targeted for drug delivery – ligand coupled nanoparticle features. Nanopharmacy: multi-targeted drugs – delivery of nucleic acids- barriers to therapeutic applications. Nanomaterials in bone substitutes and Dentistry. Biochips and Biosensors application in biology.

Suggested Books

1. Hari Singh Nalwa, 2005. Encyclopedia of Nanoscience and Nanotechnology (25

volumeset), USA
2. A. Muller, A.K.Cheetham (Eds.),(2004) The Chemistry of Nanomaterials :Synthesis , Properties and Applications ., WILEY-VCH Verlag GmbH&Co.,Weinheim
3. H.S. Nalwa (Ed) 2005. Handbook of Nanostructured Biomaterials and their applications innanobiotechnology, American Scientific Publishers.
4. C.S.S.R.Kumar, J.Harmones .C.Leusenner (Eds) Nanofabrication towards biomedicalapplications, , (2005) WILEY-VCH Verlag GmbH&Co., Weinhei
5. Christof M. Niemeyer and Chad A. Mirkin. Nano bio-technology: Concepts, Applicationsand Perspectives, Wiley- VCH Verlag GmbH & Co, 2004

Learning outcomes

By the end of the course, the student should be able to

- Understanding the properties and various types of nanomaterials.
- Acquired technical knowledge for synthesis of nanoparticles
- Studying the various tools for the characterization of synthesized nanomaterial.
- Getting sound knowledge for application of several nanomaterials for agricultural, industrial and environment.
- Understanding of the nano encapsulated drug delivery in medicine.

LECTURE SCHEDULE

S. No.	Lectures
1.	Nanomaterials- definition, example, uses
2.	Types -metallic, bimetallic and fluorescent
3.	Properties and Biocompatibility of biomaterial, structure
4.	Biomaterial types: Nanoceramics, Nano polymers
5.	Biomaterial types: Nano Silica – Carbon based nanomaterials
6.	Nanostructures: Zero-, One-, Two- and Three-dimensional structure
7.	Chemical methods: sol-gel method
8.	micro emulsion technique- an overview and method
9.	Reduction of metal salts- process
10.	organic block copolymers- an overview, synthesis and analysis
11.	Physical methods for nano material- definition and types
12.	pulsed laser deposition- process, history, technical aspects
13.	Magnetron sputtering- process, history, technical aspects
14.	Biological synthesis of nanoparticles- chemical and physical and biological methods
15.	Spectroscopy analysis: definition, procedure, history
16.	UV visible and Infrared spectroscopy,

17.	Raman spectroscopy- definition, history, method
18.	X-ray diffraction (XRD)- definition, technique, uses
19.	FT-IR, FRET and DLS- an overview, application, method
20.	Microscopic techniques: Scanning Electron Microscopy (STM)
21.	Microscopic techniques: Transmission Electron Microscopy (TEM)
22.	High resolution Transmission Electron Microscopy (HRTEM).
23.	Nanoparticles for crop improvement- role of nanoparticle in plant growth
24.	Nanoparticles for crop improvement- advantages, Breeding, application
25.	food production- different types and methods
26.	detection of plant diseases
27.	Control of plant diseases
28.	diagnosis and management of plant diseases
29.	Environmental applications of nanomaterials
30.	Remediation of aqueous contaminants
31.	photocatalyst degradation
32.	membranes incorporating nanomaterials
33.	Soil remediation an overview,
34.	Soil remediation: introduction, methods, application
35.	Nanomaterial-introduction, definition and uses
36.	Overview of nanomaterial applications in Food, Textiles
37.	Overview of nanomaterial applications in Paints, Cosmetic industries
38.	Nanomedicine: Diagnosis of diseases
39.	Nanomedicine an overview
40.	**Internal test -II**
41.	Nanomedicine: treatment of diseases
42.	Nanomedicine: preventing of diseases
43.	Therapeutic application of targeted for drug delivery
44.	ligand coupled nanoparticle features
45.	Nano pharmacy- uses, methods
46.	**Quiz /Group discussion**
47.	**Quiz /Group discussion**
48.	multi-targeted drugs- an overview
49.	Nanomedicine: delivery of nucleic acids

50.	Nanomedicine: Barriers to therapeutic applications
51.	Nanomaterials: definition, example and uses
52.	Nanomaterials in bone substitutes
53.	Nano material: in Dentistry uses
54.	Biosensor- principle, working, Types
55.	Biosensors application in biology
56.	Biochips principal types and application
57.	Seminar & Assignment
58.	Seminar & Assignment
59.	Seminar & Assignment
60.	Seminar & Assignment
61.	Seminar & Assignment
62.	Model Exam
63.	Model Exam
64.	Model Exam

ELECTIVE - II

22MBTEC303: MARKER ASSISTED PLANT BREEDING TECHNOLOGY

Credits: 4 **Hours: 4/Wk**

Course Objective

The objective of this course is to introduce students the use of molecular information in plant breeding. Students should be able to explain current approaches for mapping quantitative trait loci (QTL), genome-wide association studies (GWAS), marker-assisted selection (MAS), and genomic selection (GS).

Unit I: Genome Organization and genetic markers

Genome organization – Genome analysis –markers in genome analysis and plant breeding - role of markers in genome analysis - Morphological markers - protein markers and isozyme marker- merits and demerits and their applications in diversity - linkage mapping studies; Molecular markers - history and development of molecular markers.

Unit II: DNA Markers – Early generation markers

Types of DNA markers - Hybridization based markers- Restriction Fragment Length polymorphism (RFLP) techniques and its application; PCR based markers –Randomly Amplified Polymorphic DNA marker (RAPD) and its types; Amplified Fragment Length polymorphism (AFLP) principle and its application - Microsatellites marker/ Simple Sequence Repeat maker (SSR) development and application - Development of SCAR and STS marker principle and application.

Unit III: DNA markers - New Generation Markers

SNP marker discovery – methods and tools - whole genome SNP analysis for major gene discovery – Allele mining; Applications of DNA markers in diversity analysis – characterization of plant genetic resources – role of markers in Plant Variety protection.

Unit IV: Genome mapping

Genetic mapping - Development of mapping population – RILs, NILs and DH lines and their utility in the linkage mapping studies - Construction of linkage maps; QTL mapping – strategies and methods; Physical mapping - genome assembly - Integrating genetic map and physical map – Map based cloning - Fine mapping of the targeted genomic regions - synteny among different genome for transferability of markers to related genomes

Unit V: Marker Assisted Breeding

Association mapping – GWAS, MAGIC, NAM etc., Marker Assisted Breeding – Principles, methods, advances and case studies

References

1. Miller F.P., Vandome, A.F. and Brewster, J.M. 2010. Marker assisted selection, Alphascript Publisher

2. N. Manikanda Boopathi. 2013. Genetic mapping and marker assisted selection: Basics, Practices

and Benefits. Springer Publications.

e-resources

1. www.tigr.org
2. www.gramene.org
3. www.maswheat.ucdavis.edu/
4. www.mcclintock.generationcp.org
5. www.nias.go.jp

Course Outcome

- Understanding the genome and the need for markers in genome analysis and plant breeding.
- Learn different types of DNA markers and their application.
- Learning procedures for the development of microsatellites, SCAR and STS marker.
- Knowledge on new generation markers – SNPs for whole genome analysis.
- Perform experiments on the different methods for allele mining.
- Details of the characterization of plant genetic resources using markers.
- Learning the principles of genetic and physical mapping and the development of mapping population.
- Construction of linkage maps; QTL mapping – strategies and methods.
- Fine mapping of the targeted genomic regions – synteny among different genome for transferability of markers to related genomes
- Learn principles, methods

LECTURE SCHEDULE

S. No.	Lectures
1.	Composition of genome and organization
2.	Analysis of genome complexities
3.	Markers in genome analysis and plant breeding
4.	Morphological and genetic markers - Merits and demerits of these markers
5.	Protein markers and isozyme markers -merits & demerits-its application
6.	History of Molecular markers and recent trends in molecular markers development
7.	Hybridization based markers-RFLP principle and their application
8.	PCR based markers-RAPD principle and their application

9.	PCR based markers- AFLP principle and their application
10.	PCR based markers- Microsatellites marker development and application
11.	Development of SCAR, principle and application
12.	Development of STS marker, principle and application
13.	SNP marker discovery, methods and tools
14.	Whole genome SNP analysis for major gene discovery
15.	Allele mining
16.	Application of molecular markers in diversity analysis
17.	Application of molecular markers in characterization of plant genetic resources
18.	Role of molecular markers in Plant Variety Protection
19.	Study Mendelian genetics- two gene models for inheritance studies
20.	**Internal Test -1**
21.	Study Mendelian genetics single gene and two gene models for inheritance studies
22.	Principles of genetic linkage with suitable examples
23.	Mapping Population
24.	Development of mapping population – RILs, NILs and their utility in the linkage mapping studies
25.	Development of mapping population – NILs and their utility in the linkage mapping studies
26.	**Quiz /Group discussion**
27.	**Quiz /Group discussion**
28.	Development of mapping population- DH lines and their utility in the linkage mapping studies
29.	Construction of linkage maps using various kinds of markers with examples
30.	Mapping major gene of interest with strategies
31.	Mapping major gene of interest- applications
32.	Dissecting the complex agronomic traits using the QTL mapping approach
33.	Use of genomic BAC library for the physical mapping of genome
34.	Construction of linkage maps using various kinds of markers with examples
35.	Physical mapping methods and genome assembly using clone by clone approach
36.	Physical mapping methods and genome assembly using whole genome assembly methods
37.	Integrating genetic map and physical map

38.	Map based cloning methods I
39.	Map based cloning methods II
40.	**Internal test –II**
41.	Synteny among different genome for transferability of markers to related genomes
42.	Fine mapping of the targeted genomic regions using saturated linkage map
43.	High resolution map
44.	Association mapping principles and methods
45.	Genome wide association mapping studies (GWAS) for major gene discovery and QTL detection
46.	**Quiz /Group discussion**
47.	**Quiz /Group discussion**
48.	MAGIC and NAM methods for major gene discovery and QTL detection
49.	Case study –QTL
50.	Case study –GWAS
51.	Application of molecular markers in Marker Assisted Breeding (MAB) using complex traits -Case studies.
52.	Application of molecular markers in Marker Assisted Breeding (MAB) using complex traits -Case studies.
53.	Application of molecular markers in Marker Assisted Breeding (MAB) using complex traits -Case studies.
54.	Application of molecular markers in Marker Assisted Breeding (MAB) using complex traits -Case studies.
55.	Application of molecular markers in Marker Assisted Breeding (MAB) using complex traits -Case studies.
56.	Case studies – Marker assisted selection
57.	**Seminar & Assignment**
58.	**Seminar & Assignment**
59.	**Seminar & Assignment**
60.	**Seminar & Assignment**
61.	**Seminar & Assignment**
62.	**Model Exam**
63.	**Model Exam**
64.	**Model Exam**

22MBTED303: BIOPESTICIDE AND INTEGRATED PEST MANAGEMENT

Credits: 4 **Hours: 4/Wk**

COURSE OBJECTIVE:

- The overall course objective is to understand the role of biopesticides and their mode of action and mechanism in the insects.
- To understand the different forms and formulations of biopesticides and to know about the mass production and quality control in production of biopesticides.
- To know about the patenting process of biopesticides.

Unit 1

Insects as Pests, Insect Control measures, Concept of Integrated Pest Management, Classification of Pesticides, History of Biopesticides. Sources and types of biopesticides, Potential of biopesticides in insect control.

Unit 2

Microbial Biopesticides - types, Plant incorporated Protectants (PIPs), Biochemical pesticides - formulation and its advantages, Methods of application of biopesticides and its adverse effects on pest in sustainable agriculture.

Unit 3

Nano-biopesticides: Definition, types, composition, preparation methods and its significance, Nano-biopesticide assays. Antifeedent activity, larvicidal and pupicidal activity against stored grain pests and crop pest, Nano-biopesticides and sustainable agriculture.

Unit 4

Role of biopesticide in pest management, Mode of action of Biopesticides - Virulence, pathogenecity and symptoms of entomopathogenic pathogens (Bacteria, Virus, Fungi, Nematodes).

Unit 5

Biopesticides- current trends and advancement, Mass production of biopesticides, Quality control and limitation in production of biopesticides Biopesticide registration process and commercialization and patenting issues in the development of biopesticides.

Recommended Text Book

- Juan Morales- Ramos, Guadalupe Rojas, David I.SSharpiro- Ilan,. (2022) Mass production of Beneficial organism , Invertebrates and Entomopathogens (2nd ed.), Academic Press, USA
- Openderkoul, G.S .Dhaliwal 2001. Microbial biopesticides. Koul, O., & Dhaliwal, G.S. (Eds.). (2001). Microbial Biopesticides (1st ed.). CRC Press. London https://doi.org/10.4324/9780203303078

- H.D. burges (1998) Formulations of microbial biopesticides (1st ed). Springer Dordrecht https://doi.org/10.1007/978-94-011-4926-6
- Openderkoul, Nano-biopesticides (2019), Today and Future perspectives , Jalandhar, India. https://doi.org/10.1016/C2017-0-03028-8
- Md.Arshad Anwer (2018). Biopesticides and bioagents Novel tools for pest management, Routledge,

Course Outcome

On the completion of the course the student will be able to understand

- Importance of various biopesticides
- Sources of Biopesticides and application methods for the same
- Methods for preparation of Nanobiopesticides
- Methods of Mass Production of Biopesticides
- Procedure for registration and commercialization of biopesicides

LECTURE SCHEDULE

S. No.	Lectures
1.	Biopesticide- Definition and introduction.
2.	Insects as pest.
3.	Different kinds of insect pest.
4.	Basic Body plan of insects.
5.	Insect control measures.
6.	Concept of Integrated pest management.
7.	Classification of pesticides.
8.	Chemical pesticides Vs Biopesticides.
9.	History of Biopesticides.
10.	Sources of Biopesticides
11.	Types of Biopesticides
12.	Potential of biopesticides in insect control.
13.	Microbial Biopesticides- Introduction.
14.	Microbial Biopesticides – types.
15.	Plant incorporated Protectants (PIPs)
16.	Biochemical pesticides
17.	Biochemical pesticides – formulation
18.	Advantages of Biochemical pesticides.

19.	Methods of application of biopesticides
20.	Adverse effects of biopesticides on pest in sustainable agriculture.
21.	**Internal Test -1**
22.	Nano-biopesticides: Definition.
23.	Types of Nano-biopesticides.
24.	Composition of Nano-biopesticides.
25.	Preparation methods and significance of Nano-biopesticides.
26.	Nano-biopesticide assays- Antifeedent activity against crop pest
27.	Nano-biopesticide assays- Antifeedent activity against stored grain pests
28.	**Quiz /Group discussion**
29.	**Quiz /Group discussion**
30.	Nano-biopesticide assays- Larvicidal activity against crop pest.
31.	Nano-biopesticide assays- Larvicidal activity against stored grain pests
32.	Nano-biopesticide assays- pupicidal activity against stored crop pest.
33.	Nano-biopesticide assays- pupicidal activity against stored grain pests
34.	Nano-biopesticides and sustainable agriculture.
35.	Role of biopesticide in pest management
36.	Mode of action of Biopesticides
37.	**Internal test –II**
38.	Virulence and symptoms of entomopathogenic pathogens - Bacteria.
39.	Pathogenecity of entomopathogenic pathogen – Bacteria.
40.	Virulence and symptoms of entomopathogenic pathogens- Virus
41.	Pathogenecity of entomopathogenic pathogen-virus
42.	Virulence and symptoms of entomopathogenic pathogens – Fungi.
43.	Pathogenecity of entomopathogenic pathogen – Fungi
44.	Virulence and symptoms of entomopathogenic pathogens- Nematode.
45.	Pathogenecity of entomopathogenic pathogen- Nematode.
46.	**Quiz /Group discussion**
47.	**Quiz /Group discussion**
48.	Biopesticides
49.	current trends in Biopesticides
50.	Advances in Biopesticides.
51.	Mass production of biopesticides

52.	Quality control in production of biopestcides.
53.	Limitations in production of biopesticides.
54.	Registration process of biopesticides.
55.	Commercialization of biopesticides.
56.	Patenting issues in development of biopesticides.
57.	**Seminar & Assignment**
58.	**Seminar & Assignment**
59.	**Seminar & Assignment**
60.	**Seminar & Assignment**
61.	**Seminar & Assignment**
62.	**Model Exam**
63.	**Model Exam**
64.	**Model Exam**

22MBTEE303: BIOPROCESS ENGINEERING AND FERMENTATION TECHNOLOGY

Credits: 4 **Hours: 4/Wk**

Course objectives:

The objectives of this course are students will learn about fermentation technology and upstream process. Students will understand about importance primary and secondary metabolites. Students will understand Industrial Enzymes, Biopesticides, Biofertilizers, Biopreservatives, Biopolymers Biodiesel at end students will know Production of recombinant proteins and vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture.

UNIT I: Introduction To Industrial Bioprocess

Fermentation- Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology- A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting – block diagrams, pictorial representation.

UNIT II:Production Of Primary Metabolites

Primary Metabolites- Production of commercially important primary metabolites like organic acids, amino acids and alcohols.

UNIT III: Production Of Secondary Metabolites

Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics, Vitamins and Steroids.

UNIT IV: Production Of Enzymes And Other Bioproducts

Production of Industrial Enzymes, Biopesticides, Biofertilizers, Biopreservatives, Biopolymers Biodiesel. Cheese, Beer, SCP & Mushroom culture, Bioremediation.

UNIT V: Production Modern Biotechnology Products

Production of recombinant proteins having therapeutic and diagnostic applications, vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture.

RECOMMENDED BOOKS TEXT BOOKS

1. Satyanarayana, U. “Biotechnology” Books & Allied (P) Ltd., 2005.
2. Kumar, H.D. “A Textbook on Biotechnology” 2 nd Edition. Affiliated East West Press Pvt. Ltd., 1998.
3. Balasubramanian, D. etal., “Concepts in Biotechnology” Universities Press Pvt.Ltd., 2004.
4. Ratledge, Colin and Bjorn Kristiansen “Basic Biotechnology” 2 nd Edition Cambridge University Press, 2001. 5. Dubey, R.C. “A Textbook of Biotechnology” S.Chand& Co. Ltd., 2006.

Course outcomes

A student passing this module will be able to

- Gaining knowledge about fermentation and downstream processing
- To gain knowledge about production of primary and secondary metabolites.
- Explaining about the various commercial important enzymes andBiopesticides, Biofertilizers, Biopreservatives, Biopolymers Biodiesel. Cheese, Beer, SCP
- To gain knowledge about Production of recombinant proteins and vaccines.

LECTURE SCHEDULE

S.No.	Lectures
1	Basic introduction of fermentation
2	Introduction of fermentor
3	Types of fermentor
4	Fermentation major applications
5	Basic structure and typesBacteria,
6	Basic structure and types fungus
7	Basic structure and types yeast
8	Biochemistry of fermentation
9	History of Biotechnology
10	TraditionalBiotechnology
11	Modern Biotechnology
12	Bioprocess of organisms
13	Product of Bioprocessing
14	Basic concepts of Upstreamprocessing in Bioprocess
15	Basic concepts of downstream processing in Bioprocess
16	Basic Process flow sheeting
17	Process flow sheeting in block diagrams
18	Flow sheeting in pictorial representation
19	Introduction aboutPrimary Metabolites
20	Production of commercial important organic acids
21	Production of commercial important amino acids
22	Production of commercial important alcohols
23	**Internal assessment-1**
24	Production of Secondary Metabolites
25	Processes for various classes of secondary metabolites
26	Production of Antibiotics.
27	Production of Vitamins.
28	Production of Steroids.
29	**Quiz /Group discussion**
30	**Quiz /Group discussion**
31	Classification of vitamins
32	Classification of Steroids
33	Industrial applications of Industrial Enzymes
34	**Internal assessment-2**
35	Commercial production of Biopesticides
36	Production of Biofertilizers
37	Application of biopreservatives
38	Production of Biopolymers
39	Production of Biodiesel
40	**Quiz /Group discussion**
41	**Quiz /Group discussion**
42	Production of Cheese
43	Production of Beer
44	Production of SCP
45	Mushroom culture
46	Bioremediation

47	Introduction about rDNA technology
48	Production of recombinant proteins
49	TherapeuticApplication of recombinant proteins
50	DiagnosticApplication of recombinant proteins
51	Basic introduction of vaccines
52	Commercial production and application of vaccines
53	Introduction about plant and animal tissue culture
54	Media for plant & animal tissue culture
55	Application of Plant and Animal tissue culture
56	Bioprocess strategies in Plant Cell and Animal Cell culture
57	**Seminar & Assignment**
58	**Seminar & Assignment**
59	**Seminar & Assignment**
60	**Seminar & Assignment**
61	**Seminar & Assignment**
62	**Model Exam**
63	**Model Exam**
64	**Model Exam**

22MBTEF303: BIOETHICS, BIO-SAFETY AND BIO-ENTERPREUNERSHIP

Credits: 4 **Hours: 4/Wk**

Learning Objectives

To comprehend the ethical issues in biological research and focus consequences of biomedical research technology.

To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products.

To familiarize students with the scope of issues and decisions that managers in biotechnology face as their company progresses from its earliest stages to self-sustainability, and give students the vocabulary to participate and contribute to the business side of scientific enterprises. This course also provides a general procedural road map for bioscience students who are interested in starting their own companies.

UNIT - I

Bioethics - Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, artificial reproductive technologies, prenatal diagnosis, genetic screening and transplantation.

Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare.

Agricultural biotechnology - Genetically engineered food and environmental risk.

UNIT - II

Biosafety and Biosecurity - Introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; Generally recognized as safe (GRAS) organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals;

GMOs – Definition, principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; risk assessment of transgenic crops vs cisgenic plants or products derived from RNAi.

UNIT - III

Bio-enterpreunership - Introduction to bio-business, from the Indian context, SWOT analysis of bio-business. Ownership, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship - its barriers.

Small scale industries: Definition; Characteristics; Need and rationale; Objectives; Scope; Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. Global bio business and industry future trends.

UNIT - IV

Entrepreneurship opportunity in Agri Biotechnology - Business opportunity, Essential requirement, marketing, strategies, schemes, challenges and scope-with case study on Plant cell and tissue culture technique, polyhouse culture. Herbal bulk drug production, Nutraceuticals,

value added herbal products. Bioethanol production using Agri waste, Algal source. Integration of system biology for agricultural applications. Biosensor development in Agri management.

UNIT - V

Entrepreneurship opportunity in Industrial Biotechnology

Business opportunity, Essential requirement, marketing strategies, schemes, challenges and scope-with case study- Pollution monitoring and Bioremediation for Industrial pollutants, Pesticides, Herbicides etc. Integrated compost production- microbe enriched compost. Bio pesticide/insecticide production. Fermented products-probiotic and prebiotics. Stem cell production, stem cell bank, contract research. Production of monoclonal/polyclonal antibodies, Single cell protein and secondary metabolite production. Contact research in microbial genomics.

Text Books:

1. Principles of Management P. C. Tripathi, P.N. Reddy Tata McGraw Hill Fifth Edition, 2012
2. Entrepreneurship Development S.S. Khanka S.Chand& Co 2006
3. Practical Approach to IPR Rachana Singh Puri IK Intl. Ltd 2009
4. Bioethics & Biosafety R Rallapalli&Geetha Bali APH Publication 2007

Suggested Readings and Supplementary Materials

• Steve Blank and Bob Dorf: The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company. K & S Ranch. ISBN-13: 978-0984999309

• Craig Shimasaki, ed.: Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Elsevier Inc., 2014. ISBN: 978-0-12-404730-3. Reading list is noted within course schedule. • Lawton Robert Burns: The Business of Healthcare Innovation. Cambridge University Press, Cambridge UK, 2005

• Burrill & Company Annual Biotechnology Industry Report

• William B. Bygrave and Andrew Zacharakis: The Portable MBA in Entrepreneurship. Wiley & Sons, Hoboken, NJ. 2009

• William B. Bygrave and Andrew Zacharakis: Entrepreneurship. Wiley, Hoboken, NJ, 2010.

• Steven A. Silbiger: The Ten-Day MBA 4th Ed. HarperBusiness, 2012

• Cynthia Robbins-Roth: From Alchemy to IPO: The Business of Biotechnology. Basic Books, 2001.

• Jeffrey A. Timmons, Andrew Zacharakis, Stephen Spinelli: Business Plans That Work: A Guide for Small Business. McGraw Hill, 2004.

• John A. Tracy: How to Read a Financial Report: Wringing Vital Signs out of the Numbers. John Wiley & Sons, Hoboken, NJ. 2009

• Barry Werth: The Billion Dollar Molecule: One Company's Quest for the Perfect Drug. Simon & Schuster, 1995.

LECTURE SCHEDULE

S. No.	Lectures
1.	**Bioethics** – Introduction
2.	Ethical conflicts in biological sciences
3.	Interference with nature
4.	GMOs – Definition

5.	Animal rights
6.	Bioethics in health care
7.	Patient confidentiality
8.	Artificial reproductive technologies
9.	Prenatal diagnosis
10.	Genetic screening
11.	Transplantation
12.	Bioethics in research
13.	Cloning research
14.	Stem cell research
15.	Human experimentation
16.	Animal experimentation
17.	Animal welfare
18.	Agricultural biotechnology - Genetically engineered food
19.	Environmental risk
20.	**Internal Test -1**
21.	Introduction to biological safety cabinets
22.	Generally recognized as safe (GRAS) organisms
23.	Primary containment for biohazards
24.	Biosafety levels of specific microorganisms
25.	Recommended biosafety levels for infectious agents
26.	**Quiz /Group discussion**
27.	**Quiz /Group discussion**
28.	GMOs –principles of safety assessment of transgenic plants
29.	Concepts of familiarity and substantial equivalence
30.	Environmental risk assessment
31.	Food and feed safety assessment
32.	Risk assessment of transgenic crops vs cisgenic plants or products derived from RNAi.
33.	**Bio-enterpreunership**- Introduction to bio-business, from the Indian context
34.	SWOT analysis of bio-business
35.	Ownership
36.	Development of Entrepreneurship
37.	Stages in entrepreneurial process
38.	Role of entrepreneurs in Economic Development
39.	Entrepreneurship in India
40.	**Internal test –II**
41.	Entrepreneurship - its barriers.
42.	Small scale industries: Definition; Characteristics
43.	Market Feasibility Study
44.	Technical Feasibility Study
45.	Bioethanol production using Agri waste
46.	Integration of system biology for agricultural applications
47.	Biosensor development in Agri management.
48.	**Quiz /Group discussion**

49.	**Quiz /Group discussion**
50.	Herbal bulk drug production
51.	Integration of system biology for agricultural applications.
52.	Business opportunity - Essential requirement, marketing strategies, schemes, challenges and scope
53.	Bioremediation for Industrial pollutants
54.	Integrated compost production- microbe enriched compost.
55.	Fermented products-probiotic and prebiotics.
56.	Business opportunity - Essential requirement, marketing strategies, schemes, challenges and scope
57.	**Seminar & Assignment**
58.	**Seminar & Assignment**
59.	**Seminar & Assignment**
60.	**Seminar & Assignment**
61.	**Seminar & Assignment**
62.	**Model Exam**
63.	**Model Exam**
64.	**Model Exam**

22MBT304: PRACTICAL V: IMMUNOTECHNOLOGY, BIOINFORMATICS AND BIOSTATISTICS

Credits: 4 **Hours: 6/Wk**

Course Objective

The objective is to familiarize students with various immunological techniques like blood grouping, their types, antigen-antibody interactions, quantitation of antigens and antibody, ELISA, agglutination reactions, immunoelectrophoresis and to help student use online tools/databases for primer Designing, analysis of DNA and Protein sequences, Phylogenetic analysis

1. Blood smear identification of leucocytes by Giemsa stain
2. Blood Typing and Count : ABO grouping, Rh factor, Total WBC and Differential WBC Count
3. Double diffusion, Immuno-electrophoresis and Radial Immuno-diffusion.
4. Antibody titre by ELISA method
5. Separation of leucocytes by dextran method
6. Separation of mononuclear cells by Ficoll-Hypaque
7. Lymph node Immunohistochemistry (direct and indirect peroxidase assay)
8. Commercial Immunodiagnostic Kits
9. Introduction to Major Databases:

a) Nucleic Acid Sequence Database: DDBJ, GenBank and NCBI
b) Protein Sequence Database: UNIPROT and NCBI
c) Structure Database: PDB

10. Sequence Alignment: Use of FASTA format, BLAST tool for similarity searches
11. Multiple Sequence Alignment: Clustal X, Clustal W, and EMBOSS
12. Phylogenetic analysis of protein and nucleotide sequences.
13. Gene Prediction: EMBOSS, GENESCAN and ORF finder
14. Tools for Primer Designing: Primer3, and Fast PCR
15. Excel
16. Origin
17. SPSS

Course learning outcomes

Students will be able to

1. Describe the different types of blood groups and different types of blood cells and their function in the human body.
2. Explain the preparation of antigens and antibody in the blood sample.
3. Describe the basic knowledge about antigen and antibody interaction using (ODD,Rocket immune electrophoresis).
4. Learn various techniques like Immunoelectrophoresis, ELISA, Immunoprecipitation
5. Separation and Estimation of immunoglobulins in serum.

EXTRA DEPARTMENTAL SUPPORTIVE COURSE (EDS)

22MBTEDA305: TECHNIQUES IN BIOTECHNOLOGY

Credits : 4 **Hours : 4/Wk**

Course Objectives

This course specially designed for the students to understand the various techniques in biotechnology. To understand about the methods of biomolecules analysis, methods for culturing plant, animal, microbes. Basic understanding of immunological techniques and vaccine development.

Units I : Isolation of DNA, RNA and Proteins

Biochemical estimation – DNA, RNA and Proteins. Electrophoresis – Agarose, SDS, Native Gel. Blotting- Western, Northern, and Southern.

Unit II: Plant Tissue Culture

Basic Laboratory and media requirements - Tissue culture methods: Callus culture, Anther, pollen culture, Somatic embryogenesis, synthetic seed production and Protoplast Culture.

Unit III: Animal Cell Culture Techniques

Laboratory requirements & aseptic techniques. Culture medium Types: Natural, chemically defined & synthetic media. General procedure for tissue culture: Disaggregation (Enzymatic & Non enzymatic), Primary culture and Secondary culture (Transformed cell & continuous cell lines).

Unit IV: Immunological Techniques

Raising of Polyclonal and Monoclonal Antibody, quantification of antibodies – Immunoele
- mRNA, DNA, conjugate, peptide and Recombinant Vaccines

Unit V: Industrial Microbiological Techniques

Isolation and Identification of Industrial microbes- Enrichment culture, spread plate, pour plate and streaking methods. Techniques for identification of industrially important microbes- Staining, biochemical (IMViC) test and molecular methods

Recommended Books:

1. M. Wink, An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Application in Modern Biotechnology, Wiley-VCH, Weinheim, Germany, 2006
2. J. Sambrook and D. Russel, Molecular Cloning: A Laboratory Manual, vol. 3, Cold Spring Harbor Laboratory Press, New York, NY, USA, 3rd edition, 2001.
3. Jenni Punt; Sharon Stranford; Patricia Jones; Judy Owen, Kuby Immunology Eighth Edition, 2019
4. Roberta H. Smith (Editor) Plant Tissue Culture: Techniques and Experiments, 2021, Academic Press, USA
5. John M.Davis, Animal Cell culture, Essential methods, 2011, Wiley Blackwell

6. Osman Erkmen, Laboratory Practices in Microbiology, 2021, Academic Press, USA

Course learning outcome

Completely read this paper you will learn following knowledge:

1. In this paper the student will recognize the foundations of modern biotechnology and explain the principles that form the basis for introduction and scope of the biotechnology.

2. The student will get an overview about the fundamentals of molecular biology and the biotechnological tools in tissue cultures, application of biotechnology in agriculture, recombinant DNA technology and biodiversity and conservation.

3. The student will understand methods used for invitro animal cell culture.

4. Students will also get useful information about the importance of immunological tools for vaccine development.

5. At the end of the course, the students will have sufficient scientific understanding of the basic concepts in biotechnological techniques.

LECTURE SCHEDULE

S. No.	Lectures
1.	Isolation of DNA, RNA and Proteins- basics, introduction, history
2.	Biochemical estimation – DNA, RNA- methods
3.	Biochemical estimation- Proteins- techniques
4.	Electrophoresis – Agarose, SDS, Native Gel- preparation, requirements, methods
5.	Blotting – Western blot, Northern blot- definition, history, methods
6.	Blotting – Southern- definition, history, methods
7.	Basic Laboratory- procedure, lab condition, types
8.	Media requirements- preparation, maintenance
9.	Tissue culture methods- invitro condition, regeneration, application, laboratory
10.	Callus culture- definition, requirements, methods, lab condition
11.	Anther - definition, requirements, methods, lab condition
12.	pollen culture- History, Regeneration
13.	Somatic embryogenesis- definition, process, stages
14.	synthetic seed production- history, introduction, techniques

15.	synthetic seed production- principle, Aspect and application
16.	Protoplast Culture- definition, process, techniques
17.	Importance and regeneration of protoplanst
18.	Animal Cell Culture Techniques- History, characteristic, principle
19.	Animal Cell Culture Techniques-Definition, types, cell line, procedure
20.	**Internal Test -1**
21.	Laboratory requirements & aseptic techniques
22.	Culture medium Types: classification, types, methods
23.	Natural, chemically defined synthetic media
24.	Natural, chemically defined synthetic media- difference, types
25.	Tissue culture-types, techniques and procedure
26.	**Quiz /Group discussion**
27.	**Quiz /Group discussion**
28.	General procedure tissue culture
29.	Disaggregation (Enzymatic & Non enzymatic)
30.	Primary culture- Basics and overview
31.	Secondary culture (Transformed cell & continuous cell lines).
32.	Immunological Techniques: ELISA, Flow cytometry, Immunohistochemistry
33.	Immunological Techniques: principle application
34.	Raising of Polyclonal- an overview, production
35.	Raising of Polyclonal- steps, generation and characterization
36.	Monoclonal Antibody-fundamentals, production, cost, application
37.	Monoclonal Antibody- procedure and side effects
38.	quantification of antibodies- Introduction, principle
39.	quantification of antibodies- methods and basics, techniques
40.	**Internal test –II**
41.	Immunodiffusion-methods, principle and application
42.	Immunoelectrophoresis- definition, methods, procedure, application
43.	Immunohistochemistry-an overview
44.	Immunohistochemistry- methods, principle and application
45.	Vaccine Types and Development-importance
46.	**Quiz /Group discussion**
47.	**Quiz /Group discussion**

48.	Vaccine Types and Development- mRNA, DNA, conjugate
49.	Vaccine Types and Development- peptide, Recombinant Vaccines
50.	Industrial Microbiological Techniques, principle
51.	Isolation and Identification of Industrial microbes
52.	Enrichment culture, spread plate and pour plate method
53.	streaking methods- principle, procedure, uses
54.	culture condition, maintenance types of growth media
55.	Techniques for identification of industrially important microbes
56.	Staining, biochemical (IMViC) test and molecular methods
57.	Seminar & Assignment
58.	Seminar & Assignment
59.	Seminar & Assignment
60.	Seminar & Assignment
61.	Seminar & Assignment
62.	Model Exam
63.	Model Exam
64.	Model Exam

22MBTEDB305: BASIC BIOTECHNOLOGY

Credit:4 **Hours: 4/Wk**

Course objectives:

This course specially designed for the students to understand the basic knowledge about basic concept and scope of biotechnology. To understand about cells of single and multicellular organisms, Mendelian laws and sex determination of plant and animals. Learn about central dogma of the cells and rDNA technology and their application. Basic understanding of plant and animal cell culture, transgenic plant and animals and bioethics and safety. Application of biotechnology in agricultures and biosafety and conservation. This paper will help those in student who are willing to take up biotechnology for higher studies for project and careers.

Unit I: Basics of Biotechnology

Introduction and scope of biotechnology. Prokaryotic and eukaryotic cells. Mendelian principles of genetics. Sex determination in animals

Unit II: Central Dogma of Life

Structure of DNA and RNA. Central dogma: DNA – RNA – Protein. rDNA technology: Applications: Insulin Production.

Unit III Tissue Culture and Transgenics

Biotechnological tools: Plant and animal tissue culture. Stem cells-Embryonic and adult Transgenic plants and animals. Development of recombinant vaccines

Unit IV: Application of Biotechnology

Applications of Biotechnology in Agriculture-GM crops Industry: Biofuel and Biopolymer, Bioremediation (oil spills) and its application

Unit V: Regulatory Biotechnology

Biodiversity and conservation. Bioethics and biosafety. Intellectual property right (IPR)– Copyright, Geographical Indication, Trademarks and patents

Recommended Books

- Becker, W.M. Kleinsmith L.J. and Hardin, J. 2017. The World of Cell. 9th Edn, Pearson Press.
- Smith, J.E. 2015. Biotechnology, 5th Edn. Cambridge University Press.
- Hames D. and Hooper, N. 2011 4$4_t$ Edn. Instant notes in Biochemistry, Taylor & Francis, UK.
- Gupta, P.K. 2009. Elements of Biotechnology, Rastogi Publications.

Course learning outcome:

Completely read this paper you will learn following knowledge:

- In this paper the student will recognize the foundations of modern biotechnology and explain the principles that form the basis for introduction and scope of the biotechnology.
- The student will get an overview about the fundamentals of molecular biology and the biotechnological tools in tissue cultures, application of biotechnology in agriculture, recombinant DNA technology and biodiversity and conservation.
- The student will understand methods used for development of transgenic organisms..

- Students will also get useful information about the importance of patents and IPR in processing their innovations.
- At the end of the course, the students will have sufficient scientific understanding of the basic concepts in biotechnological process.

LECTURE SCHEDULE

S. No.	Lectures
1.	Basics of biotechnology
2.	Introduction to biotechnology
3.	Scope of biotechnology
4.	Prokaryotic cells
5.	Eukaryotic cells
6.	Concept of mendelian genetics.
7.	Medelian principles of genetics.
8.	Sex determination - Ooverview
9.	Sex determination in animals.
10.	Central dogma of life
11.	Structure of DNA
12.	Structure of RNA
13.	Central dogma- principle
14.	Translation
15.	Transcription
16.	rDNA technology- Overview
17.	Applications of rDNA technology
18.	Insulin production
19.	Tissue culture and Transgenics
20.	**Internal Test -1**
21.	Biotechnological tools
22.	Plant tissue culture
23.	Animal tissue culture
24.	Stem cells- concept
25.	Principles of stem cells
26.	**Quiz /Group discussion**
27.	**Quiz /Group discussion**
28.	Potency of stem cells
29.	Embroyonic stem cells
30.	Adult stem cells
31.	Concept of Transgenics
32.	Transgenic plants
33.	Transgenic animls
34.	Concept of recombinant vaccines
35.	Development of recombinant vaccines

36.	Applications of recombinant vaccines
37.	Applications of biotechnology
38.	Applications of biotechnology in Agriculture
39.	GM Crops industry
40.	**Internal test –II**
41.	Biofuel
42.	Biopolymer
43.	Bioremediation
44.	Oil spills
45.	Applications of bioremediation
46.	Regulatory biotechnology
47.	Introduction to regulatory biotechnology
48.	**Quiz /Group discussion**
49.	**Quiz /Group discussion**
50.	Biodiversity
51.	Bioconservation
52.	Bioethics
53.	Biosafety
54.	IPR
55.	Geographical indication
56.	Trademarks and patents..
57.	**Seminar & Assignment**
58.	**Seminar & Assignment**
59.	**Seminar & Assignment**
60.	**Seminar & Assignment**
61.	**Seminar & Assignment**
62.	**Model Exam**
63.	**Model Exam**
64.	**Model Exam**

22MBT306: SUMMER INTERNSHIP PROGRAMME

Course Objective: To offer the opportunity for the young students to acquire on job oriented skills, knowledge, attitudes, and perceptions along with the experience needed to constitute a professional identity.

ELECTIVE- III
22MBTEA401: CLINICAL NEUROSCIENCE

Credits: 4 **Hours: 4/Wk**

Course Objectives:

The main objective of the Clinical Neuroscience course is to relate fundamental neuroscience concepts to clinical scenarios, Biochemistry of Peripheral Neuropathy, Nutritional and metabolic diseases, Neurotransmitters and disorders,aging and neurogeneration, Motor Neuron disease.

Unit- 1:

Biochemistry of Peripheral Neuropathy; Disease involving myelin; Multiple sclerosis and other demyelinated disorders; Duchenne Muscular Dystrophy: Molecular, Genetic aspects and Diagnostic characteristics.

Unit- 2:

Nutritional and metabolic diseases: Disorders of amino acid metabolism; Wernicke Korsakoft Syndrome; Pellagra; Alcoholic cerebellar degeneration; Metabolic Encephalopathies and Coma.

Unit-3:

Neurotransmitters and disorders of basal ganglia; molecular targets of abused drugs; Ischemia and hypoxia; Epileptic seizures; Alzheimer's disease: Molecular, genetic, immunology aspects and diagnostics.

Unit-4:

Theories of aging; Neurobiology of aging: Cellular and molecular aspects of neuronal aging; Aging and neurodegeneration: Parkinson's disease.

Unit-5:

Motor Neuron disease; Prion's disease; Biochemical aspects of the psychotic disorders; Biochemical basis of mental illness: Anxiety disorders; Mood disorders; Attention disorders; Schizophrenia.

Reference:

1. Siegel, Basic Neurochemistry, 7th Edition, Academic press, 2006.
2. Squire, Fundamental Neuroscience, 3rd Edition, Elsevier, 2008.
3. Kendel, Principles of Neural science, 4th Edition, Mc Graw Hill, 2000.
4. Duchene E. Haines, Fundamental Neuroscience for Basic and Clinical Application, 3rd Edition, Churchill Livingstone, 2006.
5. Bear, Neuroscience: Exploring the brain, 2nd Edition, Lippincott Willians & Wilkins, 2001.

Course Outcome:

Understand and discuss of discoveries within the fields of neuroscience.
Understand and describe the disorders of nutritional metabolism in the field of neuroscience.
Analyze the neurotransmitter and disorders of basal ganglia and related diseases

Recognize their role of cellular and molecular aspects of aging in neurodegeneration.
Understand the biochemical aspects of motor neuron disease on mental illness.

LECTURE SCHEDULE

S. No.	Lectures
1.	Biochemistry of Peripheral Neuropathy
2.	Disease involving myelin
3.	Multiple sclerosis
4.	Demyelinated disorders
5.	Duchenne Muscular Dystrophy
6.	Duchenne Muscular Dystrophy : Molecular
7.	Duchenne Muscular Dystrophy : Genetic aspects
8.	Duchenne Muscular Dystrophy : Diagnostic characteristics
9.	Overview of Nutritional diseases
10.	Overview of Metabolic diseases
11.	Nutritional and metabolic diseases: Disorders of amino acid metabolism
12.	Nutritional and metabolic diseases: Wernicke Korsakoft Syndrome
13.	Nutritional and metabolic diseases: Pellagra
14.	Nutritional and metabolic diseases: Alcoholic cerebellar degeneration
15.	Nutritional and metabolic diseases: Metabolic Encephalopathies
16.	Nutritional and metabolic diseases: Coma
17.	Neurotransmitters
18.	Neurotransmitters and disorders of basal ganglia
19.	Molecular targets of abused drugs
20.	**Internal Test -1**
21.	Ischemia
22.	Hypoxia
23.	Epileptic seizures
24.	Alzheimer's disease
25.	Alzheimer's disease: Molecular
26.	**Quiz /Group discussion**
27.	**Quiz /Group discussion**
28.	Alzheimer's disease: Genetic
29.	Alzheimer's disease: Immunology aspects
30.	Alzheimer's disease: Diagnostics
31.	Concepts of Aging
32.	Theories of aging
33.	Neurobiology of aging
34.	Neurobiology of aging: Cellular
35.	Neurobiology of aging: Molecular aspects of neuronal aging
36.	Neurodegeneration
37.	Aging and neurodegeneration
38.	Parkinson's disease
39.	Aging and neurodegeneration: Parkinson's disease
40.	**Internal test –II**
41.	Motor Neuron diseases

42.	Prion's disease
43.	Psychotic disorders
44.	Biochemical aspects of the psychotic disorders
45.	Biochemical basis of mental illness
46.	**Quiz /Group discussion**
47.	**Quiz /Group discussion**
48.	Biochemical basis of mental illness: Anxiety disorders
49.	Biochemical basis of mental illness: Mood disorders
50.	Biochemical basis of mental illness: Attention disorders
51.	Biochemical basis of mental illness: Schizophrenia
52.	Disorders of nutritional metabolism
53.	Role of cellular and molecular aspects of aging
54.	Biochemical aspects of motor neuron disease on mental illness
55.	Neurotransmitter and disorders of basal ganglia
56.	Concepts of clinical scenarios
57.	**Seminar & Assignment**
58.	**Seminar & Assignment**
59.	**Seminar & Assignment**
60.	**Seminar & Assignment**
61.	**Seminar & Assignment**
62.	**Model Exam**
63.	**Model Exam**
64.	**Model Exam**

ELECTIVE PAPER
22MBTEB401: HERBAL TECHNOLOGY

Credits: 4 **Hours: 4/Wk**

Course Objectives:

Students will be able to understand the various aspects of the herbal techniques:

- Learn the Indian traditional system of medicine
- Highlights the molecular methods for plant identification
- Plant diseases and its control using plant molecules
- How to extract the molecules from plants
- Use of phytomolecules against parasitic diseases
- Role of herbals in controlling/managing most dreadful diseases in humans

Unit I

Traditional system of medicine: Ayurveda, Siddha, Unani, and Homeopathy. Plant tissue cultureand molecular markers: RAPD, RFLP and AFLP for authentication of medicinal plants.

Unit II

Viral diseases: TMV, Bacterial diseases: (Blast, blight), fungal diseases (smelt and wilt). Controlmeasures and use of herbicides.

Unit III

Herbal extraction methods: Steps, solvents and equipment. Types of herbal extract preparations and storage methods. Plant biomolecules and their future prospects in drug industry.

Unit IV

Parasitic diseases: Malaria and filaria. Metabolites as potential insecticides. Control of malaria parasite and vector.

Unit V

Herbs to treat human diseases: Diabetic, cancer, diarrhea, skin and HIV, neurodegenerative disorders

Suggested Books

1. Kiritikar K.R. and Basu, B.D. 1980. Indian medicinal plants Vol. I-V, CSIR Publications, New Delhi.
2. Janardhan Reddy, K. 2007. Advances in medicinal plants, University Press
3. Sharma, P.D. 2006. Plant Pathology, Alpha Scientific International, India
4. Cheng, 1975. Molecular parasitology, Elsevier Publications, London
5. Lee Lerner and Brenda Wilmoth, 2007. Biotechnology: Medicine Vol. I, Thomas-Gale Publications, US
6. Lee Lerner and Brenda Wilmoth, 2007. Biotechnology: Agriculture Vol. II, Thomas-Gale Publications, US
7. Lee Lerner and Brenda Wilmoth, 2007. Biotechnology: Industry Vol. III, Thomas-Gale Publications, US

Course Learning Outcomes

Upon successfully completing this course, the students could be able to:

- Understand the basic principles of traditional system of herbal medicine
- Obtain the knowledge on basics of plant diseases and their control measures using herbals
- Explain the technical aspects of plant biomolecules
- Describe the basics of parasitic diseases and their herbal control measures
- Summarize various forms of human diseases and their treatments using herbal plants

LECTURE SCHEDULE

S. No.	Lectures
1.	Traditional system of medicine: Introduction, History, Application
2.	Standard drugs in traditional medicine

3.	traditional medicine: Ayurveda, Siddha
4.	traditional medicine: Unani, and Homeopathy
5.	Plant tissue culture: definition, methods
6.	Plant tissue culture: techniques
7.	Plant tissue culture: process and uses
8.	molecular markers: Genetic markers
9.	Types of Genetic markers
10.	Mapping of Genetic marker
11.	Biochemical markers
12.	Application of markers in plant sciences
13.	molecular markers: RAPD
14.	molecular markers: RFLP
15.	molecular markers: AFLP authentication of medicinal plants
16.	Viral diseases: definition, history, effect
17.	The types and causes of Viral diseases
18.	Viral diseases: TMV
19.	Viral diseases: Bacterial diseases: (Blast, blight)
20.	**Internal Test -1**
21.	Viral diseases: fungal diseases (smelt and wilt)
22.	Controlmeasures: basics
23.	Controlmeasures: prevention or limit exposure to hazardous
24.	Controlmeasures in hazard assessment
25.	Controlmeasures - disease prevention
26.	**Quiz /Group discussion**
27.	**Quiz /Group discussion**
28.	Controlmeasures- disease control
29.	Herbicides: an overview
30.	Herbicides: definition and application
31.	Herbal extraction methods: basics
32.	Herbal extraction methods: types and protocol
33.	Herbal extraction methods: Steps, solvents
34.	Equipment used in herbal extract
35.	Different types of Herbal extract

36.	herbal extract preparations
37.	Herbal extract storage methods
38.	Plant biomolecules: introduction, structure, types
39.	Plant biomolecules: function, examples and facts
40.	future prospects of plant biomolecules in drug industry
41.	Parasitic diseases: definition and types
42.	Parasitic diseases: Malaria
43.	Parasitic diseases: filarial
44.	Parasitic diseases: causes, prevention and solution
45.	Metabolites as potential insecticides
46.	**Quiz /Group discussion**
47.	**Quiz /Group discussion**
48.	Control of malariaparasite and vector: fundamentals and efficiency
49.	Control of malariaparasite and vector: Importance
50.	Herbs to treat human diseases: fundamentals
51.	Herbs to treat human diseases: Diabetic, cancer
52.	Herbs to treat human diseases: diarrhoea, skin
53.	Herbs to treat human diseases: HIV, neurodegenerative disorders
54.	Herbs to treat human diseases: methods
55.	Herbs to treat human diseases: examples
56.	Herbs to treat human diseases: advantages and disadvantages
57.	Seminar & Assignment
58.	Seminar & Assignment
59.	Seminar & Assignment
60.	Seminar & Assignment
61.	Seminar & Assignment
62.	Model Exam
63.	Model Exam
64.	Model Exam

ELECTIVE- III

22MBTEC401: BIOPROSPECTING OF BIOMOLECULES

Credits: 4 **Hours: 4/Wk**

Course Objective

The objective of this course is to introduce students the necessity of bioprospecting. The isolation of Bioactive compounds from various bio resources like, microbes, marine, animal and plant sources will be detailed. The students will learn about metagenomics and regulatory practices of IPR to identify and protect novel genes/biomolecules.

UNIT I Bioprospecting and biodiversity

Concepts and practices of bioprospecting; Traditional and modern bioprospecting; bioprospecting and biodiversity; Biodiversity in different agro ecological region, endangered species, inventorisation and monitoring

Unit II: Bioactive Compounds from Microbes

Aerobic and anaerobic (extremophiles/archaea) organisms for bioprospecting. Bioactive compounds from microbes: bacteria, actinomycetes and fungi for antibiotics, antiviral compounds and anticancer agents; plant growth promoting bacteria, pharmacological potential of mushrooms

Unit III: Bioactive Compounds from Marine and Animal Sources

Marine organisms for bioprospecting. Discovery of novel compounds –coral and sponges, coelenterates, bryozoans, molluscs, tunicates, echinoderms. Animal sources – fishes, spiders, insects, frog and arthropods – antibiotic peptides, neurotoxins and proteins

Unit IV: Bioprospecting of Plants

Bioprospecting of plants for novel medicines; random and ethno botanical approach - indigenous traditional knowledge-screening- isolation of pure compounds-bio-assay-structure elucidation; large scale production; market accessibility

Unit V: Metagenomics and regulations for bioprospecting

Metagenomics: microbes from soil, plants, animals and human beings. Bioprospecting of novel genes/biomolecules and enzymes for industrial and medicinal uses. Regulations-Convention on Biological Diversity- Intellectual property rights- Patenting of new genes and/or bioactive principles.

References

1. Sudhir P. Singh, Upadhyay Kumar Santosh · 2021 Krishnan. S and Bhat. D.J. 2009. Plant and

Fungal Biodiversity and Bioprospecting, Broadway Book Centre, India. P. 188

2. Reddy, S R and Charya M A S. 2012. Microbial Diversity: Exploration and Bioprospecting. Scientific Publisher; 1st ed.

3. Bull A. T. (ed.) 2004. Microbial Diversity and Bioprospecting, ASM Press, Washington DC. p. 496

4. Igor, P (ed.). 2011. Research in Biodiversity - Models and Applications, InTech publishers, p.364

e-resources

1. www.westernghats.org.in
2. www.yellowstoneparknet.com
3. www.scidev.net/en/agriculture-and-environment/bioprospecting

Learning Outcomes

- Learning the concepts and practices of bioprospecting Knowledge on Traditional and modern bioprospecting.
- Updated knowledge on the biodiversity in different agro ecological regions, endangered species, inventorisation and monitoring.
- Perform procedures for the isolation and assay of bioactive compounds from microbes: bacteria, actinomycetes and fungi for antibiotics, antiviral compounds and anticancer agents; plant growth promoting bacteria, pharmacological potential of mushrooms.
- Knowledge on the discovery of novel compounds from marine organisms –coral and sponges, coelenterates, bryozoans, molluscs, tunicates, echinoderms.
- Bioprospecting of animal sources – fishes, spiders, insects, frog and arthropods for the identification of antibiotic peptides, neurotoxins and proteins.
- Bioprospecting of plants for novel medicines and learn procedures for screening and isolation of pure compounds.
- Bioprospecting of novel genes/biomolecules and enzymes for industrial and medicinal uses.
- Awareness on the regulations and convention on Biological Diversity- Intellectual property rights- Patenting of new genes and/or bioactive principles.

S. No.	Lectures
1.	Bioprospecting - definitions, concepts and practices
2.	Bioprospecting -Traditional and modern bioprospecting

3.	Biodiversity- biodiversity hotspots - biodiversity threat
4.	Endangered species: medicinal plants/ terrestrial and marine animals
5.	Inventorisation and monitoring-Aerobic and anaerobic (Extremophiles/Archaea) organisms for bioprospecting
6.	Bioactive compounds from bacteria: Antibiotics, Antiviral compounds
7.	Bioactive compounds from bacteria - Anticancer agents, Plant growth promoting bacteria
8.	Bioactive compounds from actinomycetes and fungi: Antibiotics, Antiviral compounds, Anticancer agents
9.	Pharmacological potential of endophytic fungi
10.	Pharmacological potential of mushrooms
11.	Marine organisms for bioprospecting – corals and sponges
12.	Marine organisms for bioprospecting–coelenterates, bryozoans,
13.	Marine organisms for bioprospecting - molluscs, tunicate.
14.	Marine organisms for bioprospecting - echinoderms
15.	Animal sources - antibiotic peptides and neurotoxins
16.	Animal sources – proteins
17.	Biodiversity in different agro ecological region
18.	Endangered species, inventorisation
19.	Endangered species, monitoring
20.	**Internal Test -1**
21.	Animal sources – fishes, frogs, arthropods,
22.	Animal sources - antibiotic peptides, neurotoxins and proteins
23.	Bioprospecting of plants -natural products
24.	Bioprospecting of plants - pharmaceuticals, pharmacognosy
25.	Random and ethnobotanical approach - indigenous traditional knowledge-
26.	**Quiz /Group discussion**
27.	**Quiz /Group discussion**
28.	Screening of plants and storage
29.	Preparation of crude compounds and purification
30.	Bio-assay, structure elucidation,
31.	Bioassay - large scale production and market availability
32.	Bioassay of plant extracts for antibacterial and antifungal activities

33.	Bioassay of plant extracts for antioxidant activity
34.	Metagenomics: microbes in soils, plants, animals and human beings
35.	Bioassay of Bt toxin for insecticidal properties
36.	Bioassay of PGPB for antibacterial and antifungal properties
37.	Regulations-Convention on Biological Diversity
38.	Patenting of new genes and bioactive principles
39.	Isolation of pure compounds-bio-assay-structure elucidation and large scale production
40.	**Internal test –II**
41.	Bioactive compounds - antiviral compounds and anticancer agents
42.	Bioactive compounds - antiviral compounds and anticancer agents
43.	Bioactive compounds - antiviral compounds and anticancer agents
44.	Bioprospecting of novel genes for biotic stress
45.	Bioprospecting of novel genes abiotic stress
46.	Bioprospecting of bio molecules for biotic stress
47.	Bioprospecting of biomolecules abiotic stress
48.	**Quiz /Group discussion**
49.	**Quiz /Group discussion**
50.	Novel enzymes for industrial and medicinal uses.
51.	Novel enzymes for industrial and medicinal uses.
52.	Bioprospecting regulations- Convention on Biological Diversity
53.	Intellectual property rights
54.	Intellectual property rights
55.	Patenting of new genes and/or bioactive principles
56.	Patenting of new genes and/or bioactive principles
57.	**Seminar & Assignment**
58.	**Seminar & Assignment**
59.	**Seminar & Assignment**
60.	**Seminar & Assignment**
61.	**Seminar & Assignment**
62.	**Model Exam**
63.	**Model Exam**
64.	**Model Exam**

ELECTIVE -III

22MBTED401: INSECT BIOTECHNOLOGY

Credits: 4 **Hours: 4/Wk**

COURSE OBJECTIVE:

- The objective of this course is to introduce the students to the field of insect biotechnology.
- This paper helps to know about the overall information about insects and their anatomy and classification.
- To understand the molecular techniques and the applications of insect biotechnology for future aspects..

Unit 1

Introduction, Insect morphology, classification of insects and importance of insect study. Insect food and nutrition: Minerals, carbohydrates, proteins, lipids and vitamins - their role in growth and development of insects.

Unit 2

History of Molecular entomology: Insects as model organism, DNA and RNA analysis in insects- transcription and translocation mechanisms. Identification of genes/nucleotide sequences for characters of interest. Genetic improvement of natural enemies. Cell lines, genetic engineering in baculoviruses, and entomopathogenic fungi.

Unit 3

Insect Whole Genome Sequencing Projects; DNA sequencing, RNA Sequencing; Gene Editing Systems in Insects, : CRISPR- Cas9 and Gene Drive Systems, Sterile Insect Technique (SIT), Ethics and Implications of Gene Editing Tools, Molecular Mechanisms to Study Insect-Plant Interactions, RNA interference and its use in Agriculture.

Unit 4

Application of insect biotechnology in medicine : The role of insect cell culture , Insect cell line development, maintenance and production, Development and application of the insect cell Baculovirus expression vector system, vector Application of IC-BEVS in industrial processes, vaccine and vaccination, Gene therapy ,Recombination protein production , Drug discovery. Insect enzymes for industrial biotechnology

Unit 5

Genes of interest in entomological research- marker genes for sex identification, neuropeptides, JH esterase, Heat stable toxins, chitinase, lectins and proteases. Peptides, Bt toxin, trypsin inhibitors. Insect gene transformation. Introduction of lectin genes for pest suppression. Molecular basis of metamorphosis

Recommended Text Book

- Andreas Vilcinskas, Insect Biotechnology, Springer Science (2011), Germany.
- Marjorie A. Hoy (1994), Insect Molecular Genetics, An introduction to principles and applications. Academic Presss, California.
- Chapman RF. 1998. Insects: Structure and function. ELBS Ed., London.
- Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publ., New delhi.n
- Burges HD & Hussey NW. (Eds). 1971. Microbial Control of insects and Mites. Academic Press, London.

Course Outcome

On the completion of the course the student will be able to

- Classify the insects at Order level
- Understand the Factors affecting Insect growth and development
- Understand gene editing tools used on insects
- Understand the procedures used for production of recombinant products using insect cells
- Identify various gene targets for insect control

LECTURE SCHEDULE

S. No.	Lectures
1.	Overview of insect system
2.	Introduction of insect morphology
3.	Classification of insects and benefits of study
4.	Insect important for food and nutrient overviews
5.	Insect food and nutrients source
6.	Insect food and nutrients source; minerals and CHO
7.	Insect food and nutrients source: proteins
8.	Insect food and nutrients source: lipids and vitamins
9.	Their role in growth and development of insects
10.	History overview of molecular entomology
11.	Classification of entomology
12.	History of Molecular entomology of economic importance
13.	Insect model organisms used DNA and RNA analysis in insect
14.	Insects as model organism, DNA and RNA analysis in insects- transcription and

	translocation mechanisms.
15.	Insect model organisms – identification of genes /nucleotide sequence for characters of insect
16.	Genetic improvement of natural enemies control method
17.	Genetic improvement of cell lines
18.	genetic engineering in baculoviruses
19.	genetic engineering an entomopathogenic fungi
20.	**Internal Test -1**
21.	Insect Whole Genome Sequencing Projects
22.	Insect Whole Genome Sequencing- DNA sequencing
23.	Insect Whole Genome Sequencing- RNA sequencing
24.	Insect Whole Genome Sequencing ; Gene editing systems in insects
25.	Gene Editing Systems in Insects : CRISPR- Cas9
26.	Gene Editing Systems in Insects; Gene Drive Systems
27.	**Quiz /Group discussion**
28.	**Quiz /Group discussion**
29.	Sterile Insect Technique (SIT)
30.	Ethics and Implications of Gene Editing Tools
31.	Molecular Mechanisms to Study Insect-Plant Interactions, RNA interference an
32.	Molecular Mechanisms to Study Insect-Plant Interactions, RNA interference and its use in Agriculture.
33.	Application of insect biotechnology in medicine
34.	Application of insect biotechnology in medicine
35.	The role of insect cell culture
36.	Insect cell line development, maintenance and production
37.	Development and application of the insect cell Baculovirus expression vector system
38.	vector Application of IC-BEVS in industrial processes
39.	vector Application of IC-BEVS in industrial processes, vaccine and vaccination,
40.	**Internal test –II**
41.	Gene therapy and Recombination protein production
42.	Drug discovery

43.	Insect enzymes for industrialbiotechnology
44.	Genes of interest in entomological research- marker genes for sex identification,
45.	Neuropeptides and JH esterase,
46.	Heat stable toxins, chitinase, lectins and proteases
47.	Isolation of Peptides from insect
48.	**Quiz /Group discussion**
49.	**Quiz /Group discussion**
50.	Bt toxin and trypsin inhibitors
51.	Insect gene transformation
52.	Introduction of lectin genes for pest suppression
53.	Introduction of lectin genes for pest suppression
54.	Molecular basis of metamorphosis
55.	Molecular basis of metamorphosis
56.	**Seminar & Assignment**
57.	**Seminar & Assignment**
58.	**Seminar & Assignment**
59.	**Seminar & Assignment**
60.	**Seminar & Assignment**
61.	**Seminar & Assignment**
62.	**Model Exam**
63.	**Model Exam**
64.	**Model Exam**

ELECTIVE-III

22MBTEE401: MARINE BIOTECHNOLOGY

Credits: 4 **Hours: 4/Wk**

Course objectives:

The objectives of this course are to introduce the students to the field of marine biotechnology and living things distribution, utilization in marine environment. Students will understand the important of bioactive marine products derived from marine source. Students will understand transgenic production of fishes and its application, students will learn commercial product from marine sources, i.e. bioethanol production, butanol production, Hydrogen production, and methane production.at end students will know to control marine pollution.

Unit 1. Marine Bio-Resources

Marine microbes: Viruses, Bactria, archaea, protists, fungi. Marine algae and plants: seaweeds, sea grasses, mangrove plants. Invertebrates: sponges, cnidarians, polychaetes, crustaceans, marine worms, arthropods. Vertebrate: Marine fishes (bony, cartilaginous, jawless fishes). Marine tetrapods - amphibians, reptiles, birds, mammals - their distribution and utilization.

Unit 2. Bioactive marine products

Membrane receptors, anti tumour compounds, anti-inflammatory / analgesic compounds, anti-viral agent and Bio terminators. Isolation and identification of marine bioactive compounds – labile proteins, toxins, carotenoids. Green fluorescent protein red fluorescent protein, green mussel adhesive protein, Chitosan, chitin.

Unit 3. Advanced technique in marine organisms

Transgenic production of fishes, methods of gene transfer, single gene traits, detection and screening of transgenes, site of integration, applications; Evaluation of GFP transgenics; Genetically modified fish production- prospects and problems.

Unit 4. Algal bioenergy technology: Bioenergy from micro- and macro-algae, selection of species, biomass processing, bioethanol production, butanol production, Hydrogen production, methane production Biochemical genetic and metabolic engineering of the lipid metabolism; By-products from algal biofuel production; Economic analysis of algal biofuel production; Concept of biorefinery.

Unit 5. Role of biotechnology in marine pollution control

Marine pollution-Sewage pollution, Heavy Metal pollution, Oil Pollution, plastic and microplastic pollution, biology indicators (marine micro, algae), Methods of Inorganic and

Organic waste removal; treatment of Oil pollution at sea; Biodegradation and Bioremediation.

Marine fouling and corrosion.

Recommended books

1. Raymont JEG Plankton & productivity of oceans Pergamon 2nd edition
2. David H. Attaway, 2001. Marine Biotechnology, Volume 1, Pharmaceutical and Bioactive Natural Products.
3. Scheupr, P.J. (Ed.), 1984. Chemistry of Marine Natural Products,Chemical and Biological Perspectives. Vol. I III, Academic Press, New York.
4. Johnston, R. (Ed.), 1976. Marine Pollution. Academic Press, London, 729 pp.
5. Yasunori Murakami, Kei Nakayama, shin – Kitamura., 2008. Biological Response to Chemical pollutants. Terra pub, Tokyo, 372 pp.
6. by W S et al Lakra , Genetics, genetic engineering and biotechnology in fisheries (2013)
7. Pelczar MJ Jr chan ECS and Kreig NR (2001) microbiology 5th edition

Course outcomes

A student passing this module will be able to

- Gaining knowledge about marine microbes, marine algae, plant and animal kingdom present in marine environments.
- To gain importance of bioactive marine products derived from marine source.
- Explaining about the various commercial important marine proteins
- To learn transgenic fish production, application, prospects and problems
- To learn about bioenergy production from marine micro- and macro-algae
- To gain knowledge about marine pollution control

LECTURE SCHEDULE

S.No.	Lectures
65.	Study of Marine microbes: Viruses, Bactria,
66.	Study of Marine microbes: Archaea, Protists, Fungi
67.	Marine algae and plants: seaweeds, sea grasses, mangrove plants
68.	Study of mangrove plants
69.	Invertebrates: sponges, cnidarians, polychaetes, crustaceans,
70.	Study of marine worms, arthropods.
71.	Vertebrate: Marine fishes-bony, cartilaginous,
72.	Study of jawless fishes
73.	Marine tetrapods - amphibians, reptiles, birds,
74.	Study of mammals
75.	Study of Membrane receptors, anti tumour compounds,
76.	Study of anti-inflammatory / analgesic compounds.
77.	Detail about anti-viral agent
78.	Detail about Bio terminators
79.	Isolation and identification oflabile proteins
80.	Isolation and identification of toxins
81.	Isolation and identification ofcarotenoids
82.	Structure and Application Green fluorescent protein and red fluorescent protein
83.	Definition and application of green mussel adhesive protein, Chitosan and chitin
84.	Transgenic production of fishes
85.	Methods of gene transfer

86.	Determined single gene traits
87.	Detection and screening of transgenes, site of integration
88.	Applications in Evaluation of GFP transgenic
89.	Genetically modified fish production
90.	GFP prospects and problems
91.	**Internal assessment-1**
92.	Algal bioenergy technology
93.	Bioenergy from micro and macro-algae
94.	Selection of micro- and macro-algae
95.	Biomass processing of Algal bioenergy
96.	**Quiz /Group discussion**
97.	**Quiz /Group discussion**
98.	Productionof bioethanol
99.	Production of butanol
100	Hydrogen production
101	Methane production
102	Biochemical genetic and metabolic engineering of the lipid metabolism
103	By-products from algal biofuel production
104	Economic analysis of algal biofuel production
105	Concept of biorefinery.
106	**Internal assessment-2**
107	Introduction for marine pollution
108	Role of biotechnology in marine pollution control
109	Marine pollution-Sewage pollution
110	Heavy Metal pollution
111	Oil Pollution
112	Plastic and microplastic pollution
113	**Quiz /Group discussion**
114	**Quiz /Group discussion**
115	Biology indicators of marine microbes and algae
116	Methods of Inorganic and Organic waste removal
117	Treatment of Oil pollution at sea
118	Biodegradation
119	Bioremediation
120	Marine fouling and corrosion
121	**Seminar & Assignment**
122	**Seminar & Assignment**
123	**Seminar & Assignment**
124	**Seminar & Assignment**
125	**Seminar & Assignment**
126	**Model Exam**
127	**Model Exam**
128	**Model Exam**

ELECTIVE - IV
22MBTEA402: ANIMAL MODELS IN BIOMEDICAL RESEARCH

Credits: 4 **Hours: 4/Wk**

Course objectives:

The course will provide knowledge regarding various animal models used in biomedical research. To providethe knowledge on animal models and understanding of advantages and disadvantages of using these models in different areas of research.

UNIT: I

***Xenopus* (Frog)**: Introduction to developmental model organism of Xenopus. Germ cells and fertilization; embryogenesis as modelled through Xenopus. Anatomical, genetic, evolutionary, teratology and experimental approaches of Xenopus.

UNIT: II

***Drosophila melanogaster* (Fruit fly);** Introduction; life cycle of drosophila; used in model organisms; anaesthetizing flies; procedure and preparation culture medium; general information and fly husbandry; Nomenclature used in genetics.

UNIT: III

C.elegans; Definition and Advantages; life cycle of *C.elegans*; Growth and maintenance of *C. elegans;* Identification of wild-type and mutant *C. elegans*; Isolation of nucleic acids from *C. elegans*; Single worm PCR; Expression of GFP-tagged proteins on live *C. elegans* model; Reverse Transcriptase PCR and Real Time PCR.

UNIT: IV

Zebrafish; General description of fish; Classification based on feeding habit; habitat and manner of reproduction and development; Management of fish hatcheries; Preparation and maintenance of fish aquarium; Preparation of compound diets for fish; Role of water quality in aquaculture; life cycle of Zebrafish; Zebrafish as a model organism in research.

UNIT: V

Rodents: Introduction to life cycle of mice and Rat used in model organisms; Advantages and disadvantages. Knockout animals. Regulations for laboratory animal care and ethical requirements; Pre-clinical and clinical models employed in the screening of new drugs.

REFERENCE:

1. Wolpert, L. 2001. Principles of Development. Second Edition. Oxford Univ. Press, UK
2. Gilbert, S.F. 2000. Developmental Biology. Sixth edition. INC Publishers, USA
3. Arking, A., Biology of Aging (Sinauer Associates Inc) 2002.
4. Stanly R. Maby (2006). Microbial Genetics (2nd Edition). Narosa Publishing House.
5. Q Bone and R Moore, Biology of Fishes, Talyor and Francis Group, 3rdedtion (2008) CRC Press, U.K.
6. S.S. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, (2014) Narendra Publishing House.
7. Drugs: From Discovery to Approval by Rick NG, 3rd Edition, Wiley-Blackwell

Course outcome:

1. Describe different animal models used in research in their life cycle and characteristics that make them suitable as animal models.
2. Describe various research areas in which specific model animals are used and explain what makes the specific animal suitable for this research.
3. Propose which animals should be used for biomedicalrelated research.
4. Recognize the benefits of using zebrafish as a model organism for toxicological research.
5. Describe the hierarchy of testing models-*Xenopus*, *Drosophila, C.elegan,* Zebrafish, Rodents.

LECTURE SCHEDULE

S. No.	Lectures
1.	Concepts of animal development, fertilization in early development of *Xenopus* (Frog)
2.	Introduction to developmental model organism of *Xenopus*
3.	Germ cells of *Xenopus*
4.	Fertilization of *Xenopus*
5.	Embryogenesis as modelled through Xenopus
6.	Anatomical approaches of Xenopus
7.	Genetic approaches of Xenopus
8.	Evolutionary approaches of Xenopus
9.	Teratology approaches of Xenopus
10.	Experimental approaches of Xenopus
11.	Concepts of animal development, fertilization in early development of *Drosophila melanogaster* (Fruit fly)
12.	Introduction of Drosophila
13.	Life cycle of Drosophila
14.	Used in model organisms
15.	Anaesthetizing flies
16.	Procedure of culture medium
17.	Preparation culture medium
18.	General information and fly husbandry
19.	Nomenclature used in genetics
20.	**Internal Test -1**
21.	Concepts of animal development, fertilization in early development of *C.elegans*
22.	Definition and Advantages of *C.elegans*
23.	Life cycle of *C.elegans*

24.	Growth and maintenance of *C. elegans*
25.	Identification of wild-type and mutant *C. elegans*
26.	**Quiz /Group discussion**
27.	**Quiz /Group discussion**
28.	Isolation of nucleic acids from *C. elegans*
29.	Single worm PCR
30.	Expression of GFP-tagged proteins on live *C. elegans* model
31.	Reverse Transcriptase PCR
32.	Real Time PCR
33.	Concepts of animal development, fertilization in early development of Zebrafish
34.	General description of Zebrafish
35.	Classification based on feeding habit
36.	Classification based on habitat
37.	Classification based on manner of reproduction
38.	Classification based on development
39.	Management of fish hatcheries
40.	**Internal test –II**
41.	Preparation of fish aquarium
42.	Maintenance of fish aquarium
43.	Preparation of compound diets for fish
44.	Role of water quality in aquaculture
45.	Life cycle of Zebrafish
46.	**Quiz /Group discussion**
47.	**Quiz /Group discussion**
48.	Zebrafish as a model organism in research
49.	Concepts of animal development, fertilization in early development of Rodents
50.	Introduction to life cycle of mice used in model organisms
51.	Introduction to life cycle of Rat used in model organisms
52.	Advantages and disadvantages of mice and rat model organisms
53.	Knockout animals
54.	Regulations for laboratory animal care and ethical requirements
55.	Pre-clinical models employed in the screening of new drugs
56.	Clinical models employed in the screening of new drugs
57.	**Seminar & Assignment**
58.	**Seminar & Assignment**
59.	**Seminar & Assignment**
60.	**Seminar & Assignment**
61.	**Seminar & Assignment**
62.	**Model Exam**
63.	**Model Exam**
64.	**Model Exam**

ELECTIVE - IV
22MBTEB402: BIOREMEDIATION TECHNIQUES FOR POLLUTED ENVIRONMENT

Credits: 4 **Hours: 4/Wk**

Course Objectives:

Students will be able to understand the various aspects of the Bioremediation techniques:

- Recall the types, sources and effects of pollution
- Illustrate the currently available methods for pollution control
- Explain the steps and actual mechanism of action of plants and microbes used for bioremediation of pollutants
- How to use microbes and plants for degrading targeted metals and oil spills.
- Biotechnological approach towards the hazardous waste management in polluted environment

Unit I

Basics of Pollution- Sources and effects of Air, Water and Soil pollution. Types of pollutants-monitoring system of environmental pollution. Methods for pollution control (physical, chemical and biological). Role of plants and microbes in remediation of pollutants.

Unit II

Bioremediation- I Introduction, constraints and priorities of Bioremediation, Biostimulation of naturally occurring microbial activities, Bioaugmentation, in situ, ex situ, intrinsic & engineered bioremediation

Unit III Bioremediation – II Solid phase bioremediation - land farming, prepared beds, soil piles, Phytoremediation. Composting, Bioventing & Biosparging; Liquid phase bioremediation - suspended bioreactors, fixed biofilm reactors. Vetiver bioremediation technique for soil reclamation.

Unit IV

Bioremediation of toxic metal ions. Biosorption and bioaccumulation techniques. Microbial leaching of ore-direct and indirect mechanisms. Use of microorganisms in augmentation of petroleum recovery, pesticide degradation. Biotechnology-with special reference to Copper and Iron removal in polluted environment.

Unit V

Hazardous Waste Management through biotechnology application - cyanide detoxification -

detoxification of oxalate, urea etc. - toxic organics -phenols. Biodegradation of biomedical waste, plastics degradation and management of e-waste.

Suggested Books:

1. S. K. Agarwal, (1988), Environmental Biotechnology, APH publishing
2. Martin Alexander (1999), Biodegradation & Bioremediation, Academic press.
3. Stanier R. Y., Ingram J.L., Wheelis M.L., Painter R.R., General Microbiology, McMillan Publications, 1989.
4. Foster C.F., John Ware D.A., 1987. Environmental Biotechnology, Ellis Horwood Ltd.,
5. Karrely D., Chakrabarty K., Omen G.S., 1989. Biotechnology and Biodegradation, Advances in Applied Biotechnology Series, Vol.4, Gulf Publications Co. London,
6. John. T. Cookson, Jr. 1995. Bioremediation engineering; design and application, Mc Graw Hill, Inc.

Learning outcomes

By the end of the course, the student should be able to

- Familiar with the basics of pollution viz. types, sources and effect of pollution.
- Understanding the various methods for pollution control
- Exploring the mechanism of action of plants and microbes in remediation of environmental pollutants
- Use of biotechnological methods/ tools in remediation of environmental pollution.
- Getting sound knowledge for application of bioremediation techniques in remediation of targeted polluted environment.

LECTURE SCHEDULE

S. No.	Lectures
1.	Basics of Pollution- Sources and effects of Air
2.	Water and Soil pollution- Introduction, causes, effects and solution
3.	Types of pollutants- examples, effects
4.	monitoring system of environmental pollution
5.	Methods for pollution control (physical, chemical and biological)
6.	Role of plants and microbes in remediation of pollutants
7.	Bioremediation: Introduction, constraints,
8.	priorities of Bioremediation- in situ and ex situ techniques
9.	Bio stimulation of naturally occurring microbial activities
10.	Bioaugmentation- application, potential solution
11.	in situ, ex situ, intrinsic techniques
12.	engineered bioremediation- classification
13.	Bioremediation – II- an overview
14.	Solid phase bioremediation

15.	Solid phase bioremediation: land farming, prepared beds, soil piles
16.	Phytoremediation- definition, types, process
17.	Composting- fundamentals. Technologies, uses, history
18.	Bioventing-introduction, methods, application
19.	Biosparging- introduction, methods, application
20.	**Internal Test -1**
21.	Liquid phase bioremediation-techniques, application
22.	suspended bioreactors-fundamentals, uses
23.	suspended bioreactors-types, methods
24.	fixed biofilm reactors- an overview
25.	fixed biofilm reactors –application
26.	**Quiz /Group discussion**
27.	**Quiz /Group discussion**
28.	Vetiver bioremediation technique for soil reclamation
29.	Bioremediation of toxic metal ions
30.	Biosorption: introduction, process.
31.	Biosorption: principle and application
32.	bioaccumulation techniques an overview
33.	bioaccumulation techniques principle and application
34.	Microbial leaching of ore-direct mechanism
35.	Microbial leaching of indirect mechanisms
36.	Use of microorganisms in augmentation of petroleum recovery
37.	Role of microorganism in remediation
38.	pesticide degradation: introduction and principle
39.	pesticide degradation: effects and process
40.	**Internal test –II**
41.	Biotechnology-with special reference to copper removal in polluted environment
42.	Biotechnology-with special reference to Iron removal in polluted environment
43.	Hazardous Waste Management through biotechnology application
44.	cyanide detoxification: introduction and principle
45.	cyanide detoxification: methods
46.	**Quiz /Group discussion**
47.	**Quiz /Group discussion**

48.	detoxification of oxalate: definition, effect
49.	detoxification of oxalate: symptoms, danger and treatment
50.	Hazardous Waste Management: urea etc. - toxic organics -phenols
51.	Biodegradation of biomedical waste and overview
52.	Biodegradation of biomedical waste techniques and application
53.	environment implication
54.	Plastics degradation
55.	management of e-waste: challenges and opportunities
56.	management of e-waste: strategies
57.	Seminar & Assignment
58.	Seminar & Assignment
59.	Seminar & Assignment
60.	Seminar & Assignment
61.	Seminar & Assignment
62.	Model Exam
63.	Model Exam
64.	Model Exam

ELECTIVE - IV

22MBTEC402: COMMERCIAL PLANT TISSUE CULTURE TECHNOLOGY

Credits: 4 **Hours: 4/Wk**

Course Objective

Students will learn about plant tissue and cell culture's concepts, technical requirements, research and commercial applications.

Students will learn about plant tissue and cell culture support systems, micropropagation techniques, and tissue and cell culture applications in plant improvement and its commercial exploitation.

UNIT I: Techniques in Plant Tissue Culture

Commercial PTC Lab Organization-Brief overview of nutrient requirements and factors influencing plant tissue culture. Micropropagation – applications and limitations. Low cost alternatives in micro propagation.

UNIT II: Mass propagation of plants

Commercial scale micropropagation – ornamentals- Carnation, rose, anthurium, gerbera, Leaffoliages - Philodendron, dieffenbachia, plantation crops – date palm, arecanut. Medicinal plants- Coleus, Ocimum, Phyllanthus. Tuber crops-potato, tapioca. Micropropagation of sugarcane and banana. Micropropagation of woody perennials- Neem,Teak, Bamboo, Paulownia, Eucalyptus. Micropropagation of rare and endangered plants.

UNIT III: Disease detection and elimination

Production of Virus free plants – shoot meristem culture. Virus elimination methods - Thermotherapy, cryotherapy and chemotherapy - virus indexing methods- indicator plants

– ELISA test, PCR, nucleic acid hybridization test.Case studies in vegetatively propagated crops for virus free plants-banana, tapioca and potato and case studies on virus indexing methods.

UNIT IV: Hardening, Packaging and transportation of TC plants - Certification system for Accreditation of labs and tissue culture plants

Methods for hardening-acclimatization-Physiological changes during hardening. Packaging and transport of tissue cultured plants –domestic and export. National certification system – Guidelines for Accreditation of Test laboratory for virus diagnosis and genetic fidelity testing of tissue culture raised plants and Tissue Culture Production Facility

UNIT V: Plant cell cultures for secondary metabolites production

Classification of secondary plant metabolites. Extraction and quantification methods for secondary metabolites. Plant Cell cultures for secondary metabolite production–steps. Large scale production through bioreactors.

References

1. AcramTaji, Prakash P. Kumar, PrakashLakshmanan, 2002. In vitro plant breeding. The Haworth Press Inc., New York.

2. Bhojwani, S.S and Dantu, P. 2013. Plant Tissue Culture – An Introductory Text. Springer Publications

3. Cassells, A. C and Peter B. Gahan. 2006. Dictionary of plant tissue culture. Food Products Press, an Imprint of the Haworth Press, Inc., New York-London-Oxford

4. Gamborg, O.L and G.C.Philips (eds.). 2013. Plant Cell, Tissue and Organ culture-Lab Manual.Springer Science & Business media.

5. Karl-Hermann Neumann, Ashwani Kumar and JafargholiImani. 2009. Plant Cell and TissueCulture- A Tool in Biotechnology- Basics and Application. Springer-Verlag, Berlin Heidelberg

6. Razdan, M.K. 2003. Introduction to Plant Tissue Culture. (II Edn.). Science Publishers Inc, Enfield (NH) U.S.A.

7. Roberta H. Smith, 2000. Plant tissue culture: Techniques and Experiments. Gulf ProfessionalPublishing

e- resources

1.Plant Tissue Culture Information exchange -www.aggie-horticulture. tamu.edu/tisscult/ tcintro. html

2.Applications of Biotechnology in Crop Improvement - http://nptel.ac.in/courses/102103016/1

3.e-book: Recent Advances in Plant in vitro Culture - http://www.intechopen.com/books/recent-advances-in-plant-in-vitro-culture

4.e-book: Plant Propagation by Tissue Culture. Vol. I-3 rdEdn – pp.504. Springer publications. ISBN978-1-4020-5005-3 (e-book)

Learning Outcomes

- Gaining Knowledge on the organization of commercial PTC Lab
- Understanding brief overview of nutrient requirements and factors influencing plant tissue culture.
- Learning techniques on the production of virus free plants by shoot meristem culture.
- Learning methods for Virus elimination by Thermotherapy, cryotherapy and chemotherapy – and nucleic acids and serological assays.
- Acquiring information on the Hardening, Packaging and transportation of TC plants.
- Updated knowledge on the National certification system – Guidelines for Accreditation of Test

laboratory for virus diagnosis and genetic fidelity testing

S. No.	Lectures
1.	Introduction to Plant tissue culture
2.	Overview of nutrient requirements in PTC lab
3.	Conditions to multiply plants *in vitro*-principles
4.	Sterilization techniques for plant tissue culture
5.	Nutritional requirements for plant tissue culture-Inorganic nutrients, carbon source, Vitamins,gelling agents
6.	Nutritional requirements for plant tissue culture-Undefined supplements, Plant growth regulators, pH of the medium
7.	Micropropagation- methods- steps, advantages.
8.	Applications and Limitations of micropropagation
9.	Low cost alternatives in micropropagation.
10.	Large scale micropropagation of ornamentals- chrysanthemum, carnation
11.	Large scale micropropagation of ornamentals- orchids, gerbera and rose
12.	Large scale micropropagation of leaf foliages- Philodendron, dieffenbachia
13.	Large scale micropropagation of medicinal plants- Coleus, Ocimum, Phyllanthus
14.	Large scale micropropagation of plantation crops- rubber, pepper, cardamom,
15.	Large scale micropropagation of plantation crops- date palm, arecanut
16.	Large scale micropropagation of potato, tapioca
17.	Large scale micropropagation of sugarcane, banana
18.	Large scale micropropagation in woody perennials- Neem, Teak, Bamboo, Paulownia, Eucalyptus
19.	Large scale micropropagation of rare and endangered medicinal plants - any five Plants
20.	**Internal Test -1**
21.	Production of Virus free plants – shoot / meristem culture
22.	Virus elimination methods- Thermotherapy, cryotherapy and chemotherapy
23.	Virus Indexing – Biological methods and physical methods
24.	Virus Indexing- indicator plants- ELISA test, nucleic acid hybridization test
25.	Virus Indexing- indicator plants- PCR, Dotblot immunoassay.
26.	**Quiz /Group discussion**

27.	**Quiz /Group discussion**
28.	Case studies in vegetatively propagated crops for virus free plants-banana, tapioca and potato
29.	Case studies on virus indexing methods.
30.	Rooting- *in vitro* and *ex vitro* rooting.
31.	Introduction of hardening of TC plants.
32.	Methods for hardening and Acclimatization for hardening
33.	Physiological changes during hardening of TC plants
34.	Packaging and transport of tissue cultured plants – for domestic.
35.	Packaging and transport of tissue cultured plants - for export.
36.	National certification system for TC plants (NCS-TCP).
37.	Guidelines for Accreditation of Tissue Culture Production Facility
38.	Guidelines for Accreditation of Test laboratory for virus diagnosis
39.	Guidelines for Accreditation of Test laboratory for genetic fidelity testing of tissue culture raised plants
40.	**Internal test –II**
41.	Plant secondary metabolites and its classification I
42.	Plant secondary metabolites and its classification II
43.	Application of secondary metabolites
44.	Application of secondary metabolites
45.	Extraction methods for secondary metabolites
46.	**Quiz /Group discussion**
47.	**Quiz /Group discussion**
48.	Extraction methods for secondary metabolites
49.	Quantification methods for secondary metabolites
50.	Quantification methods for secondary metabolites
51.	Plant Cell cultures for secondary metabolite production –steps
52.	Effect of precursor and elicitors in secondary metabolite production
53.	Effect of elicitors in secondary metabolite production
54.	Hairy root culture and its applications
55.	Biotransformation using plant cell culture
56.	Large scale production through bioreactors
57.	**Seminar & Assignment**

58.	**Seminar & Assignment**
59.	**Seminar & Assignment**
60.	**Seminar & Assignment**
61.	**Seminar & Assignment**
62.	**Model Exam**
63.	**Model Exam**
64.	**Model Exam**

ELECTIVE - IV
22MBTED402: INSECT TOXICOLOGY

Credits: 4 **Hours: 4/Wk**

Course Objectives:

The course is designed to increase the understanding

- processes involved in the toxic response in insects to insecticides
- Classification of insecticides.
- Consequences of insecticide use.

Unit I: Principles of Toxicology

Introduction to Toxicology and Pesticides, Exposure and evaluation of Toxicity, Physicochemical Properties, Toxicodynamics I: Penetration through Biological Membranes, Toxicodynamics II: Phase 1 Metabolism, Toxicodynamics II: Extra-microsomal Phase 1 Metabolism, Toxicodynamics III: Phase 2 Metabolism

Unit II: Insecticides Classification and Mode of Action

Neurophysiology, Insecticides Affecting GABA Receptors, Anti-cholinesterase's, Insecticides Affecting the Voltage Gated Sodium Channel, Other Insecticides, Metabolic Inhibitors and Synergists, Microbials, growth Regulators, Evaluation of Toxicity

Unit III: Environmental effects of Insecticides

Environmental Toxicology of Insecticides, Pesticides Laws and Regulations, Biomagnification, Effect on Food Chain,

Unit IV: Insecticide Resistance

Definition, Current Scenario, Major Insect Pests exhibiting Insecticide Resistance, Mechanism of Insecticide Resistance- Metabolic, Behavioral, Environmental. Methods to Assess Resistance – Bioassay, Metabolic Assay, and WHO Protocols.

Unit V: Integrated Pest Management and Emerging Technologies

Concept, Control Measures: Cultural, Mechanical, Chemical, Biological, Botanicals, Insect Growth Regulators, Sterile Insect technique. Gene Drive Systems in Insect Control; Crispr-CAS 9 and other gene existing technologies

References

1. Toxicology and Risk Assesssment: A Comprehensive Introduction, Greim H., and Snyder, R. (ed), John Wiley and Sons, UK

2. The Complete Book of pesticide management, Whitford, F., Wiley Interscience, John Wiley and Sons, UK
3. Chattopadhyay SB. 1985. Principles and Procedures of Plant Protection. Oxford & IBH, New Delhi.
4.Gupta HCL.1999. Insecticides: Toxicology and Uses. Agrotech Publ., Udaipur.
5.Ishaaya I & Degheele (Eds.). 1998. Insecticides with Novel Modes of Action. Narosa Publ. House, New Delhi.
6.Matsumura F. 1985. Toxicology of Insecticides. Plenum Press, New York.
7. Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. Insecticides in Agriculture and Environment. Narosa Publ. House, New Delhi.
8. Prakash A & Rao J. 1997. Botanical Pesticides in Agriculture. Lewis Publ., New York

Course Outcome

At the end of the course the student is expected to:

- Outline the history of insecticides
- Recognize the major classes of insecticide and understand their mode of action
- Become aware of the limitations of insecticide use such as resistance and environmental contamination
- Develop basic understanding on performing insect bioassays
- Appreciate the new technologies used for insect

LECTURE SCHEDULE

S. No.	Lectures
1.	Overview of Toxicology and Pesticides
2.	Principles of Toxicology
3.	Introduction to Toxicology and Pesticides
4.	Exposure and evaluation of Toxicity
5.	Physicochemical Properties
6.	Toxicodynamics I: Penetration through Biological Membranes
7.	Toxicodynamics I: Penetration through Biological Membranes
8.	Toxicodynamics II: Phase 1 Metabolism,
9.	Toxicodynamics II: Extra-microsomal Phase 1 Metabolism
10.	Toxicodynamics II: Extra-microsomal Phase 1 Metabolism
11.	Toxicodynamics III: Phase 2 Metabolism
12.	Insecticides Classification and Mode of Action
13.	Neurophysiology
14.	Insecticides Affecting GABA Receptors
15.	Overview of enzyme assay

16.	Enzymes of studies of Anti-cholinesterase's,
17.	Insecticides Affecting the Voltage Gated Sodium Channel
18.	Insecticides Affecting the Voltage Gated Sodium Channel other insecticides
19.	Metabolic Inhibitors and Synergists
20.	**Internal Test -1**
21.	Microbials growth Regulators
22.	Evaluation of Toxicity
23.	Overview of Environmental effects of Insecticides
24.	Environmental effects of Insecticides
25.	Pesticides Laws and Regulations
26.	**Quiz /Group discussion**
27.	**Quiz /Group discussion**
28.	Pesticides Laws and Regulations
29.	Biomagnifications
30.	Biomagnification
31.	Effect on Food Chain
32.	Insecticides resistance Definition Current Scenario activity
33.	Mechanism of Insecticide Resistance- metabolic activity
34.	Mechanism of Insecticide Resistance- Behavioral and Environmental
35.	Mechanism of Insecticide Resistance- Behavioral and Environmental
36.	Methods to Assess Resistance – Bioassay
37.	Metabolic Assay
38.	Mosquito control using standard protocols of WHO method
39.	Integrated Pest Management and Emerging Technologies
40.	**Internal test –II**
41.	Insect control using IPM
42.	Concept and Control Measures
43.	Types of insect control methods
44.	insect control using Cultural method
45.	insect control using Mechanical method
46.	**Quiz /Group discussion**
47.	**Quiz /Group discussion**
48.	insect control using Chemical

49.	insect control using Biological
50.	insect control using Botanicals
51.	Insect Growth Regulators
52.	Sterile Insect technique
53.	Sterile Insect technique- case study
54.	Gene Drive Systems in Insect Control Crispr-CAS 9
55.	Gene Drive Systems in Insect Control Crispr-CAS 9 – case study
56.	Gene Drive Systems in Insect Control: gene existing technologies
57.	**Seminar & Assignment**
58.	**Seminar & Assignment**
59.	**Seminar & Assignment**
60.	**Seminar & Assignment**
61.	**Seminar & Assignment**
62.	**Model Exam**
63.	**Model Exam**
64.	**Model Exam**

ELECTIVE - IV

22MBTEE402: PHARMACEUTICAL BIOTECHNOLOGY

Credits: 4 **Hours: 4/Wk**

Course objective: To provide basic and applied knowledge of biotechnological processes in the field of drugs and vaccines.

UNIT I

Biotechnology in pharmaceutical industry: Major areas for biotechnology in the pharmaceutical industry such as antibiotics, vaccines, diagnostics, antibodies, biopharmaceuticals (insulin, interferon, GSF, CSF & therapeutic proteins etc.); Commercial aspects, priorities for future biotechnological research.

UNIT II

Biotech Products and Herbal Medicines: Basic concepts and applications, composition, preparation, physicochemical considerations in manufacture. Qualitiy controle (QC), storage and stability of biotech products. Concept and testing of preformulations and their parameters. Drug abuse and dependence, Prescription and non-prescription drugs.

UNIT III

Industrial enzymes in drug development: Penicillin amidase, lipase, oxidoreductase, nitrilase, protease etc. Use of all these enzymes for enantioselective synthesis of pharmaceutically important drugs/drug intermediates, future directions. Approved follow-on proteins/Biosimilars; Characteristics of high-selling peptides and proteins, Products with expired patents; Challenging originator‟s patents; Recombinant non glycosylated proteins; Recombinant glycosylated proteins; Industries dealing with biogenerics and its market value; World scenario; Indian scenario.

UNIT IV

Metabolism of Drugs and Toxicity: Evolution of drug metabolism Phase I metabolism (microsomal oxidation, hydroxylation, dealkylation) Phase II metabolism (drug conjugation pathway) CYP families. Basic concepts, Dose response-Fundamental issues in toxicology, LD50, ED50, PD50, Graphs and calculations. Dose respose relationships for cumulative effects. Toxic intermediates; Toxickinetics and Toxicity testing-*In vitro* methods and *in vivo* methods.

UNIT V

Advanced pharmacology and Pharmacotherapy: Introduction and scope: Psychotherapeutic agents, Immuno-modulators, heavy metals and heavy metal antagonists, therapeutic gases. Free radical biology, antioxidants and antitoxicants. Pharmacotherapy of migrane, Alzheimers, TB, Diabetes and male sexual dysfunction. Hormone replacement therapy (HRT). Advances and promises of gene therapy in combating diseases wherein cure presently unknown.

References:

1. An Introduction to synthetic drugs- Singh &Rangnekar, Himalya Publishing House, 1980.
2. Priciples of Medicinal chemistry-Foye, L W Publishers 2008.
3. Biopharmaceuticals, Biochemistry and Biotechnology- Gary Walsh, Wiley Pub, 2nd Edn.

2003.
4. Industrial Pharmaceutical Biotechnology- Heinrich Klefenz- Wiley-VCH Edn, 2002
5. Biopharmaceutical Drug Design and Development-S Wu Pong, Y Rojanasakul, and J Robinson, Humana Press 1999.
6. Pharmaceutical Biotechnology- K Sambamurthy and AshutoshKar, New age International Publishers-New Delhi 2006.
7. Pharmaceutical Biotechnology-S P Vyas and V K Dixit, CBS Publishers, 2007
8. Hand book of Modren Pharmaceutical Analysis by Satinder Ahuja et.,al. Acadimic Press 2001.
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11. Pharmaceutical Biotechnology (2014) Sreenivasulu V, Jayaveera KN and Adinarayana K, S Chand & Company, ISBN: 978-8121942478. 27
12. Pharmaceutical Biotechnology Fundamentals and Application (2013) Kokare C, NiraliPrakashan, Educational Publishers, ISBN: 978-8185790688.
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14. Pharmaceutical Biotechnology (2002) 2nd ed. Cromelin DJA and Sindelar RD, Taylor and Francis Group, ISBN: 978-3-527-65125-2.

Learning outcomes:

- Understanding the roles of biomolecules in the treatment of diseases
- Knowledge of developing new drug and vaccine products
- Understanding role of genomic information in development and treatment of diseases

LECTURE SCHEDULE

S.No.	Lectures
1)	Biotechnology's major applications in the pharmaceutical sector
2)	Production of antibiotics and vaccines
3)	Monoclonal Antibodies as diagnostics
4)	Commercial production of insulin and interferon
5)	Commercial production of GSFand CSF
6)	Commercial aspects biopharmaceuticals industries like therapeutic proteins,
7)	priorities for future biotechnological research
8)	Basic concepts and applications of herbal drug formulation
9)	Herbal medicine composition, preparation, physicochemical considerations in manufacture.
10)	Biotech product quality assurance, storage, and stability.
11)	Herbal medicine Concept of preformulation and testing of their parameters.
12)	Drug abuse and dependence of herbal products.
13)	Prescription and non-prescription drugs classification.
14)	Industrial aspects of drug development using enzymes
15)	Production of industrial enzymes – penicillin amidase, lipase.
16)	Production of industrial enzymes – Oxidoreductase, Nitrilase, & protease
17)	Enzymes for enantioselective synthesis of pharmaceutically important drugs/drug

	intermediates and future directions.
18)	Approved follow-on proteins/Biosimilars and challenges, Characteristics of high-selling peptides and proteins,
19)	Products with expired patents and Challenging originator‟s patents
20)	**Internal assessment-1**
21)	Recombinant proteins
22)	Glycosylated and nonglycosylated recombinant proteins
23)	World scenario among industrial deals with biogenerics and its market value
24)	Indian scenario - Industries dealing with biogenerics and its market value
25)	**Quiz /Group discussion**
26)	**Quiz /Group discussion**
27)	Drug metabolism and evolutions
28)	Phase I metabolism occurs in microsomal oxidation, hydroxylation, dealkylation
29)	Phase II metabolism occurs by Drug conjugation pathway
30)	CYP families participates in metabolism
31)	Basic concepts and Fundamental issues of dose response in toxicology
32)	Lethal Dose(LD50), Graphs and calculations
33)	Effective Dose(ED50), Graphs and calculations
34)	Protective Dose(PD50), Graphs and calculations
35)	Dose response relationships for cumulative effects
36)	Toxic intermediates
37)	Toxickinetics
38)	Toxicity testing in *In vitro* study methods
39)	Toxicity testing in *In vivo* study methods
40)	**Internal assessment-2**
41)	Aim of Pharmacology and advance approaches
42)	Basic concept of Pharmacotherapy and advances
43)	Introduction and scope of Psychotherapeutic agents
44)	Introduction and scope of Immuno-modulators
45)	Introduction and scope of heavy metals and heavy metal antagonists
46)	**Quiz /Group discussion**
47)	**Quiz /Group discussion**
48)	Introduction and scope of therapeutic gases
49)	Free radical biology, antioxidants and antitoxicants
50)	Pharmacotherapy of migrane, Alzheimers and Tuberculosis(TB)
51)	Pharmacotherapy of migrane, Alzheimers and Tuberculosis(TB)
52)	Pharmacotherapy ofDiabetes and male sexual dysfunction
53)	Pharmacotherapy ofDiabetes and male sexual dysfunction
54)	Hormone replacement therapy (HRT)
55)	Gene therapy
56)	Advances and promises of gene therapy in combating diseases wherein cure presently unknown
57)	**Seminar & Assignment**
58)	**Seminar & Assignment**
59)	**Seminar & Assignment**
60)	**Seminar & Assignment**
61)	**Seminar & Assignment**
62)	**Model Exam**
63)	**Model Exam**

64)	**Model Exam**

22MBT403 Credit Seminar

Credit-1 **Hours: 1/Wk**

Course Objective: To test the technical skills and the communication skills. The research skill is tested by the student's ability to study the given topic and arrive at potential research topics. The communication skills tested in oral communication.

22MBT404 Project Work

Credit-14 **Hours: 12/Wk**

Course Objective: To analyze a scientific occurrence with an investigation or to solve a problem with an invention

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