# Scheme for M.Sc. Biotechnology NEP 2020

## For 2 Year PG programme

## First Year

# Scheme for M.Sc. Biotechnology NEP 2020

## For 2 Year PG programme

## Scheme sem-1: (For the course of science having major practicum components)

### M.Sc. Biotechnology I Semester

| S.No | Course Code | Course Name | Total Mark | Credit (s) | End Semester Exam Marks | | Internal Marks | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Max | Min. | Max | Min. |
| 1. | MBT2-511 | Biochemistry and Analytical Techniques | 100 | 6 | 60 | 24 | 40 | 16 |
| 2. | MBT2-512 | Cell and Molecular Biology | 100 | 6 | 60 | 24 | 40 | 16 |
| 3. | MBT2-513 | Practical - I | 100 | 4 | 60 | 24 | 40 | 16 |
| 4. | MBT2-514 | Practical – II | 100 | 4 | 60 | 24 | 40 | 16 |
| 5. | MBT2-515 | Internship/ Seminar/Field Project | 100 | 2 | - | - | 100 | 40 |
| | | Grand Total | 500 | 22 | | | | |

| BRANCH | Subject | Subject Code |
|---|---|---|
| M.Sc. (Biotechnology) | Biochemistry and Analytical Techniques | MBT2-511 |

## Course Learning Outcomes

To create general understanding about Biochemistry and Analytical Techniques.

1. To provide the insights of the macromolecules involved in the structure and function of a cell.

2. To apply the knowledge of metabolic pathways in production of commercially important products.

3. To apply the knowledge of metabolic pathways to solve physiological and molecular aspects.

4. To enable the students to acquaint with basic principle, instrumentation, procedure, and applications of various classical as well as sophisticated biochemical techniques.

5. To develop competence in various chromatographic and electrophoresis techniques and apply them in isolating and characterizing different biological molecules.

6. To provide information on fundamental laws relating to photochemistry and applications of UV-visible, fluorescence and IR spectrophotometry in analytical determination and characterization of biomolecules.

### Unit-1

Study traditional enzymatic treatments mentioned in texts like Charaka Samhita and correlate them with modern enzymology (e.g., digestion-related enzymes like amylase, lipase). Structure-function relationships in model proteins like ribonuclease A, myoglobin, haemoglobin, chymotrypsin etc.; Enzymology: Physico-chemical characterization & classifications, nomenclature of enzymes, Enzyme kinetics, Mechanism of enzyme catalysis and inhibition

Proteins - classification and separation, purification and criteria of homogeneity, end group analysis, hierarchy in structure, Ramachandran maps, Tools to characterize expressed proteins.

### Unit-2

Nucleic acids-DNA Structure; Replication; Repair & Recombination Structure of DNA-A-B-, Z- and triplex DNA; Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Gene stability and DNA repair- enzymes; Recombination: Homologous and non-homologous; Site specific recombination; Gene targeting; Gene disruption.

## Unit-3

Post Transcriptional Modifications, RNA editing; Nuclear export of mRNA, mRNA stability; Calalytic RNA. RNA splicing: Nuclear splicing Translation & Transport Translation machinery; Ribosomes; Wobble hypothesis: Mechanism of initiation, elongation and termination; Co- and post-translational modifications; Genetic code in mitochondria; Transport of proteins and molecular chaperones.

## Unit-4

Analytical techniques:

Cell disruption techniques: Mechanical and non-mechanical methods of cell disruption; Separation techniques: Centrifugation: basic principle, components, Types: differential velocity, density gradient; difference in g value and RCF; applications of preparative and analytical centrifugation.

Chromatography Techniques: Modes: Column, TLC and Paper chromatography; Principle; components; working and applications of - Adsorption, Gel permeation, Ion exchange, Partition, Affinity chromatography. Electrophoretic techniques: Theory and application of gel electrophoresis.

## Unit-5

Spectroscopy Techniques: Basic principle of light absorption; Jablonski diagram: Principle; components, working and applications of UV-visible spectroscopy, Atomic absorption Spectroscopy.

Microscopy: Basic principle; factors affecting image formation and magnification; components, working, types: light, phase contrast, fluorescence microscopy; Electron microscopy: TEM, SEM.

| BRANCH | Subject | Subject Code |
|---|---|---|
| M.Sc. (Biotechnology) | Cell and Molecular Biology | MBT2-512 |

**Course Learning Outcomes**

1. To have detailed understanding of various processes including cell division, signal transduction pathways and regulation of overall structure and function of the cells.

2. To know about the developmental processes at molecular level in model organisms.

3. To apply the knowledge in knockout and knocking in of the genes and understanding of the polygenic diseases.

4: To enable students to comprehend the structure and function of nucleotides and the basics of genome organization.

5. To provide detailed understanding of the DNA replication, transcription, translation, protein folding and sorting as well as their regulation, respectively.

6. To develop understanding that how errors in the above mentioned processes can cause several problems in living systems and how we can develop some tactics to reverse them.

**Unit-1**

Ayurvedic concepts of Beeja (seed), Beeja-bhaga (chromatin), and Beeja-bhagavayava (gene) in context to molecular biology and cell division. Membrane Structure and Function Structural models; Composition and dynamics; Transport of ions and macromolecules; Pumps, carriers and channels; Endo- and Exocytosis; Membrane carbohydrates and their significance in cellular recognition; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata.

**Unit-2**

Organelles Nucleus - Structure and function of nuclear envelope, lamina and nucleolus; Macromolecular trafficking; Chromatin organization and packaging; Cell cycle and control mechanisms; Mitochondria-structure, organization of respiratory chain complexes, ATP synthase, Structure-function relationship: Mitochondrial DNA and male sterility: Origin and evolution; Chloroplast-Structure-function relationship; Chloroplast DNA and its significance; Chloroplast biogenesis, Origin and evolution.

**Unit-3**

Cell cycle: Molecular events and model systems, Control mechanism; Apoptosis. Cellular basis of differentiation and development - mitosis, gametogenesis and fertilization, development Arabidopsis;

Spatial and temporal regulation of Gene Expression Differentiation of Specialized Cells Stem cell differentiation; Blood cell formation; Fibroblasts and their differentiation; Cellular basis of immunity.

**Unit-4**

Cancer: Biology of cancer; properties and features of cancer cells; oncogenes; tumor suppresser genes; mechanism of cancer; metagenesis; types of cancer Genes, Mutation and Mutagenesis: UV and chemical mutagens; Types of mutation; Ames test for mutagenesis; Methods of genetic analysis.

Differentiation of cancerous cells and role of proto-oncogenes; Phase changes in Salmonella; Mating cell types in yeast; Surface antigen changes in Trypanosomes; Heterocyst differentiation in Anabaena; Sex determination in Drosophila.

**Unit-5**

Stem cells-Introduction Definition and basics of stem cells, Classification of stem cells different types of stem cells human embryonic stem cells. adult stem cells etc. Sources of Stem cells Fetus and various adult tissues. Advantages of stem cells.

| BRANCH | Subject | Subject Code |
|---|---|---|
| M.Sc. (Biotechnology) | **Practical – I (Biochemistry and Analytical Techniques)** | **MBT2-513** |

**Course Learning Outcomes**

The overall course outcome is that the student shall develop deeper understanding of biochemical estimations using different techniques.

The student shall be able to:

1. Learn quantitative analysis test of carbohydrates, amino acids and proteins

2. Understand the working of UV spectrophotometry, Flourimetry, FT-IR and justify its application in drug analysis

3. Classify the chromatographic separation methods and choose appropriate technique for analysis of biomolecules

4. Design methods for performing quantitative & qualitative analysis of biomolecules and drugs using various analytical instruments

## List of Practical

1. To prepare an Acetic-Na Acetate Buffer system and validate the Henderson-Hasselbach equation.

2. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.

3. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC.

4. Urea-SDS PAGE for separation of low molecular weight proteins.

5. Separation of Cell organelles by centrifugation

6. Use of marker enzyme assays for organelles

7. AN ENZYME PURIFICATION THEME (such as E.Coli Alkaline phosphatase or any enzyme of the institutions choice).

(a) Preparation of cell-free lysates

(b) Ammonium Sulfate precipitation

(c) Ion-exchange/Gel/Affinity Chromatography

(d) Generating a Purification Table

(g) Assessing purity by SDS-PAGE Gel Electrophoresis.

8. Demonstration of gel Filtration chromatography

9. Demonstration of Ion exchange chromatography

10. Demonstration of High performance Liquid chromatography (HPLC)

| BRANCH | Subject | Subject Code |
|---|---|---|
| M.Sc. (Biotechnology) | **Practical – II (cell and Molecular Biology)** | **MBT2-514** |

**Course Learning Outcomes**

After finishing this lab work, student will be able to:

1. use standard lab equipment and techniques common in cell and molecular biology, such as microscopy, DNA extraction, PCR, gel electrophoresis

2. to communicate scientific findings effectively, in written form (e.g., lab reports)

3. design and conduct experiments to test hypotheses and address research questions in cell and molecular biology.

4. to critically evaluate scientific literature and research findings.

**List of Practical's**

1. Separation of cell organelles

2. Marker enzyme assay for seeing activity of separated organelle.

3. Isolation of DNA from bacterial cells

4. Isolation of plasmid DNA

5. Agarose gel electrophoresis of DNA.

6. Transfer of DNA from gel-Southern Blotting.

7. Transfer of RNA from gel-Northern Blotting.

8. Bacterial Transformation (Selection of transformants with Blue-white selection)

9. Polymerase Chain Reaction

10. Radiation induced genetic damage assessment (Root meristem of Allium cepa).

11. Chemical induced genetic damage assessment (Root meristem of Allium cepa).

12. Preparation of metaphase chromosomes from blood.

13. G-banding and karyotyping.

14. Restriction digestion of DNA

15. Thermal Denaturation of DNA and UV absorption studies

| BRANCH | Subject | Subject Code |
|---|---|---|
| M.Sc. (Biotechnology) | **Internship/Seminar** | MBT2-515 |

Project /Dissertation work (Six weeks) in the form of small thesis based upon the topic related to the M.Sc. Biotechnology syllabus . The topics of the dissertation with synopsis will be decided by the

Departmental Research Advisory Committee (DRAC).

## M.Sc. Biotechnology II Semester

| S.No | Course Code | Course Name | Total Mark | Credit (s) | End Semester Exam Marks | | Internal Marks | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Max | Min. | Max | Min. |
| 1. | MBT2-521 | Environmental Biotechnology | 100 | 6 | 60 | 24 | 40 | 16 |
| 2. | MBT2-522 | Advanced Plant and Animal Biotechnology | 100 | 6 | 60 | 24 | 40 | 16 |
| 3. | MBT2-523 | Practical - I | 100 | 4 | 60 | 24 | 40 | 16 |
| 4. | MBT2-524 | Practical – II | 100 | 4 | 60 | 24 | 40 | 16 |
| 5. | MBT2-525 | Value-added course (VAC) from /MOOCS, SWAYAM, NPTEL | 100 | 2 | - | - | 100 | 40 |
| | | Grand Total | 500 | 22 | | | | |

| BRANCH | Subject | Subject Code |
|---|---|---|
| M.Sc. (Biotechnology) | Environmental Biotechnology | MBT2-521 |

**Course Learning Outcomes**

After studying this course, the student will be able to:

1: address the issues of environmental changes, pollution and talk about the biotechnological solutions.

2: Be aware of the types and source of pollution.

3: Identify the toxic chemicals and their biochemical aspects in environment, their mode of entry and carcinogenicity.

4: Explain biogeochemical factor in environmental health.

5: Be aware of uses and preparation of biopesticides, biofertilizers, etc.

6: Students will be able to find novel solutions for the climate change and pollution.

**Unit-1**

Concept of Prayavaran in Indian knowledge system.

Environment: Basic concepts and issues Environmental Pollution: types of pollution, Methods for the measurement of pollution; Methodology of environmental management - the problem solving approach, its limitations.

**Unit-2**

Air pollution and its control through Biotechnology. Water Pollution and Its Control: Water as a scarce natural resource, Need for water management, Measurement of water pollution, sources of water pollution, Waste water collection, Waste water treatment -physical, chemical and biological treatment processes.

**Unit-3**

Microbiology of waste water treatment aerobic process, activated slug, oxidation ditches, trickling filters, towers, rotating disc, rotating drums, oxidation pond. Anaerobic processes, anaerobic digestion, anaerobic filters.
Up flow anaerobic sludge blanket reactors. Treatment schemes for waste water of dairy distillatory tannery, sugar , antibiotic industries

**Unit-4**

Microbiology of degradation of Xenobiotics in Environment. Ecological considerations, decay behaviour& degradative plasmids; Hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides.

Bioremediation of contaminated soils and waste land. Biopesticides in integrated pest management.

**Unit-5**

Solid wastes: sources and management (composting, wormi culture and methane production). Global Environmental Problems: Ozone depletion, UV-B, green -house effect and acid rain, their impact and biotechnological approaches for management.

| BRANCH | Subject | Subject Code |
|---|---|---|
| M.Sc. (Biotechnology) | **Advanced Plant and Animal Biotechnology** | **MBT2-522** |

**Course learning outcomes (CLO)**:-

To create advanced understanding about Plant and Animal Biotechnology

1: Acquaint with principles, technical requirement, scientific and commercial applications in plant biotechnology.

2: Support methodologies in plant tissue/cell culture to plant improvement, as well as DNA handling with PCR-based detection diagnostic tools.

3: Become motivated to set goals towards pursuing higher level positions, such as lab manager and key scientist in plant biotechnological research institutes and industries.

4: Students will learn about the concept of new gene transfer in animal cell culture techniques and associated medical implications.

5: Students will have strengthened bio-medical research from basic research to the modern drug discovery.

**Unit-1**

Ancient Indian insights on embryology (Garbha Upanishad) and their philosophical relevance to developmental biology.

Protoplast Culture and Somatic Hybridization, Protoplast isolation; Culture and usage; Somatic hybridization - methods and applications; Cybrids and somatic cell genetics.

Measurement of viability and cytotoxicity. Biology and characterization of the cultured cells, measuring parameters of growth. Basic techniques of mammalian cell culture in vitro; culture, maintenance of cell culture; cell separation. Disaggregation of tissue and primary culture, maintenance of cell culture; cell separation.

**Unit-2**

Genetic Engineering for Plant Architecture and Metabolism, Seed storage proteins; Proteins engineering; Vitamins and other value addition compounds; Source- sink relationships for yield increase; Post-harvest bioengineering; Concept of biofactories; Cell cultures for secondary metabolite production; Production of pharmaceutically important compounds; Bioenergy generation.

**Unit-3**

Plant Genomics, Identification of candidate genes using genetic information (positional cloning), using biochemical and expression analysis(microarray analysis, proteomics, metabolomics); Characterization and functional analysis of candidate genes: transformation, mutant populations, knockout system; Heterologous

expression systems; Protein analysis; Bioinformatics and database; Plantgenetic resources: Patenting of biological material: Plant breeders rights(PBRs) and farmers right; Biosafety and containment practices.

**Unit-4**

Types of stem cells-Totipotent, pluripotent, oligopotent, multipotent, unipotent; Embryonic stem cell culture, Induced pluripotency, Molecular mechanisms of stem cell maintenance, Role of protooncogenes and tumor suppressor genes in maintenance of stem cells and senescence, Models of cancer stem cells development.

**Unit-5**

Application of stem Cells, Overview of embryonic and adult stem cells for therapy Neurodegenerative diseases; Parkinson's, Alzheimer, Spinal Code Injuries and other brain Syndromes; Tissue system Failures; Diabetes; Cardiomyopathy; Kidney failure; Liver failure; Cancer; Hemophilia Etc.

| BRANCH | Subject | Subject Code |
|---|---|---|
| M.Sc. (Biotechnology) | **Practical–I(Environmental Biotechnology)** | **MBT2-523** |

**Course Learning Outcomes**

1: develops students skills in the design, implementation, and interpretation of experiments related to environmental biotechnology application

2: develops student's skills physiochemical quality assessment of waste water for planning monitoring programmes for pollution prevention assessment.

3: demonstrated and quantify the physiological parameters for waste water treatment and discharge.

4: communicated scientific information related to environmental biotechnology in oral and written formats including the repletion of lab reports.

## List of Practical

1. Estimation of Biochemical Oxygen Demand (BOD).
2. Estimation of Chemical Oxygen Demand (COD).
3. Isolation and Characterization of Pollutant-Degrading Microorganisms.
4. Wastewater Treatment Using Activated Sludge or Microbial Consortia.
5. Estimation of Heavy Metals in Soil/Water Samples by AAS or Colorimetry.
6. Biosorption of Heavy Metals Using Microbial or Agricultural Biomass
7. Vermicomposting of Organic Waste
8. Phytoremediation Studies Using Metal-Accumulating Plants
9. Estimation of Chlorine demand in the wastewater sample
10. Estimation of Total suspended solids in wastewater sample
11. Quantitative estimation of nitrates in the wastewater sample
12. Quantitative estimation of phosphates in the wastewater sample

| BRANCH | Subject | Subject Code |
|---|---|---|
| M.Sc. (Biotechnology) | **Practical - II (Advanced Plant and Animal Biotechnology)** | **MBT2-524** |

**Course Learning Outcomes**

1: Students will learn about plant cell culture techniques and secondary metabolites production.

2: Students will learn about trangenesis and molecular markers.

3: Students will learn about animal cell culture techniques.

4: Students will learn about transgenic animal and gene therapy.

## List of Practical

1. Electro elution of insert DNA from Agarose gel slice.
2. Mobilization of recombinant Ti plasmid from common laboratory host (E. coli) to an Agro bacterium tumefactions strain
3. Agro bacterium tumefactions-mediated plant transformation
4. Direct DNA delivery to plant by Particle Bombardment.
5. Isolation of plant genomic DNA by modified CTAB method
6. Molecular analysis of putative transformed plants by Polymerase Chain Reaction
7. Mammalian cell transfection.
8. Bacterial transformation and gene cloning.
9. Staining techniques for toxicity and viability determination.
10. Measurement of cell death.
11. Transwell migration and scratch assays.
12. Cryopreservation and revival of cell lines

## M.Sc. Biotechnology III Semester

| S.No | Course Code | Course Name | Total Mark | Credit (s) | End Semester Exam Marks | | Internal Marks | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Max | Min. | Max | Min. |
| 1. | MBT2-531 | Bioprocess Engineering and Technology | 100 | 6 | 60 | 24 | 40 | 16 |
| 2. | MBT2-532 | Plant and Animal Biotechnology | 100 | 6 | 60 | 24 | 40 | 16 |
| 3. | MBT2-533 | Practical - I | 100 | 4 | 60 | 24 | 40 | 16 |
| 4. | MBT2-534 | Practical – II | 100 | 4 | 60 | 24 | 40 | 16 |
| 5. | MBT2-535 | Internship/Seminar /Field Project | 100 | 2 | - | - | 100 | 40 |
| | | Grand Total | 500 | 22 | | | | |

| BRANCH | Subject | Subject Code |
|---|---|---|
| M.Sc. (Biotechnology) | Bioprocess Engineering and Technology | MBT2-531 |

**Course learning outcomes (CLO):-**

To create general understanding about Industrial Biotechnology and Bioprocess engineering

1. Knowledge of industrial applications of biotechnology and tactics to convert lab scale to industry scale production of commercially important products.

2. To understand the bioprocess engineering, basic techniques, methods, functions and industrial products.

3. To know the different microorganisms and their products (enzymes, polymers, metabolites, etc.) that are used in the biotech industry

**Unit – I**

Explore native microbial cultures used in Ayurveda and traditional medicine.

Basic principle of Biochemical Engineering-Isolation, screening and maintenance of industrially important microbes; Microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); Strain improvement for increased yield and other desirable characteristics.

**Unit - II**

Concepts of basic mode of fermentation processes-Bioreactor designs; Types of fermentation and fermenters; Concepts of basic modes of fermentation Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermentation economics; Fermentation media; Fermenter design mechanically agitated; Pneumatic and hydrodynamic fermenters; Large scale animal and plant cell cultivation and air sterilization; Upstream processing: Media formulation; Sterilization: Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters: Scale up and scale down process.

**Unit – III**

Downstream processing: Bioseparation filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction;

Purification by chromatographic techniques; Reverse osmosis and ultra-filtration; Drying; Crystallization; Storage and packaging: Treatment of effluent and its disposal.

**Unit - IV**

Applications of enzymes in food processing, Mechanism of enzyme function and reactions in process techniques; Enzymic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn

Syrup: Interesterified fat; Hydrolyzed protein etc. and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing, cheese making by proteases and various other enzyme catalytic actions in food processing.

Applications of Microbes in food process operations and production,

Fermented foods and beverages; Food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods.

**Unit - V**

Production, recovery and scaling up of enzymes and their role in food and other industries; Immobilization of enzymes and their industrial applications. Enzyme Technology-production, recovery, stability and

formulation of bacterial and fungal enzymes- amylase, protease, penicillin acylase, glucose isomerase; Cell based biotransformations -steroids, antibiotics, alkaloids, enzyme/cell electrodes.

| BRANCH | Subject | Subject Code |
|---|---|---|
| M.Sc. (Biotechnology) | Plant and Animal Biotechnology | MBT2-532 |

**Course Learning Outcomes:**

1. This course provides understanding of the tools and techniques of biotechnology to develop genetically engineered or genetically modified plants for agronomic purposes.

2. Become familiar with sterile techniques, media preparation, DNA extraction methods, gene isolation and nucleotide sequence analysis.

3. Students will gain a basic working knowledge of concepts and techniques necessary for animal tissue culture.

4. It will give students an overview of the latest developments in animal cell culture and various technical applications including cell line and stem cells.

## Unit - I

Application of micropropagation techniques to conserve endangered medicinal plants mentioned in classical texts (e.g., Ashwagandha, Guduchi).

Plant Tissue Culture: Historical perspective; Totipotency; Organogenesis;

Somatic embryogenesis; Regulation and applications; Artificial seed production; Micropropagation; Somaclonal variation; Androgenesis and its applications in genetics and plant breeding; Germplasm conservation and cryopreservation.

Structure and organization of animal cell, Equipments and materials for animal cell culture technology Primary and established cell line cultures, Introduction to the balanced salt solutions and simple growth medium, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serurm and supplements. Serum & protein free defined media and their application.

## Unit – II

Agrobiology: Agrobacterium-plant interaction; Virulence; Ti and Ri plasmids; Opines and their significance: T-DNA transfer, Disarming the Ti plasmid.

Genetic Transformation, Agrobacterium-mediated gene delivery; Co integrate and binary vectors and their utility; Direct gene transfer-PEG-mediated, electroporation, particle bombardment and alternative methods; Screen able and selectable markers; Characterization of transgenics; Chloroplast transformation; Marker-free methodologies; Gene targeting.

## Unit – III

Molecular Mapping & Marker Assisted Selection (MAS) Quantitative and qualitative traits; MAS for genes of agronomic importance, e.g. insert resistance, grain quality and grain yield; Molecular

polymorphism, RFLP, RAPD, STS AFLP, SNP markers; Construction of genetic and physical map; Gene mapping and cloning; QTL mapping and cloning.

Strategies for Introducing Biotic and Abiotic Stress Resistance/Tolerance, Bacterial resistance; Viral resistance; Fungal resistance; Insects and pathogens resistance; Herbicide resistance; Drought, salinity, thermal stress, flooding and submergence tolerance.

**Unit – IV**

Scaling-up of animal cell culture, Cell synchronization, Cell cloning and micro manipulation, Cell transformation, organ and histotypic cultures, 3-D culture and tissue engineering, transfection of mammalian cells, applications of animal cell culture, cell culture-based vaccines.

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**Unit – V**

Application of animal cell culture; Stem cell cultures, embryonic stem cells and their applications Cell culture, based vaccines, Somatic cell genetics, Organ and histotypic cultures, Measurement of cell death; Apoptosis.

| BRANCH | Subject | Subject Code |
|---|---|---|
| M.Sc. (Biotechnology) | **Practical – I (Bioprocess Engineering and Technology)** | **MBT2-533** |

**Course learning outcomes (CLO):-**

Student will be able to:

1. Student will be able to Understand Fundamentals of Bioprocess Engineering.
2. Master Bioreactor Design and Operation
3. Analyze Bioprocess Kinetics and Mass Transfer
4. Apply Downstream Processing Techniques
5. Become industry ready and competent enough to apply basic concepts in Industry

## List of Practical

1. Determination of oxygen transfer rate and volumetric oxygen mass transfer coefficient (KLa) under variety of operating conditions in shake flask and bioreactor.
2. Determination of mixing time and fluid flow behavior in bioreactor under variety of operating conditions.
3. Rheology of microbial cultures and biopolymers and determination of various rheological constants.
4. Production of microbial products in bioreactors.
5. Studying the kinetics of enzymatic reaction by microorganisms.
6. Production and purification of various enzymes from microbes.
7. Comparative studies of Ethanol production using different substrates.
8. Microbial production and downstream processing of an enzyme, e.g. amylase.
9. Various immobilization techniques of cells/enzymes, use of alginate for cell immobilization.
10. Batch Growth Kinetics of bacteria

| BRANCH | Subject | Subject Code |
|---|---|---|
| M.Sc. (Biotechnology) | **Practical–II (Plant and Animal Biotechnology)** | **MBT2-534** |

**Course Learning Outcomes**: After finishing this lab work, student will be able to:

On successful completion of the course, the students will be able to

1. Learn about plant tissue culture techniques and secondary metabolites production.

2. Learn about transgenesis and molecular markers.

3. Learn about animal tissue culture techniques

4. Learn about transgenic animals and gene therapy.

**List of Practical's**

1. Aseptic culture techniques for establishment and maintenance of cultures
2. Preparation of stock solutions of MS basal medium and plant growth regulator stocks.
3. Micropropagation of Tobacco plant by leaf disc culture.
4. Micropropagation of Rice by indirect organogenesis from embryo
5. Preparation of competent cells of E. coli for harvesting plant transformation vector
6. Transformation of competent cells of E. coli with plant transformation vectors.
7. Small scale plasmid preparation from E. coli.
8. DNA check run by Agarose Electrophoresis
9. Restriction digestion of insert plasmid) and binary vector.
10. Primary cell culture.
11. Preparation of media for animal cell culture.
12. MTT Assay for viability.
13. Apoptosis study by ELISA.
14. Animal tissue culture maintenance of established cell lines.
15. Estimation of cell viability by dye exclusion (Trypan blue).

| BRANCH | Subject | Subject Code |
|---|---|---|
| M.Sc. (Biotechnology) | **Internship/Seminar/Field Project** | MBT2-535 |

Project /Dissertation work (Six weeks) in the form of small thesis based upon the topic related to the M.Sc. Biotechnology syllabus . The topics of the dissertation with synopsis will be decided by the

Departmental Research Advisory Committee (DRAC).

## M.Sc. Biotechnology IV Semester

| S.No | Course Code | Course Name | Total Mark | Credit (s) | End Semester Exam Marks | | Internal Marks | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Max | Min. | Max | Min. |
| 1. | MBT2-541 | IPR, Bioethics and Biosafety | 100 | 6 | 60 | 24 | 40 | 16 |
| 2. | MBT2-542 | Regenerative Biotechnology & Cancer Genetics | 100 | 6 | 60 | 24 | 40 | 16 |
| 3. | MBT2-543 | Practical - I | 100 | 4 | 60 | 24 | 40 | 16 |
| 4. | MBT2-544 | Practical – II | 100 | 4 | 60 | 24 | 40 | 16 |
| 5. | MBT2-545 | Value-added course (VAC) from /MOOCS, SWAYAM | 100 | 2 | - | - | 100 | 40 |
| | | Grand Total | 500 | 22 | | | | |

| BRANCH | Subject | Subject Code |
|---|---|---|
| M.Sc. (Biotechnology) | **IPR, Bioethics and Biosafety** | MBT2-541 |

**Course Learning Outcomes**

On completion of course, student will able to:

1. Define biosafety, bioethics and intellectual property rights.
2. Discuss the different regulations pertaining to biosafety.
3. Categorize the various forms of IPR.
4. Compile different attributes of intellectual property rights and their implications in biological research and product development
5. Appraise the importance of bioethics in biotechnology.
6. Defend and modify ethical aspects related to biological, biomedical, health care and biotechnology research..

**Unit-1**

Introduction to Intellectual Property

IKS: Ethics as a common practice in every aspects of life in ancient India.

Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP, IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of WIPO and TRIPS.

**Unit-2**

Concept of 'prior art': invention in context of "prior art"; patent databases country-wise patent searches (USPTO, EPO, India); analysis and report formation
Basics of Patents
Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; patent Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Country Patent
Office: Procedure for filing a PCT application

**Unit-3**

Patent filing and Infringement Implications; Role of a Patent application-forms and guidelines, fee structure, time frames; Types of patent applications: and complete specifications; PCT and convention patent applications; International provisional patenting-requirement, procedures and costs; Financial

assistance for patenting-introduction to patents-gazette of India, status in Europe and US existing schemes; Publication of Patenting by research students, lecturers and scientists-university/organizational rules in India and sharing by workers, financial incentives Patent infringement- meaning, scope, litigation, abroad, credit case studies and examples.

**Unit-4**

**Biosafety**

Introduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines -Government of India; Definition of GMOs & LMOS; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

**Unit-5**

**Bioethics**

Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research -cloning and stem cell research, Human and animal experimentation, animal rights/welfare,

Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity - biopiracy.

| BRANCH | Subject | Subject Code |
|---|---|---|
| M.Sc. (Biotechnology) | **Regenerative Biotechnology & Cancer Genetics** | MBT2-542 |

**Course Learning Outcomes**

1. To familiarize the students with stem cell technology and its applications for betterment of the society.
2. Student will have a broad view of mammalian stem cells, reviewing where they are found in the body, the different types and how they are cultured.
3. Student will know about the basic biology of these stem cells as well as bioengineering and application of these stem cells to poential treatments of human diseases.
4. To advance knowledge about organism develops from a single cell and how healthy cells replace damaged cells in adult organisms.

**Unit-1**

**EMBRYONIC AND ADULT STEM CELLS**

IKS: Discussion on the examples of regenerative medicine and tissue engineering during ancient India in mythological literature.

Stem cell differentiation; stem cells cryopreservation. Somatic stem cells, Test for identification of adult stem cells, Adult stem cell differentiation -Trans differentiation -Plasticity - Different types adult stem cells-Isolation of haemopoietic stem cell, Muscle and Cardiac stem cell and their applications.

**Unit-2**

**ADVANCEMENT OF STEM CELL IN TISSUE ENGIEERING**

Tissue engineering triad, ECM components and their role in tissue development, Tissue engineering application - Production of complete organ - Kidney Eyes Heart - Brain.

**Unit-3**

Gene therapy - genetically engineered stem cells - stem cells and Animal cloning - transgenic animals and stem cells - Therapeutic applications Parkinson's disease - Neurological disorder limb amputation - heart disease spinal cord injuries diabetes-burns - HLA typing- Alzheimer's
disease.

**Unit-4**

**CANCER GENETICS**

Cell Transformation and tumorigenesis:

Oncogenes; Tumour Suppressor genes; DNA repair genes and genetic instability; Epigenetic modifications, telomerase activity, centrosome malfunction; Genetic heterogeneity and clonal evolution, Familial Cancers: Retinoblastoma, Wilm's Tumour, Li-Fraumeni syndrome, colorectal cancer, breast cancer, Genetic sporadic cancer

**Unit-5**

**Tumour progression:**

Angiogenesis and metastasis; Tumour specific markers
Cancer and environment: physical, chemical and biological carcinogenesis; Cancer risk assessment, gene therapy and counselling

| BRANCH | Subject | Subject Code |
|---|---|---|
| M.Sc. (Biotechnology) | **Practical-I** (IPR, Biosafety and Bioethics) | MBT2-543 |

**Course learning outcomes (CLO)**:-

The overall course outcome is that the student shall develop deeper understanding of IPR, Biosafety and Bioethics

## List Of Practical

1. Learning about Patent application processes

2. Risk assessment of genetically modified organisms (GMOs), and ethical considerations in research involving humans and animals.

3. Specific examples include analyzing case studies on biopiracy, practicing good laboratory biosafety practices, and evaluating the ethical implications of gene therapy.

| BRANCH | Subject | Subject Code |
|---|---|---|
| M.Sc. (Biotechnology) | **Practical-II** (Regenerative Biotechnology & Cancer Genetics) | MBT2-544 |

**Course Learning Outcomes:** .

1. Understanding the differences between germ cell types
2. Understanding the transcriptional networks and epigenetic factors that reflect pluriprotency
3. Status and cellular reprogramming

**List of Practical**

1. MTT Assay for cell proliferation/cytotoxicity

2. Cell culture techniques, passaging and maintenance of human cancer cell line

3. preparation and counting of cells

4. Cryopreservation: Freezing & thawing of human cancer cell line

5. Genomic DNA isolation from cancer cell line

6. Bioinformatics tools for the above techniques: DNA databases

7. Sequence Analysis: Pairwise sequence alignment, Multiple sequence alignment, BLAST tools