PERIYAR UNIVERSITY

DEPARTMENT OF BIOTECHNOLOGY

M.Sc., BIOTECHNOLOGY

Course Objectives and Learning Outcomes

2019-2020

DEPARTMENT OF BIOTECHNOLOGY
PERIYAR UNIVERSITY, SALEM- 11
M.Sc. BIOTECHNOLOGY
(CURRICULUM DETAILS-2019-2020)

I- SEMESTER		**Credits**
MBT101	Cell Biology	5
MBT102	Biochemistry	5
MBT103	Plant Biotechnology	5
MBTEA104, B104	ELECTIVE PAPER**:**	4
	MBTEA 104 Vermiculture and Sericulture/ MBTEB 104 Ecotechnology	
MBT 105	Practical- I: Cell Biology and Biochemistry	3
MBT 106	Practical- II: Plant Biotechnology	3
MBT 107	MOOC Course I	-
II - SEMESTER		
MBT201.	Genetics and Molecular Biology	5
MBT202.	Genetic Engineering and Nanobiotechnology	5
MBT203.	Microbiology and Industrial Biotechnology	5
MBT204.	Recombinant DNA (rDNA) Technology	5
	Practical III Molecular Biology, Genetic Engineering and rDNA Technology	3
MBT205.	Practical- IV Genetics, Microbiology and Industrial Biotechnology	3
MBTEDA207	ED/ Basic Biotechnology	3
MBT208	Human Rights	
III - SEMESTER		
MBT301.	Immunotechnology	5
MBT302.	Animal Biotechnology and Developmental Biology	5
MBT303	Bioinformatics, Biostatistics and Bioinstrumentation	5
MBTEA304, B304	ELECTIVE PAPER	4
	MBTEA 304 Environmental Biotechnology MBTEB 304 Food and Medical Biotechnology	
MBT305	Practical V: Immunotechnology, Developmental Biology and Animal Biotechnology	3
MBTED 306	Herbal Biotechnology	3
MBT 307	MOOC Course II	-
MBT308	Summer Internship Programme	1
IV - SEMESTER		
MBT401	Industrial Skill Development Programme	2
MBT 402	Project Work	10
	Total Credits:	**92**
	Total Hours:	**92**

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 scientific skills for biotechnology related careers, in Research, Industry and higher education sectors. Also this framework are master graduates may attribute 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, this framework is fostering in 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, this framework is aimed to mould responsible Indian citizen who have adequate knowledge and skills in reflective thinking, rational skepticism, scientific temper, digital literacy.

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.

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.

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.

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.
- Knowledge to implement multidisciplinary concepts and ideas for the development of innovative technologies.
- Expertise to demonstrate leadership, quality and entrepreneurship.
- Demonstrate technical skills in operation and maintenance of sophisticated instrumentations.
- Intelligence to protect their innovative research through IPR.
- Innovation for high quality research on par with international laboratories.
- Expert to explore scientific projects for need based industry.
- Capability 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 enable to learn and demonstrate about basic experimental techniques in classical and modern biotechnology.
- The students will able to understand and explain various aspects such as Cell and Molecular Biology, Genetic Engineering, Immunology, Biochemistry and Enzymology.
- The students will gain sound knowledge in various fields including Plant, Animal, Microbial Biotechnology, Bioprocess technology, Medical Biotechnology and Environmental Biotechnology.

Analytical Ability

- The students will capable of 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 analyse the data.

Critical thinking and Problem solving ability

- An increased understanding of fundamental scientific concepts, principles and their applications is expected at the end of this course. Students will become critical thinker and acquire in depth knowledge in problem solving capabilities.

Digital knowledge

- Students will acquire digital skills and integrate the fundamental concepts with modern biotechnological 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 in 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	MBT101	MBT102	MBT103	MBT201	MBT202	MBT203	MBT204	MBT301	MBT302	MBT303
Core competency	S	S	S	S	S	S	S	S	S	S
Critical Thinking	S	M	M	M	M	M	M	M	M	M
Analytical Reasoning	M	S	M	S	S	M	M	M	M	S
Research Skills	M	S	S	S	S	S	S	M	S	S
Team work	S	S	S	S	S	M	S	S	S	M

MBT101- Cell Biology, **MBT102**-Biochemistry, **MBT103**-Plant Biotechnology, **MBT201**- Genetics and Molecular Biology, **MBT202**-Genetic Engineering and Nanobiotechnology, **MBT203**- Microbiology and Industrial Biotechnology, **MBT204**- Recombinant DNA (rDNA) Technology, **MBT301**-Immunotechnology, **MBT302**- Animal Biotechnology and Developmental Biology, **MBT303**- Bioinformatics, Biostatistics and Bioinstrumentation (**S**: 'Strong' ; **M**: 'Medium')

Skill Enhancement Courses (Practicals) + MOOC course

Program Outcome	MBT105	MBT106	MBT205	MBT206	MBT305	MBT107	MBT307
Additional Knowledge	S	S	S	S	S	S	S
Exposure beyond discipline	S	S	S	S	S	S	S
Analytical Reasoning	S	M	M	M	M	M	M
Digital Literacy	M	S	S	M	M	S	S
Moral and Ethical Awareness	M	S	S	S	S	M	M

Discipline Related Elective Courses

Program Outcome	MBTEA104	MBTEB104	MBTEA304	MBTEB 304	MBTED207	MBTED306
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

MBTEA104-Vermiculture and Sericulture, **MBTEB104**-Ecotechnology, **MBTEA304**-Environmental Biotechnology, **MBTEB304**-Food and Medical Biotechnology, **MBTED207**- Basic Biotechnology, **MBTED306**- Herbal Biotechnology **MBT10**5- Practical's in Cell Biology and Biochemistry, **MBT106**- Practical's in Plant Biotechnology, **MBT205**- Practical's in Molecular Biology, Genetic Engineering and rDNA Technology, **MBT206**- Practical's in Genetics, Microbiology and Industrial Biotechnology, **MBT305**- Practical's in Immunotechnology, Developmental Biology and Animal Biotechnology, **MBT 107**- MOOC Course-I, **MBT307**- MOOC Course-II (**S**: 'Strong' ; **M**: 'Medium')

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
- Practical 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.

Examination Pattern

Total Marks-100

Internal Assessment-25 Marks

External Assessment-75 Marks

Internal Assessment (25 Marks)

1. Monthly test and model examination-10 marks
2. Seminar-5 marks
3. Assignment – 5 Marks
4. Attendance- 5 Marks

External Assessment (75 Marks)

Section A (Objective type question)

(1x20=20 Marks)

Section B (Analytical Questions)

(Answer Any three out of five questions)

(3x5=15 Marks)

Section C (Descriptive Questions)

(5x8=40 Marks)

LEARNING OUTCOME BASED CURRICULUM FRAMEWORK

Graduate Attributes

Following the completion of the course the candidate will be proficient in various areas of biotechnology.

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 ideas, 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 Graduates will have the capability to apply the knowledge and understanding of biotechnology subject in new contexts and to identify problems and solutions for day to day life.

Analytical Reasoning

Graduates will have proficiency in analysis and interpretation of the results obtained from the experiment.

Research Skills

Graduates will be efficient 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.

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 explain 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 aquired 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.

(xi) Apply the gained knowledge and understanding of Biotechnology to new/unfamiliar contexts and to identify problems and solutions in ever day life.

DISTRIBUTION OF DIFFERENT TYPES OF COURSES WITH THEIR CREDITS

Semester	**Core Course** 10 Core Courses 5 credits each All courses are compulsory 10 credits- Project Work	**Skill Enhancement Courses** 5 Practical's 3 credits each 2 Credits- Industrial Skill Development Programme	**Discipline specific Electives** 4 Elective courses 4 credits each Choose any 1 course per semester	**Generic Elective** 2 Elective courses 3 credits each Choose any 1 course per semester 1 Mandatory Course (Human Rights)	**Seminar Project Group Discussions**	**Credit Hour Load**
I	1.Cell Biology, 2. Biochemistry, 3.Plant Biotechnology	1.Cell Biology and Biochemistry 2.Plant biotechnology	1.Vermicultue And Sericulture 2. Ecotechnology			25
II	1.Genetics and Molecular Biology, 2.Genetic Engineering and Nanobiotechnology, 3.Microbiology and Industrial Biotechnology 4.Recombinant DNA (rDNA) technology	1.Molecular Biology, Genetic Engineering and rDNA Technology, 2. Genetics, Microbiology and Industrial Biotechnology		Basic Biotechnology		29

III	1.Immunotechnology, 2.Animal biotechnology and developmental biology 3. Bioinformatics, Biostatistics and Bioinstrumentation	1.Immunotechnology, Developmental Biology and Animal Biotechnology	1.Environmental Biotechnology 2. Food and Medical Biotechnology	Herbal Biotechnology	Summer Internship	27
IV	Project work	Industrial Skill Development Programme				20
Credits	60	17	8	6	1	92
%Courses	65	18.5	9	6.5	1	100

Courses at a Glance
CBCS structure of the programme

Course Component	No of Course	Hours of learning/week	Marks	Credits
Part A (credit courses)				
Core courses	10	5	1000	50
Practicals	5	6	500	15
Elective courses (any two course)	4	3	400	8
Supportive courses	2	3	200	6
Summer Internship (2 Weeks)	1	-	50	1
Skill Enhancement course	1	5	50	2
Project Work	1	20	200	10
Total(A)	**24**	**42**	**2400**	**92**
Part B (Self-learning credit/non-credit courses)				
MOOC Course	**2**	**-**		
Mandatory Course	1	-	100	
Total (B)	**3**	**-**		
Total (A+B)	**25**		**2500**	**92**

A. Dis Specific Discipline Specific Elective Courses

Core Courses
A. Discipline Specific

Course Code	Name of the Course	Type of Course	Lecture	Tutorials	Practical's	Credits
MBT101	Cell Biology	Core Course	5	0	3	8
MBT102	Biochemistry	Core Course	5	0	3	8
MBT103	Plant biotechnology	Core Course	5	0	6	11
MBT201	Genetics and molecular biology	Core Course	5	0	3	8
MBT202	Genetic Engineering and nanobiotechnology	Core Course	5	0	2	7
MBT203	Microbiology and industrial biotechnology	Core Course	5	0	5	10
MBT204	Recombinant DNA (rDNA) technology	Core Course	5	0	2	7
MBT301	Immunotechnology	Core Course	5	0	3	8
MBT302	Animal biotechnology and Developmental Biology	Core Course	5	0	3	8
MBT303	Bioinformatics, biostatistics and bioinstrumentation	Core Course	5	0	0	5

Course Code	Name of the Course	Type of Course	Lecture	Tutorials	Practical's	Credits
MBTEA104	Vermiculture and Sericulture	Elective Courses	3	0	0	4
MBTEB104	Ecotechnology	Elective Courses	3	0	0	4
MBTEA304	Environmental Biotechnology	Elective Courses	3	0	0	4
MBTEB304	Food and Medical Biotechnology	Elective Courses	3	0	0	4

Skill Enhancement Courses

Course Code	Name of the Course	Type of Course	Lecture	Tutorials	Practical's	Credits
MBT105	Cell Biology and Biochemistry	Skill Enhancement Courses	0	0	6	3
MBT106	Plant biotechnology	Skill Enhancement Courses	0	0	6	3
MBT205	Molecular Biology, Genetic Engineering and rDNA Technology,	Skill Enhancement Courses	0	0	6	3
MBT206	Genetics, Microbiology and Industrial Biotechnology	Skill Enhancement Courses	0	0	6	3
MBT305	Immunotechnology, Developmental Biology and Animal Biotechnology	Skill Enhancement Courses	0	0	6	3
MBT308	Summer Internship Programme	Skill Enhancement Courses	0	0	0	1
MBT401	Industrial Skill Development Programme	Skill Enhancement Courses	0	0	5	2
MBT 402	Project Work	Skill Enhancement Courses	0	0	10	10

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.
- Current Developments in Techniques.
- GM crops for food and non-food products.
- Air pollution and climate change.
- Biodiversity under climate changing scenarios.
- Genome modification/ editing.
- rDNA technology.
- Basic fundamentals of Biotechnology.
- Entrepreneurship Opportunities.

MBT 101: CELL BIOLOGY

Credits: 5 **Hours: 5/Wk**

Course objectives:

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.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		K1 and K2	K3, K4 and K5	
I	Cell Organization	Molecular organization of prokaryotes and eukaryotes, Structure and function of peroxisomes and Nucleus	Structure and function of cell organelles: Mitochondria, chloroplast, golgi apparatus, lysosomes, endoplasmic reticulum and ribosomes	10
II	Cell Structure and Function	Fluid Mosaic model. Gap junction, Tight junction and Desmosomes.	Membrane transport: passive and facilitated diffusion, active transport, symport, antiport, ATPase, ABC transporters, ion channels and aquaporins. Intercellular communication:	20
III	Cell Signalling	Concept, ligands and receptors. Endocrine, paracrine and autocrine signaling.	G protein coupled receptors, receptor kinases. Signal transduction: Cytoplasmic and nuclear receptors. Secondary Messengers: cAMP, Ca+, cGMP and Nitrous oxide	20
IV	Cytoskeleton	Microtubules, Microfilaments, Intermediate filaments, Amyleoid fibers.	Cell mobility: Endocytosis and Exocytosis. Proton pumps	10
V	Cell cycle and Imaging	Mitosis, Meiosis, Cell Cycle: phases	Cell cycle regulation, checkpoints. Cell death: Apoptosis and necrosis. Microscopy: Light, Confocal, SEM, TEM, Phase contrast and Fluorescence	15

Recommended Books

- 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.

Web sources

- https://library.stanford.edu
- https://www.khanacademy.org
- http://www.cellbiol.com

Course learning outcome:

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

- Understand 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 signaling.
- 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.

MBT102 BIOCHEMISTRY

Credits: 5 **Hours: 5/Wk**

Course objectives:

The aim of this course is to provide basic knowledge and fundamentals of biochemistry. Basic techniques will demonstrate the ability to engage in scientific knowledge as well as quantitative and qualitative reasoning. 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	Unit Title	Intended Learning Chapters		Hours of Instruction
		K1 and K2	K3, K4 and K5	
I	Introduction	Water and buffers: Molecular structure of water. Vitamins and minerals. Nucleic acids: Purines, pyrimidines, DNA and RNA.	Biosynthesis of purine and pyrimidine.	15
II	Carbohydrate	Classification, functions of biologically important monosaccharides, disaccharides and polysaccharides	Carbohydrate metabolism: Glycolysis, citric acid cycle, gluconeogenesis and glycogen metabolism. Diabetes mellitus.	20
III	Proteins	Amino acids: Classification and Biologically important peptides. Proteins: Classification.	Protein denaturation and renaturation; Orders of protein structure: Primary, secondary (α-helix, β-pleated sheets), tertiary, and quaternary structures. Urea cycle	15
IV	Lipids	Classification, structure and functions of cholesterol.	Lipid metabolism: β-oxidation and biosynthesis of fatty acids. An overview. Coronary heart disease	15
V	Enzymology	Enzymes: Classification and nomenclature. Specificity, factors affecting enzyme activity: substrate, pH and temperature.	Michaelis-Menten equation and L-B plot. Enzyme inhibition. Applications of enzymes in clinical diagnosis and therapeutics	10

Recommended Books

- Robert K. Murray, Daryl K. Granner, Victor W.Harper's Illustrated Biochemistry, 31th Edn (2018.) Rodwell. McGraw-Hills.USA
- David L. Nelson and Michael M. Cox, Lehninger Principles of Biochemistry, 7th Edn, 2017,W.H. Freeman and Co., NY.
- Lupert Styrer, Jeremy M. Berg, John L. Tymaczko, Gatto Jr., Gregory J. Biochemistry. 9th Edn (2019). W.H.Freeman & Co. New York.
- Donald Voet, Fundamentals of Biochemistry. 5th Edn (2016), Wiley. Pennsylvania (US)
- Despo Papachristodoulou, Alison Snape, William H. Elliott, Daphene C. Elliott Biochemistry and Molecular Biology. 6th Edn (2018), Oxford University Press. Australia
- Amit Kessel & Nir Ben-Tal. Introduction to Proteins: structure, function and motion. 2nd edn, Chapman and Hall/CRC (2018). UK
- Neale Ridgway and Roger McLeod, Biochemistry of Lipids, lipoproteins and membranes. 6th Edn Elsevier Science, (2015). USA
- Donald Voet and Judith G. Voet, Biochemistry, 4th Edn, John Wiley & Sons, (2011). US

Web sources

- https://themedicalbiochemistrypage.org/
- https://www.nature.com/nchembio/
- https://biochemistry.org/
- https://www.ebooks.com/en-ae/2110659/biochemistry-of-lipids-lipoproteins-and-membranes/neale-ridgway-roger-mcleod/

Course learning outcome:

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:

- 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 its applications.

MBT 103: PLANT BIOTECHNOLOGY

Credits: 5 **Hours: 5/Wk**

Course objectives:

This course aims to help the students to gain an advanced level of understanding in the comprehensive components of plant biotechnology. The content of the course contributes for food security and human health towards sustainable agriculture. On top of technical insights into plant breeding, tissue culture, plant genes and genetic modification (GM), will have the overview of GM crops in the market and pipeline for their various applications like improved food quality and medicine. They will also gain a good knowledge on global regulation framework on GM crops and product as well as intellectual property rights related to plant biotechnology. 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	Unit Title	Intended Learning Chapters		Hours of Instruction
		K1 and K2	K3, K4 and K5	
I	Plant Kingdom	Lower plants-Algae–food and its industrial applications	Economic important of Angiosperms: Food crops, Cash crops and Medicinal plants	10
II	Plant Tissue Culture	Totipotency, cytodifferentiation, callus culture, cell suspension culture, micropropagation, organogenesis, somatic embryogenesis, protoplast culture	Somaclonal variation Production of haploids: Bulbosum technique and its uses. Seed terminator technology	15
III	Plant Molecular Biology	Plant genome organization: Nuclear, Plastid and Mitochondrial.	Tools for stress induced gene identification-mRNA differential display and SSH analysis. Molecular markers: RAPD, AFLP, RFLP, SSR and SNP.	20
IV	Plant Transformation	Vectors – Agrobacterium mediated transformation, particle bombardment.	Confirmation of transgene expression by Molecular Techniques-PCR, Northern, Southern and Western blot analyses, Gene silencing by antisense and RNAi technology in plants	20
V	Biotechnological Applications	Application of genetic manipulation in crop improvement: Herbicide, insecticide and disease resistance. IPR, Plant breeders and Farmers Right	Techniques for industrial and pharmaceutical products: Edible vaccines.	10

Recommended Books

- Adrian Slater, Nigel Scott, and Mark Fowler, 2008, Plant Biotechnology, 2nd edition, Oxford university press, USA.
- Paul Christou,Harry Klee,2010,Handbook of Plant Biotechnology, Vol-I &Vol-II,Wiley publishers,USA.

- Roberta H. Smith,2013. Plant Tissue culture, Techniques and Experiments 2rd edition, Academic Press,USA.
- Kalyan Kumar De, 2013. Plant Tissue Culture 2nd Edn. New Central Book Agency, Calcutta.
- Purohit S.S .2010. Plant Tissue Culture , Axis books, Jodhpur.
- Palmiro Poltronieri, Yiguo Hong, 2015. Applied Plant Genomics and Biotechnology ,1st Edition, Elsevier- Woodhead Publishing. Cambridge.
- Tamara Thompson, 2015. Genetically Modified Food, Greenhaven Press.USA
- Colin J. Sanderson, 2007.Understanding Genes and Gmos, World Scientific publishers,Australia.
- Sheldon Krimsky Jeremy Gruber Ralph Nader, 2014. The GMO Deception, Skyhorse Publishing,New York.

Web sources

- https://plant-biotech.net/
- https://onlinelibrary.wiley.com
- www.nipgr.res.in › library_web › free_online_res

Course learning outcome:

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

- Understand the basic principles of plant kingdom and their economic importance.
- Explain the basics, methodology and applications of plant tissue culture.
- Design experiments for functional characterization of plant genes and to identify those suitable for creating agronomically important traits.
- Conceptualize plant transformation, selection of desirable genes for crop improvement, design binary vector and procedure for generating GM crops.
- Describe what GM crops and products are in the market and pipeline, and their contributions towards food security, sustainable environment and medicine.
- Evaluate critically the safety issues of GM crops and products in the society.
- Summarize various forms of IP rights related to GM crops and formulate suitable IP strategy for a selected plant biotechnology projects/products.

ELECTIVE PAPER

MBTEA 104: Vermiculture and Sericulture

Course objectives:

This paper aims to learn basic concepts of Vermiculture and Sericulture. The content of the paper is covered with the biology of the vermicomposting and ecology of the earthworms. Students will be able to understand the source of organic waste vermicomposting methods and factors affecting vermicomposting and to try establishing vermicomposting in a limited space. Concept of origin, growth and study of the sericulture as science. To understand the scientific approach of mulberry. Cultivation, silkworm rearing and silk reeling. To have a better understanding about the status, classification, season of occurrence and the life cycle of pests infesting mulberry and silkworm. They also throw light on the management of pests and diseases of mulberry and silkworm with special reference to integrated approaches. This paper will help those students in her/his careers because this is useful for self employment/setting up farm related business.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		K1 and K2	K3, K4 and K5	
I	Biology of Earthworms	*Eudrilus eugeniae* and *Lampito mauritii*. Ecological groups of earthworms: Epigeic, anecic, endogeic earthworm	earthworm casts- An outline of their importance in agriculture	10
II	Vermiculture	Sources of organic wastes: Problems in traditional composting- vermicomposting: Definition and methods - pit method, heap method and indoor method	Factors affecting vermicomposting: pH, moisture, temperature and nutritional value of feed	15
III	Application of Vermiculture	Advantages of vermicomposting Application of vermicompost in agricultural and horticultural farms.	Economics of Vermiculture and marketing	10
IV	Biology of Silkworm	Silkworm: Morphology- life cycle. Rearing programme- hatching, feeding, cleaning and spacing care at mounting- environmental conditions:	Leaf quality- rearing early age silkworms- rearing late age silkworms- mounting and harvesting	15
V	Processing and Application of Sericulture	Bacterial diseases: Viral diseases- fungal diseases- enemies of silk worm	Process of stifling: Reeling techniques- process of reeling- methods of collection of silk.	10

Recommended Books

- Jawaid Ahsan and Subhash Prasad Sinha, 2010. A handbook of economic zoology. S. Chand & Co. Ltd.India.

- Edwards, C.A.Hendrix P.F., and Arancon N.Q., 4th edition 2019. Biology and ecology of earthworms, , Springer Pubications. United States.
- Katsumi Maenaka, Enoch Y. Park 2018 Silkworm Biofactory: Silk to Biology. CRC Press. United States.
- G Ganga J Sulochana Chetty, **2019** Introduction to Sericulture**.** Oxford & Ibh Publishing Co Pvt Ltd**.** India.
- Tv Sathe, Ad Jadhav, 2012 Sericulture & Pest Management Daya Publishing House . India.
- Karaca, Ayten 2011 Biology of Earthworms Springer-Verlag Berlin Heidelberg. United States.

Web sources

- http://www.nzdl.org/cgi-bin/library.cgi
- https://www.biotecharticles.com/Agriculture-Article/Vermiculture-Types-of-Earthworms-and-Applications-3133.html
- http://agritech.tnau.ac.in/org_farm/orgfarm_vermicompost.html
- http://silks.csb.gov.in/bandipore/techniques-of-rearing-silkworm/
- http://agritech.tnau.ac.in/sericulture/seri_silkworm4_lateage%20rearing.html

Course learning outcome:

The completely read the Vermiculture and sericulture paper, students able to understand following knowledge:

- Understand the basic knowledge about the biology of the composting using earthworms like *Eudrilus eugeniae* and *Lampito maurtii*.
- Clearly to know the source of organic waste and problems in traditional composting. Also able to understand different types of vermicomposting methods with problems in vermicomposting.
- Understand the value of vermicomposting and vermicompost importance in modern agriculture.
- Describe the basic concept of sericulture, morphology and biology of the silk worm.
- The learner will understand about methods of rearing, collecting silk, microbial pathogens and their disease.
- Vermiculture and sericulture paper will be useful to students in setting up farm related business.

ELECTIVE PAPER

MBTEB 104: 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	Unit Title	Intended Learning Chapters		Hours of Instruction
		K1 and K2	K3, K4 and K5	
I	Biofuel	Introduction to Biofuel, Bioenergy sources – Sugar waste, Starch waste, Lignocellulosic waste, livestock waste	Categories- Biodiesel: Source & production Biogas : Source & production Bioethanol : Source & production	10
II	Biopolymers	Introduction to Biopolymers ; Sources – natural sources, microbial polysaccharides, poly hydroxyl alkaonates	Biosynthesis of polymers, Production- fermentation, enzymatic synthesis, characterization and analysis of biopolymers, Applications	10
III	Biopesticides	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	15
IV	Biofertilizers	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, Nano Biofertilizers	15
V	Biostimulants	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	10

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.

MBT 105: PRACTICAL I: CELL BIOLOGY AND BIOCHEMISTRY

Credits: 3 **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 Mitosis cell division
3. Meiosis Cell division Experiment
4. Staining of 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 amino acids by paper chromatography/TLC.
11. Analysis of proteins by SDS-PAGE.

Course learning outcome:

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 amino acids from a mixture of samples.

MBT 106: PRACTICAL II: PLANT BIOTECHNOLOGY

Credits: 3 **Hours: 6/Wk**

Course objectives:

The purpose of the course is to

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

Course Content

1. Basic sterilization techniques and culture media preparation.
2. Shoot tip culture.
3. Root culture.
4. Endosperm culture.
5. Anther culture.
6. Plant DNA- Isolation and analysis.
7. PCR and RAPD analysis.
8. Restriction digestion of genomic DNA and PAGE analysis.
9. Protoplast isolation and culturing.
10. Synthetic seed production (Artificial seed).
11. *Agrobacterium* mediated gene transformation.

Course learning outcome:

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 sterile techniques, media preparation, DNA extraction methods, gene isolation and nucleotide sequence analysis,
- Acquaint with principles, technical requirement, scientific and commercial applications in Plant Biotechnology,
- Support methodologies in plant tissue/cell culture to plant improvement, as well as DNA handling with PCR-based detection diagnostic tools,
- Become motivated to set goals towards pursuing higher level positions, such as lab manager and key scientist in plant biotechnological research institutes and industries.

MBT 201: GENETICS AND MOLECULAR BIOLOGY

Credits: 5 **Hours: 5/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	Unit Title	Intended Learning Chapters		Hours of Instruction
		K1 and K2	K3, K4 and K5	
I	Mendalian Genetics	Mendelian principles: Dominance Segregation and independent assortment, Test cross, Back cross..	Incomplete dominance: Epistasis. Linkage and crossing over. Population genetics: gene pool, Hardy-Weinberg equilibrium, genetic drift and speciation	15
II	Bacterial Genetics	Recombination: Plasmids-origin of replication, incompatibility. Mutations & genetic analysis – auxotrophic, conditional lethal, resistant mutants. Isolation, selection and replica plating of mutants – complementation & recombination test.	Transformation- natural and artificial. Generalized Transduction, Conjugation: Mating types, F-factor and chromosome mapping	15
III	DNA structure and Function	DNA: Types and structure. Central dogma concept.	DNA replication in prokaryotes and eukaryotes. Regulation of DNA replication. DNA Repair Mechanisms: SOS, thymine dimerization, mismatch repair.	15
IV	RNA structure and Function	RNA: Types of RNA, RNA polymerase, and Promoters: classes and consensus sequences, transcription factors.	Transcription in prokaryotes and eukaryotes; RNA processing. Genetic Codes- Universal and Mitochondrial; Translation: Steps; protein folding and post translational modification. Intracellular protein trafficking and targeting	15
V	Gene Regulation	DNA methylation – histone modification – acetylation and deacetylation, DNA binding motifs – Zinc finger, Leucine Zipper, HLH, and HTH	Regulation of gene expression in prokaryotes: Lactose and tryptophan; epigenetic regulation of gene expression in eukaryotes	15

Recommended Books

- Benjamin Lewin. Genes XII.2017. Benjamin-Cummings Pub Co. London.
- Harvey Lodish. 2016. Molecular cell biology. 8th Edition.W. H. Freeman. America.
- David. P. Clark. 2010. Molecular Biology. Academic Press. USA.
- Brown. T.A.2017. Genomes. 4thEdn. Wiley-Liss (New York).
- Larry Snyder, Wendy Champness. 2013. Molecular Genetics of Bacteria. 4th Edn. American Society for Microbiology. USA.
- Sandy B. Primrose, Richard M. Twyman, Robert W. Old, 2016. Principles of Gene Manipulation and genomics. 8th Edn. Blackwell Science. United States.
- Volker A. Erdmann. 2015. RNA and DNA Diagnostics. Springer International Publishing. Switzerland.
- Suming Huang. Michael. D. Litt. C. Ann Blakey. 2016. Epigenetic Gene Expression and Regulation. Academic Press London.

Web sources

- https://www.gmb.org.br/
- https://libguides.lib.umt.edu/cellular_molecular_biology
- https://guides.lib.umich.edu/

Course learning outcome:

- Completely read this course student will learn following knowledge in genetics and molecular biology:
- Basic concept of Mendelian and non-Mendelian inheritance pattern in plants and animals.
- Relate modern techniques to the understanding of genetics, and Hardy-Weinberg principle to explain changes in population genetics.
- Microbial genetic process like generation of mutants for genetic analysis as well as to get an in-depth understanding about the molecular genetics.
- Describe the principles of gene expression and regulation in prokaryotic and eukaryotic cells.
- Apprise the importance of epigenetic and methylation systems in gene regulation.
- Understand the importance of DNA binding motifs in gene regulation.

MBT202: GENETIC ENGINEERING AND NANOBIOTECHNOLOGY

Credits: 5 **Hours: 5/Wk**

Course objectives:

Students will 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, Nanoparticle types and their applications.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		K1 and K2	K3, K4 and K5	
I	Gene Cloning	Basic steps in gene cloning. Type II Restriction endonucleases. Cloning vectors: plasmids (pBR322 and pUC), phage vectors (λ), cosmids.	Methods of ligation of insert and vector DNA molecules: cohesive end method, homopolymeric tailing, blunt-end ligation	10
II	Gene Transfer Methods	Gene transfer methods: calcium phosphate coprecipitation, electroporation, lipofection, viruses, microinjection. Choice of host organisms for cloning.	Cloning strategies- genomic cloning, cDNA cloning	15
III	Techniques in Genetic Engineering	Techniques in genetic engineering: Probe-Types- Radiolabeled/Non Radiolabeled.	PCR- basic principles and applications. Basic concepts of RT-PCR and real-time qPCR. Applications of genetic engineering in agriculture, environment and medicine. Cloning of insulin gene in bacteria	20
IV	Genome Mapping and Sequencing	Genome sequencing methods (DNA Sequencing: Automated sequencing. Next-generation sequencing (basic concepts only). shotgun and clone-contig methods. (Overview only)	Genetic and physical Mapping Restriction mapping.	15
V	Nanobiotechnology	Nanobiotechnology- introduction. Nanoparticles- metal, and bimetallic nanoparticles and fluorescent nanoparticles.	Biological synthesis of nanoparticles. Techniques for visualization of biomolecules at nanoscale- FTIR, XRD, EDX, FRET and DLS. Applications of nanotechnology in biology, medicine and environment	15

Recommended Books

- T.A.Brown. 2016, An Introduction to Gene cloning & DNA analysis ,7th edition, Wiley balckwell, US.
- Bernard R.Glick and Cheryl L.Patten, 2017, Principles and Applications of Recombinant DNA - Molecular Biotechnology.,5th ed, ASM Press, United states.
- T.A.Brown,2018, Genomes 4, Taylor and Francis, New York.
- Desmond S.T Nicholl,2008, An Introduction to Genetic Engneering.3rd Edition, Cambridge UniversityPress,New York.
- Tuan Vo-Dinh , 2017, Nanotechnology in Biology and Medicine: Methods, devices and applications,2nd edition, CRC Press, Florida.
- Vaibhay jain and Akshay kokil,2015, Optical properties of functional polymers and Nano engineering applications. CRC press,Florida
- Mikhail Y.Berezin,2015, Nanotechnology for biomedical Imaging and Diagnotics, Wiley Publishers,US
- Chaudhery Mustansar, Hussain Ajay Kumar Mishra,2018, Nanotechnology in Environmental science ,Wiley Publishers,US.

Web source

- https://jnanobiotechnology.biomedcentral.com/
- https://onlinelibrary.wiley.com

https://www.nature.com › nature nanotechnology

Course learning outcome:

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.

MBT 203: MICROBIOLOGY AND INDUSTRIAL BIOTECHNOLOGY

Credits: 5 **Hours: 5/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 about 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	Unit Title	Intended Learning Chapters		Hours of Instruction
		K1 and K2	K3, K4 and K5	
I	Basics of microbes	Introduction to bacteria - Cell wall, cell membrane, flagella and cell inclusions. Introduction to bacterial, plant and animal viruses: Lytic cycle and lysogeny. DNA and RNA viruses. Viroids and prions	Staining: principle and types, Fungi and Bacteria.	15
II	Microbial Growth and Metabolism	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	15
III	Bioprocess Engineering	Isolation and screening of industrially important microbes.	Bioreactors: Fermentation -Downstream processing: Solid-liquid separation, release of intracellular compartments, concentration of biological products, purification. Industrial production of ethanol, citric acid, penicillin and amino acids	15
IV	Bioremediation	Bioleaching: Use of microorganisms in ores of gold, aluminum and iron. Introduction to phytoremediation.	Wastewater treatment: Physical, chemical and biological treatment processes. Effluent treatment: Bioremediation and oil spill clean-up	15
V	Industrial Biotechnology	Immobilization of enzymes: Methods, and applications	. Use of enzymes in detergents, textiles, leather and food industries. Methods of food preservation: canning and packing. Industrial production of wine and beer.	15

Recommended Books

- Peter F. Stanbury, Allan Whitaker, Stephen J. Hall. 2016. Principles of Fermentation Technology. 3rd Edn. Elsevier Science Ltd. Netherlands.
- Joanne Willey, Linda Sherwood, Christopher J. Woolverton.2016. Prescott's

Microbiology. 10th Edn. McGraw-Hill Education. United States

- Maheshwari D K, Dubey R C 2013. A Textbook of Microbiology.4th Edn S Chand Publishing India.
- Christoph Wittmann , James C. Liao , Sang Yup Lee 2017.1st Edn Wiley VCH. Germany
- Nduka Okafor. 2017. Modern Industrial Microbiology & Biotechnology 2th Edn. CRC press. Taylor and Francis group. United Kingdom
- Peppler H. J. and Perlman. D. 2014. Microbial Technology. Vol. 1&2. 2th Edn Academic Press. United States
- Casida L. E. and John Jr. 2015. Industrial Microbiology. 2th Edn Wiley and Sons Inc. United States

Web Source

- https://aem.asm.org/content/77/5/1907
- http://www.biologydiscussion.com/biotechnology/downstream-processing/stages-in-downstream-processing-5-stages/10160

Course learning outcome:

A student passing this module will be able:

- To show the main microbial processes, methods, cultivation, preservation, metabolism and synthesis activity.
- To explain about the microorganisms (Bacteria, Fungi, Algae, Protozoa and viruses) type's specifics 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, bioremediation and energy sources.
- To know the different microorganisms and their products (enzymes, polymers, metabolites, etc.) that are used in the biotech industry.

MBT 204: RECOMBINANT DNA (RDNA) TECHNOLOGY

Credits: 5 **Hours: 5/Wk**

Course objectives:

The aim of this course is to acquaint the students to versatile tools and techniques employed in recombinant DNA technology. A sound knowledge on methodological repertoire allows students to innovatively apply these in basic and applied fields of biological research. This course conceptualize properties and applications of versatile DNA modifying enzymes, cloning strategies, vector types, host genotype specificities for selection and screening of recombinants and/or recombinant clones. Students will also be introduced to prominent nucleic acid labeling techniques. Introduction to various types of vectors viz. cloning, transformation, expression; and also vectors for genomic and cDNA library will be provided. This course will serve to illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences and to expose students to use recombinant DNA technology in biotechnological research. The course will also help to train students in strategizing research methodologies employing genetic engineering techniques.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		K1 and K2	K3, K4 and K5	
I	Introduction to rDNA Technology	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	10
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	15
III	Gene Cloning Strategies	Gene cloning strategies: DNA cloning. Use of adapters & linkers. Construction of genomic DNA and cDNA libraries. Preparation of radiolabelled and nonradiolabelled DNA & RNA probes	Screening and selection of recombinant clones- Colony Hybridization techniques. lacZ complementation (Blue-white selection), Immuno-screening.	20
IV	rDNA Techniques	PCR applications. DNA footprinting, Chromosome walking.	Medical and forensic applications of rDNA technology- DNA Profiling, Diagnosis of inherited disorders and infectious diseases by PCR. Gene therapy for ADA and cystic fibrosis. CRISPR-Cas9 gene editing technology	15
V	Applications of rDNA	Synthesis and purification of recombinant proteins from cloned genes. Hazards and safety regulations in r DNA Technology	Production of enzymes. Therapeutic products for use in human health care- insulin, growth hormones, Hepatitis B vaccine	15

Recommended Books

- S. B. Primrose and R. M. Twyman, John Wiley & Sons. Principles of Gene Manipulation and Genomics 7th Edn. Oxford Publisher (2009). USA
- Julia Lodge, Pete Lund and Steve Minchin, Gene Cloning Taylor and Francis (2006). NY
- Desmond S.T. Nicholl, An introduction to Genetic Engineering 3th Edn 2008. Cambridge University Press. Scotland
- T. A. Brown, Gene Cloning and DNA Analysis. An Introduction (2016) 7thEdn Blackwell Scientific Publications. India
- Michal Janitz, Next-Generation Genome Sequencing (2011) Wiley-Blackwell Publications. Germany
- Sambrook, J., Russell, D.W., Molecular cloning: A Laboratory Manual 3th Edn. (2001) Cold Spring Harbor, New York.
- Moo-Young, Robinson Howell Comprehensive Biotechnology 4thEdn. Elsevier Science (Vol.1-4) (2008)
- Monika Jain Recombinant DNA Techniques: A Text book (2014) Narosa, India
- Sure carson, Dominique Robertson. Manipulation and Expression of Recombinant DNA (2005) California USA

Web sources

- https://www.ncbi.nlm.nih.gov/ /
- https://www.khanacademy.org/
- https://trove.nla.gov.au/work/11788984
- https://www.ncbi.nlm.nih.gov/ /
- https://www.khanacademy.org/

Course learning outcome:

Upon successfully completing this course the students could be able to

- Outline the fundamental steps in a genetic engineering procedure.
- Describe the mechanism of action and the use of restriction enzymes in biotechnology research and recombinant protein production.
- Explain the usefulness of plasmid preparations, how they are performed, and how the concentration and purity of plasmid samples can be determined.
- Discuss cloning strategies and techniques used to probe DNA for specific genes of interest.
- Conceptualize PCR technique in medical and forensic science.
- Summarize various applications of rDNA technology in human health care and safety regulations.

MBT 205: PRACTICAL III:MOLECULAR BIOLOGY GENETIC ENGINEERING AND rDNA TECHNOLOGY

Credits: 3 **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 Practicals

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.

Course learning outcome:

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 genetic engineering as well as in rDND research laboratories conducting advanced research.

MBT 206: PRACTICAL IV GENETICS, MICROBIOLOGY AND INDUSTRIAL BIOTECHNOLOGY

Credits: 3 **Hours: 6/Wk**

Course objectives:

The objective of this laboratory course is to introduce students to experiments in genetics, microbiology and industry. The course is designed to teach students the utility of set of experimental methods and how to handle microbiology experimental problems in industry-oriented manner.

1. Preparation of different media & Sterilization methods.
2. Enumeration of microorganisms in soil & water.
3. Gram staining and streaking methods.
4. Isolation of microbes from spoiled vegetables.
5. Isolation of amylase producing microorganisms.
6. Microbial production of citric acid using *Aspergillus niger*.
7. Isolation of antibiotic resistant microbes.
8. Antibiotic Sensitivity Test by Kirby-Bauer Disk Diffusion method.
9. Wine production (using Yeast).
10. Culturing and selection of Auxotrophs.
11. Isolation of nitrogen fixing bacteria.
12. Isolation of carotenoid producing bacteria.

Course learning outcome:

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 culturesTo demonstrate a clear understanding of wine production.
- To know the different microorganisms and their products (metabolites, enzymes, pigments, etc.) that are used in the biotech industry.
- To show the main microbiological processes those are used in the biotech industry.
- To different uses of the microorganisms in the industry and their products.

EXTRA DEPARTMENTAL SUPPORTIVE COURSE (EDS)
MBTEDA 207: BASIC BIOTECHNOLOGY

Credits : 3

Hours : 3/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 agriculture 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	Unit Title	Intended Learning Chapters		Hours of Instruction
		K1 and K2	K3, K4 and K5	
I	Basic of Biotechnology	Introduction and scope of biotechnology. Prokaryotic and eukaryotic cells.	Mendelian principles of genetics. Sex determination in animals	9
II	Central Dogma of Life	Structure of DNA and RNA. Central dogma: DNA – RNA – Protein	rDNA technology: Applications: Insulin Production	9
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	9
IV	Application of Biotechnology	Applications of Biotechnology in Agriculture-GM crops	Industry: Biofuel and Biopolymer, Bioremediation (oil spills) and its application	9
V	Regulatory Biotechnology	Biodiversity and conservation. Bioethics and biosafety.	Intellectual property right (IPR) – Copyright, Geographical Indication Trademarks and patents	9

Recommended Books

- Becker, W.M. Kleinsmith L.J. and Hardin, J. 2017. The World of Cell. 8th Edn, Pearson Press,USA.
- Smith, J.E. 2012. Biotechnology, 5th Edn. Cambridge University Press,USA.
- Hames D. and Hooper, N. 2011 4^{4t} Edn. Instant notes in Biochemistry, Taylor & Francis, UK.
- Jocelyn E.Krebs ,Elliott S.Goldstein, Stephen T.Kilpatrick,2017, Lewins Bnegamin Genes XII, Jones and Bartlett publishers,Burlington.
- Matin Qaim, 2016, Genetically modifies crops and agricultural development, 1 st edition Macmillan publishers,UK.
- Deepa Goel and Shomini parashar, 2013, IPR, Biosafety and Bioethics, Pearson publishers,India.
- Seema,A.Sambrani, 2017,Plant and Animal Tissue culture,2nd Edition, Vision publications,India.
- Palmiro Poltronieri,Yiguo hong, 2015, Applied Plant Genomics and Biotechnology, 1 st edition,Woodhead publishers,Cambridge.

Web sources

- https://www.pdfdrive.com › biodiversity-books
- www.freebookcentre.net › biology-books-download › Plant-Cell-and-Tiss...

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.

MBT 301: IMMUNOTECHNOLOGY

Credits: 5 **Hours: 5/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. 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	Unit Title	Intended Learning Chapters		Hours of Instruction
		K1 and K2	K3, K4 and K5	
I	Cells and Organs	Innate and acquired. Humoral and cell mediated immunity. Central and peripheral lymphoid organs. Cells of the immune system- lymphocytes, mononuclear phagocytes-dendritic cells, granulocytes, NK cells and mast cells.	Antigens- antigenicity, epitopes, haptens. Immunoglobulins- structure, classification and functions	15
II	Immune Receptors	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.	15
III	Vaccine development	Active and passive immunization. Vaccines- killed, and attenuated. Recombinant vaccines: DNA vaccines, synthetic peptide vaccines.	Production of applications of polyclonal and monoclonal antibodies	15
IV	Transplantation Immunology	Transplantation types: MHC antigens in transplantation. Immunodeficiency disorders: AIDS: The HIV genome and life cycle.	Autoimmunity and hypersensitivity (elementary details only). Cancer immunotherapy	15
V	Immunological Techniques	Immunoelectrophoresis, RIA, Immunoblotting, Immunohistochemistry, immunofluorescence.	ELISA-principle and applications. Flow cytometry	15

Recommended Books

- Goldsbyet al. Kuby Immunology. WH Freeman & Co. 8th Edn. 2018. New York
- Abbas et al. Cellular and Molecular Immunology. Elsevier 9th 2017. India
- Janeway, C. (Ed), Paul Travers. Immunobiology 8th ed. Garland Publ. 2016.
- Coico and Sunshine. Immunology: A short course. 7th ed. Wiley, 2015. UK
- Ivan Lefkovits Benvenuto Pernis. Immunological Methods 1st Edn. Academic press, 2010 Switzerland

- Xian C. Li, M. Jevnikar Anthony Transplant Immunology 1st Edn. Wiley, 2015. USA
- AK Abbas, AHH Lichtman, S Pillai Basic Immunology. 5th Edn. Elsevier, 2015. India
- S.K. Gupta Essentials of Immunology 2nd Edn Arya Publications, 2017. India
- Ashim K. Chakravarty Immunology and Immunotechnology 1st Edn. Oxford University Press, 2006. India
- Gerd Burmester, Antonio Pezzutto Color Atlas Of Immunology 1st Edn 2016. New York
- Frederick W. Alt (ed.) Advances in Immunology, Vol. 105 1st Edn Academic Press, 2010.

Web Sources

- https://www.mdpi.com/2076-393X/4/2/12/pdf
- https://www.historyofvaccines.org/content/articles/passive-immunization
- https://www.ncbi.nlm.nih.gov/books/NBK27129/
- https://nptel.ac.in/content/storage2/courses/102103038/download/modulel
- https://www.medicine.mcgill.ca/physio/vlab/immun/backg.htm

Course learning outcome:

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

- 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.
- Describe the organization of Ig genes, class switching in constant regions of genes and expression and regulation of Ig genes.
- How antigens are processed, presented and immune activation occurs.
- How B-cell and T-cell are activated and differentiate.
- Immune response during allergic reaction.
- Cancer, AIDS and other immunodeficiency diseases.
- Development of vaccines, molecular diagnoses tools.
- This course helpful to the student at his/her project, higher studies and employment in pharmacological industries.

MBT 302: ANIMAL BIOTECHNOLOGY AND DEVELOPMENTAL BIOLOGY

Credits: 5 **Hours: 5/Wk**

Course objectives:

The course is designed to provide students a perspective on recent advances in animal cell culture and various technical applications including cell line and stem cells. The students will get familiarized with the concept of transfer of new genes in animal cells culture methods and to understand the different phases of the embryo development and associated medical implications basic embryo structure and morphological fundamentals will be imparted to the students.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		K1 and K2	K3, K4 and K5	
I	Animal Cell Culture	Animal cell culture: types of media, sterilization, disaggregation of tissue (mechanical and enzymatic), subculture and contamination. Primary and secondary culture.	Cell viability and cytotoxicity. Organ culture: advantages and applications.	15
II	Techniques in Animal Biotechnology	Stem cells: Types -embryonic and adult, isolation, identification, expansion, differentiation and uses.	Methods for producing transgenic animals: Lipofection, sperm-mediated transfer, and microinjections. Transgenic cattle, sheep. Production of recombinant vaccines for foot and mouth diseases.	15
III	Application of Animal Biotechnology	Manipulation of reproduction in animals: Artificial insemination, embryo transfer, *in vitro* fertilization.	Embryo transfer in cattle and applications. Somatic cell cloning: Cloning of Dolly. Somatic cell-Nuclear transfer, embryo splitting, nuclear transplantation.	20
IV	Introduction to Developmental Biology	Types of cell specification and morphogens gradients. Ultrastructure of sperm, egg, pollen and ovule.	Spermatogenesis and Oogenesis. Gametogenesis in plant. Mammalian fertilization: Acrosome reaction and Capacitation. Transcription of Lampbrush Chromosomes.	15
V	Sex Determination and Developmental Symbiosis	Chromosomal and environmental Sex Determination. Metamorphosis in amphibians and insects.	Diapause, developmental symbiosis. Biology of aging.	10

Recommended Books

- Freshney RI. 2016. Culture of animal cells: A manual of basic technique and Specialized Applications. 7th Edn. Wiley- Blackwell.. United States of America.
- Singh, B., Mal, G., Gautam, S.K., Mukesh, M.2019 Advances in animal biotechnology 1st Edn Springer International Publishing. Switzerland
- Sastry K. V, Vinita Shukal (2012) Developmental Biology Rastogi Publication.India

- Primrose Twyman and Old. 2014. Principles of gene manipulation. 8th Edn. Blackwell Sci.United States Of America
- Scott F Gilbert. 2013. Developmental Biology. 10th Edn. Sinauer Associates Inc. United States
- Mohamed Al-Rubeai 2015 Animal Cell Culture Springer International Publishing. Switzerland
- S. M. Bhatt 2011 Animal Cell Culture: Concept and Application Narosa Publishing House. India

Course learning outcome:

The overall goal of this course is for the student to gain a basic working knowledge of 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 basic cell culture, type, subculture media preparation and applications.
- To understand the difference between stem cell types and methods for producing transgenic animals.
- To improve artificial embryo transfer and nuclear transfer methods and applications.
- To learn the various type cell morphology, stages, and fertilization and transformation techniques employed in animal systems.
- To understand and identify the sex determination of various organs.

MBT 303: BIOINFORMATICS, BIOSTATISTICS AND BIOINSTRUMENTATION

Credits: 5 **Hours: 5/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	Unit Title	Intended Learning Chapters		Hours of Instruction
		K1 and K2	K3, K4 and K5	
I	Biological Databases	Biological Databases: primary and secondary. Database similarity search engine – BLAST, FASTA (NCBI, EMBL). Protein Structural Database (PDB).	Multiple sequence alignments: CLUSTAL. Molecular Phylogenetics.	15
II	Biostatistics	Collection, Organization and representation of data.	Measurement of central tendency: standard deviations – parametric and nonparametric hypothesis testing. Student *t* test. Correlation and regression. Chi square test. ANOVA.	15
III	Bioinstrumentation I - Spectroscopy	Beer and Lamberts Law, Principle, instrumentation and applications of UV-visible spectrophotometry and Atomic absorption spectroscopy. Autoradiography. Liquid scintillation counter.	Applications of Radioisotopes in biology.	15
IV	Bioinstrumentation II – Proteomics	Principles and types of centrifugation. Subcellular fractionation. Ultracentrifugation.	Electrophoresis: Principle, technique and applications of Native-PAGE, agarose gel electrophoresis, isoelectric focusing and MALDI-TOF.	15
V	Bioinstrumentation III - Chromatography	Principles and applications of gel filtration and adsorption chromatography. Principle, and applications of thin layer Chromatography.	Ion-exchange, molecular exclusion, and affinity chromatography. HPLC &GC: Types, principle and applications.	15

Recommended Books

- Wilson and Walker. Principles and techniques of Biochemistry and Molecular biology.7th Edn. Cambridge University Press 2012.
- Upadhyay, Upadhyay and Nath. Biophysical Chemistry principles and Techniques. Himalaya Publ. 2016 4thEdn.
- Welham, S. J, Gezan, S. A, Clark, S. J, Mead, A. 2014.Statistical Methods in Biology [electronic

resource] . Design and Analysis of Experiments and Regression Hoboken : CRC Pres.

- Pavan Kumar Agrawal and Rahul Shrivastava. 2017. Bioinformatics Database Resources chapter – 4. DOI: 10.4018/978-1-5225-1871-6.ch004
- Mark F. Vitha. 2018. Spectroscopy: Principles and Instrumentation. Wiley, ISBN: 978-1-119-43660-7.
- Kay Ohlendieck and Stephen E. Harding. 2017. Centrifugation and ultracentrifugation. Basic principles of sedimentation.
- Baraem Ismail and Suzanne Nielsen. 2010. Basic Principles of Chromatography. Food Science Texts Series, DOI 10.1007/978-1-4419-1478-1-27.

Web sources

- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5037948/
- https://www.amboss.com/us/knowledge/Statistical_analysis_of_data
- https://www.nottingham.ac.uk/-sczsteve/Ohlendieck%20and%20Harding%202018.pdf

Course learning outcome:

Upon successfully completing this course the students could be able to

- Explain which type of data is available from the most common public databases like (NCBI, EMBI, UniProt, GenBank, Protein Data Bank, CATH).
- 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.
- 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.
- Understand the use of basic biomedical instrumentation, principles and techniques of preparative analytical centrifugation, include ultra centrifugation, sedimentation analysis and gradient centrifugation.
- Understand the theory and application of Chromatography techniques, Gel filtration, ion exchange, affinity, HPLC and electrophoresis.
- Know the theory and application of UV and visible spectroscopy. Fluorescence spectroscopy, NMR, ESR, AAS, X-ray diffraction, MS, MALDI-TOF, and application radioisotopes in different techniques.

ELECTIVE PAPER

MBTEC 304: ENVIRONMENTAL BIOTECHNOLOGY

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

Course objectives:

Students will understand the various fields of the Environmental biotechnology, i.e. Ecosystems, Biodiversity, Threats and policy. Sources for environmental pollution and its remedial measures, Toxic chemicals and their impact on environment and human health, Role of microbes in remediation of environmental pollutants, applications of bio-products in society.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		K1 and K2	K3, K4 and K5	
I	Ecosystem Diversity	Components, types, structure and function. Biodiversity: Types, values, threats, hotspots, IUCN redlisted flora and fauna and their conservation. Environmental impact assessment (EIA), Environmental Policy and Ethics.	Global warming, greenhouse effect and climate change.	12
II	Air Pollution and its management	Major air pollutions and their sources. Air pollution and disasters. Effects of air pollution on human, plant, animal and environment.	Formation of fog, photochemical smog and acid rain. Monitoring of air pollution. Control on release of particulate matter using different control devices.	12
III	Water Pollution and its management	Major water pollutions and their sources. water pollution and disasters. Effects of water pollution on human, plant, animal and environment.	Treatment methods and controlled release of effluents.	12
IV	Soil pollution and its management	Concepts of soil pollution, soil acidity, saline soil alkaline soil. Causes of soil salinity.	Physical, chemical and biological methods of soil reclamation. Chemical and metallic pollution of agriculture soil.Control of soil pollution.	12
V	Waste Management	Concept of solid waste, Types of solid waste(Industrial, Domestic, Agricultural, Municipal) Effect of solid waste on health and environment.	Waste management strategies for organic, biomedical, plastic and hazardous wastes.	12

Recommended Books

- Sharma. P.D. 2017. Environmental Biology. 13th Edn. Rastogi Publishers.
- Chatterjee A.K. 2011 3th Edn. Introduction to Environmental Biotechnology. Printice- Hall, India.
- Bharat Raj Singh and Onkar Singh. 2012. Study of impacts of global warming on climate change: Rise in Sea level and disaster frequency. DOI: 10.5772/50464.

- Mark Brusseau, Ian Pepper, Charles Gerba. 2019. Environmental and Pollution Science 3rd Edition. Academic Press. USA.
- Philip Wexler. 2014. Encyclopedia of Toxicology 3rd Edition. ISBN: 9780123864543 Academic Press.
- Rodríguez-Eugenio, N., McLaughlin, M. and Pennock, D. 2018. Soil Pollution: a hidden reality. Rome, FAO. 142.
- Vasile Stoleru and Vicenzo Michele Sellitto. 2016. Pest control in organic systems. DOI: 10.5772/644457.

Web sources

- https://openoregon.pressbooks.pub/envirobiology/chapter/10-4-climate-change/
- http://www.ddegjust.ac.in/studymaterial/pgdem/pgdem-03.pdf
- https://niphm.gov.in/Recruitments/ASO-Pathology.pdf

Course learning outcome:

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

- Understanding the various types of ecosystems, biodiversity components, environmental threats and Policy.
- Studying the impact of environmental pollution and its remediation measures.
- Role of Toxic chemicals in the environment and their associated health issues in humans.
- Explaining the role of microbes in remediation of various products, i.e. pesticides, heavy metals, plastics and oil spills.
- Getting sound knowledge for application of several bio-products in the betterment of society.

ELECTIVE PAPER

MBTED 304: FOOD AND MEDICAL BIOTECHNOLOGY

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

Course objectives:

Students will understand the basic and applied aspects of foods, i.e. the types and nutritive value of foods, microbial sources for food contamination, Principle and methods of food preservation, control of food borne microbes, fermented foods, enzymes used in the food industry, genetic and chromosomal disorders and their control.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		K1 and K2	K3, K4 and K5	
I	Biotechnology in Food Industry	Biotechnology in relation to the food industry. Nutritive value of food. Types and sources of microorganisms associated with food. Conditions for microbial growth in food.	Food hazards: bacterial diseases, staphylococcal intoxication, botulism, food poisoning, Salmonellosis, fungal illness, mycotoxins and aflatoxins.	12
II	Food Packaging and Preservation	Principles of food packaging: Methods of food preservation.	Control of microorganisms by retarding growth- low temperature, drying, chemicals. Control of microorganisms: Gas treatments, heat, ionization radiation and ultraviolet radiation.	12
III	Food Processing	Basic principles of food fermentation. Fermented foods- fermented milk - cheese, bread, fermented vegetables. Fermented meats and fish. Production of vinegar. Mushroom farming.	Uses of enzymes in food industry: Proteases in food processing, enzymes used in baking and dairy industry, enzymes in fruit juice and brewing industries.	12
IV	Human Diseases	Genetic diseases: Chromosomal disorders - Down syndrome. Monogenic disorders: Autosomal dominant, autosomal recessive and sex-linked.	Cancer: Growth characteristics of cancer cells and Agents causing cancer.	12
V	Diagnostics and Drug Delivery	Diagnostic kits. Tumor markers: hormones and enzymes. Prenatal and neonatal screening for genetic disorders.	PCR in disease diagnosis. Monoclonal antibodies. Therapeutic agents from non-recombinant and recombinant organisms. Drug delivery and targeting.	12

Recommended Books

- Alina Maria Holban. Alexandru Mihai Grumezescu. 2018. Advances in Biotechnology for Food Industry: Handbook of Food Bioengineering. Volume 14. Academic Press. Cambridge, Massachusetts. USA.
- Dr. Peng Zhou. 2015. Modern food processing Biotechnology. Delve Publishing LLC. Canada.
- Firdos Alam Khan. 2014. Biotechnology in Medical Sciences. CRC press. USA.
- Sharma. P.D. 2017. Ecology and Environmental Biology. 13th Edn. Rastogi Publishers. India.
- Chatterjee A.K. 2011. Introduction to Environmental Biotechnology. 3rd Edn. Printice- Hall, India.
- Bernard R. Glick, Terry L. Delovitch, Chery L. Patten. 2014. Medical Biotechnology. Volume 90. American Society of Microbiology Press and distributed by Taylor and Francis. USA.

- Morris Brown. Pankaj Sharma. Fraz Mir. Peter Bennett. 2018. Clinical Pharmacology. 12th Edition. Elsevier. Netherland.
- Vincent T. Devitha. Theodre S. Lawrence. Steven A. Rosenberg. 2018. Cancer Principles and Practice of Oncology. Wolters Kluwer. Netherland.

Course learning outcome:

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

- Gaining knowledge of the basics of foods, nutritive values and food borne illnesses.
- Studying the importance and methods of food preservation.
- Explaining the various fermented foods and the role of enzymes in food industry.
- To gain the knowledge about the genetic and chromosomal disorders.
- Understanding the overview of HIV infections and cancer.
- Getting the knowledge for the diagnostics and treatment of genetic and chromosomal disorders.

MBT305- PRACTICALS' IN IMMUNOTECHNOLOGY, DEVELOPMENTAL BIOLOGY AND ANIMAL BIOTECHNOLOGY

Credits: 3 **Hours: 6/Wk**

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. The student also learns animal cell culture methods like preparation of culture media, sterilization, and single cell suspension from spleen. Also learn basic knowledge about cryopreservation and thawing. This paper contains methods for identifying the viability of live cells.

1. Blood Typing and analysis: ABO grouping, Rh factor, WBC, TLC, Platelets counts
2. Preparation of antigen, serum and antiserum
3. Antigen- antibody interaction: Flocculation, Precipitation and agglutination reaction.
4. ELISA
5. Preparation of culture media and sterilization
6. Preparation of single cell suspension from spleen
7. Trypsinization of monolayer and sub culturing
8. Cryopreservation and thawing
9. Cell counting and viability
10. Acrosome reaction

Course learning outcome:

Students will be able to

- Describe the different types of blood groups and different types of blood cells and their function in the human body.
- Explain the preparation of antigens and antibody in the blood sample.
- Describe the basic knowledge about antigen and antibody interaction using (ODD, Rocket immune electrophoresis).
- Learn various techniques like Immunoelectrophoresis, ELISA, Immunoprecipitation etc.
- Culture and maintain animal cell cultures, various method of preservation and counting of viable cells.

EXTRA DEPARTMENTAL SUPPORTIVE COURSE (EDS)

MBTEDB 306: HERBAL BIOTECHNOLOGY

Credits: 3 **Hours: 3/Wk**

Course objectives:

The purpose of this course is to provide basic knowledge in the area of basic science, herbal biotechnology, agriculture and human health. This course will be helpful for the students from various science disciplines to explore the application of medicinal values of herbs.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		K1 and K2	K3, K4 and K5	
I	Traditional Medicine Systems	Traditional System of medicine: Ayurveda, Siddha, Unani and Homeopathy.	Conservation(Plant tissue culture) and adulterant identification of medicinal plants by molecular markers.	9
II	Role of Transgenic plants in human welfare	Hepatitis B, Golden Rice, Plant bodies, Edible Vaccines, Hormones Production.	Transgenic plants-Recombinant Protein . Insulin production in yeast.	9
III	Herbal Drug Extraction	Herbal extraction methods: Steps, solvents and equipment.	Types of herbal extract preparations and storage methods. Plant biomolecules in drug industry.	9
IV	Human Diseases I	Parasitic diseases: Malaria and filarial. Metabolites as potential insecticides.	Control of malarial parasite and vector(Cinchona, Artemisia, Vernonia)	9
V	Human Diseases II	Herbs to treat human diseases: Diabetic-Stevia, Gymnema, Momordica, cancer-Allium, Taxus, Vinca.	Hepatitis B(Jaundice)- Phyllanthus, Eclipta,skin-Curcuma, Azdirachta and HIV (Mentha, Garcinia, Salvia)	9

Recommended Books

- Kiritikar K.R. and Basu, B.D. 2011. Indian medicinal plants Vol. VIII, CSIR Publications, New Delhi.
- C.P. Khare.2012. Indian Medicinal plants,I.K. International Publishing house,New Delhi.
- Peter Hotez,Robert W. Gwadz,Daniel O.Griffin, 2019,Parasitic diseases ,7th edition, Parasites without borders,Inc,New York.
- V.K.Gupta, 2016,Traditional and Folk herbal medicine, Recent researchers, Vol-3, 1 st edition, Handcover publisher,India.
- Lee Lerner and Brenda Wilmoth, 2012 5thEdn. Biotechnology: Medicine Vol. I, Thomas-Gale Publications, US.
- Lee Lerner and Brenda Wilmoth, 2007. Biotechnology: Agriculture Vol. II, Thomas- Gale Publications, US.

- Lee Lerner and Brenda Wilmoth, 2007. Biotechnology: Industry Vol. III, Thomas-Gale Publications, US.
- S.S.Agarwal, M.Paridhavi,2012, Herbal Drug Technology,2nd edition, Orient balck swan.India.

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- https://www.ncbi.nlm.nih.gov › pmc › articles › PMC4204075
- https://www.hindawi.com › journals › ecam

Course learning outcome:

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 herbal plants.
- Explain 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.