

# Syllabus for MSc. in Molecular Biology and Biotechnology (MBBT)

**SEMESTER III**  
**PAPER CODE: MBB901C**  
**PLANT AND ANIMAL BIOTECHNOLOGY**  
**CREDITS: 3+0+1**

## **Unit 1: Organization of Genome**

Introduction to genome organization in prokaryote and eukaryote; Chloroplast Genome and mitochondrial genomes; Endosymbiont theory of chloroplast evolution; plastid encoded and nuclear-encoded proteins in chloroplast; coding capacity of mitochondrial genome; RNA editing.

**4 Hours**

## **Unit 2: DNA marker technology in plants**

Role of DNA markers with special emphasis on RFLPs, RAPD markers, STS, EST, microsatellites, SNP (single nucleotide polymorphism), SCAR (sequence characterized amplified regions), SSCP( single strand conformational polymorphism), AFLP; map based cloning.

**4 Hours**

## **Unit 3: Plant Cell and Tissue Culture**

Tissue culture media; Callus and suspension culture; Somaclonal variation; Micropropagation; Organogenesis; Somatic embryogenesis; transfer and establishment of whole plants in soil; Embryo culture and embryo rescue; Protoplast fusion and somatic hybridization, production of haploid plants.

**4 Hours**

## **Unit 4: Techniques and Vectors for Plant Transformation**

Agrobacterium mediated gene transfer-Agrobacterium and crown gall disease, Ti plasmids, Organization of T-DNA and vir region, T-DNA transfer mechanism; Ri plasmids; Direct gene transfer methods; Chloroplast transformation, Basic features of a plant transformation vector-promoters and terminators, selectable markers, reporter genes, Binary vectors and co-integrative vectors.

**7 Hours**

## **Unit 5: Plant Transformation and Genetic manipulation**

Genetic manipulation of herbicide resistance; pest resistance; Plant disease resistance- natural disease resistance; chitinase, 1,3-beta glucanase, ribosome-inactivating protein (RIP), antimicrobial proteins; Viral resistance; Antisense RNA approaches; strategies for engineering stress tolerance, Phenylalanine and Shikimate pathway, molecular pharming.

**7 Hours**

## **Unit 6: Animal cell and Tissue Culture**

Laboratory facilities for Animal cell and tissue culture; Substrate for cell culture; Culture Media; 3D culture; Organ culture: Embryo culture and tissue engineering.

**5 Hours**

## **Unit 7: Primary Culture and Establishment of Cell Lines:**

Primary culture-Isolation of tissue, Tissue disaggregation methods and selection of viable cells, Establishment of cell lines, Immortalization of cell lines and maintenance, Characterization of cell lines; Application of animal cell culture-vaccine production, interferons, recombinant proteins.

**5 Hours**

## **Unit 8: *In vitro* fertilization and embryo transfer:**

Media for IVF; Steps in IVF; Different techniques of micromanipulation to assist fertilization; Stem cells; embryonic stem cell and their applications; Ethical issues in animal biotechnology.

**4 Hours**

### **Unit 9: Expression of Recombinant DNA in Animal Cells:**

Cell lines; Gene transfer techniques; Gene construct, selectable markers; transient expression of cloned genes; Virus based vector for gene cloning-Adenovirus, adeno-associated virus, retrovirus, Herpes virus, Vaccinia virus, and Baculovirus; Expression of therapeutic proteins in yeast, Transgenic animals, knockout mice; Gene therapy-Somatic and germline, gene replacement, in vivo and ex vivo gene delivery, retrovirus gene transfer system, gene correction, replacement/augmentation, editing, regulation and silencing.

**8 Hours**

#### **Practical**

1. Plant tissue culture media and hormone stock preparation.
2. Sterilization, callus induction, organogenesis
3. *Agrobacterium* mediated transformation of plant tissues and verification by PCR.
4. GUS histochemical staining.
5. Basic animal cell culture techniques (Demonstration).

#### **Suggested Readings**

##### **Plant Biotechnology:**

1. Slater, A. N. S. and Fowler M. Plant Biotechnology: The genetic manipulation of plants, Oxford University Press, Oxford, 2008.
2. Grierson, C. and Covey S. N. Plant Molecular Biology, Springer Netherlands, 1991.
3. Hammond, J. H., P. Mcgarvey and V. Yusibov, Plant Biotechnology, Springer Verlag, Heidelberg, 2000.
4. Buchanan, B. B., W. Gruissen and Jones R. L. Biochemistry and Molecular Biology of Plants. American Society of Plant Biologist, Rockville, USA, 2000.
5. Das, H. K. Text Book of Biotechnology. Wiley India Pvt Ltd., New Delhi, 2004.
6. Razdan, M.K. Plant Tissue Culture, Oxford and IBH Pub. Co. Pvt. Ltd.

##### **Animal Biotechnology:**

1. Spier. R. E and Griffiths .J. B., Animal cell biotechnology. Academic Press, 1994.
2. Freshney R. Ian, Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 6th Ed, Wiley-Blackwell, 2010.
3. Puhler. A, Genetic Engineering of Animals, Vch Publisher, 1993.
4. Martin. C., Animal cell culture Techniques, Springer, 1998.

**SEMESTER III**  
**PAPER CODE: MBB902C**  
**BIOPHYSICS AND INSTRUMENTATION**  
**CREDITS: 3+0+1**

#### **Unit 1: Introduction to Biophysics**

Level of molecular organization, Structure of proteins, nucleic acid, protein-protein and protein-nucleic acid interaction; Role of protein and Lipids in biological membrane.

**6 Hours**

#### **Unit 2: Chromatography and electrophoretic techniques**

Chromatography Techniques: TLC, Gel Filtration Chromatography, Ion exchange chromatography, Affinity Chromatography, GLC, HPLC, ion exchange chromatography, molecular exclusion chromatography.

Electrophoretic techniques: PAGE, SDS PAGE, Agarose gel electrophoresis, capillary electrophoresis, Isoelectric Focusing, Pulse field gel electrophoresis.

**9 Hours**

**Unit 3:Centrifugation**

Basic principles and theory, types of centrifuge: Preparative and Analytical Centrifuges, Density gradient centrifugation and Ultracentrifugation.

**8 Hours**

**Unit 4:Microscopy**

Introduction to microscopy-light and Dark Interference microscopy-differential and fluorescence interference contrast microscopy, Principle, instrumentation and application of Fluorescence microscopy, Scanning and Transmission Electron microscopy, Atomic force Microscopy, Confocal Microscopy, Cytophotometry and Flow cytometry.

**9 Hours**

**Unit 5:Spectroscopy Techniques**

UV, NMR, ESR, LASER Raman Spectroscopy, MALDI-TOF Mass Spectrometry, Fluorescence Spectroscopy, X Ray spectroscopy, Circular dichroism spectroscopy.

**8 Hours**

**Unit 6:Radioactivity**

Radioactive decay, units of radioactivity, Geiger Muller counter, Scintillation counter, Autoradiography, Application of radio isotopes, X-ray crystallography.

**8 Hours**

**Practical**

1. GC-MS for compound identification.
2. Spectrophotometric analysis of biomolecules.

**Suggested Readings**

1. Upadhyay. A, Upadhyay. K and Nath. N, Biophysical chemistry. Himalayan Publishing House, Bombay, 1993.
2. Palanivelu. P. Analytical Biochemistry and Separation Techniques. 3<sup>rd</sup> Ed, 21<sup>st</sup> Century Publication, Palkalai Nagar, Madurai, 2004.
3. Wilson. K and Walker. J, Principles and techniques of Biochemistry and Molecular Biology. 7<sup>th</sup> Ed, Cambridge University Press, 2010.
4. Rickwood. D and Hames. BD, Gel Electrophoresis of Nucleic acids-A Practical Approach. 2<sup>nd</sup> Ed, Oxford University Press, 1990.
5. Veerakumari.L Bioinstrumentation, 1st Edition, MJP Publishers, 2015.

**SEMESTER III**  
**PAPER CODE: MBB903C**  
**INDUSTRIAL BIOTECHNOLOGY**  
**CREDITS: 3+0+1**

**Unit 1:Introduction to Industrial Microbiology**

Isolation, screening and preservation of industrially important microorganisms; Development of inocula for industrial fermentations; aseptic inoculation of the fermentor; Strain improvement and selection.

**7 Hours**

**Unit 2: Media formulation and Bioreactors**

Microbial substrates and Media formulation;Types of Bioreactor: continuous stirred tank flow reactors, loop reactors, air lift reactors, fed batch reactors, fluidized bed reactors, Rotatory Disc reactor.

**9Hours**

### **Unit 3: Bioprocess technology**

Types of fermentation process: Batch process, continuous process, recycled and non-recycled processes, liquid and solid state fermentations. Bioreactor operation; Sterilization; Aeration and agitation; Sensors; Instrumentation; Concept of control, basic control theory, turbidostatic and chemostatic control.

**10 Hours**

### **Unit 4: 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.

**10 Hours**

### **Unit 5: Biotechnology in generation of Industrial products**

Primary metabolites - amino acid; secondary metabolite- antibiotics production, Bioremediation , waste water treatment, Microbes as source of industrially important enzymes, immobilized enzymes and their applications. Microbial polysaccharides and polyester, microbial insecticides. Single cell protein, Fermented foods and beverages, fermentation as a method of preparing and preserving foods.

**12 Hours**

### **Practical**

1. Isolation and screening of industrially important microorganisms from natural environments.
2. Microbial production and downstream processing of an enzyme: *Amylase*.
3. Technique of enzyme immobilization- use of alginate for cell immobilisation.

### **Suggested Readings**

1. Glazer. A.N and Nikaido B. H, Microbial Biotechnology, Fundamentals of Applied Microbiology. 2<sup>nd</sup> Ed, Cambridge University Press, 2007.
2. Glick.B.J and Pasternak J. J, Molecular Biotechnology: Principles and Applications of Recombinant DNA. 4<sup>th</sup>Ed , AMS Press, 2010.
3. Rittmann. B and Perry McCarty, Environmental Biotechnology: Principles and Applications. McGraw Hill, 2000.
4. Casida. L.E, Industrial Microbiology, 1st Edition, Wiley Eastern Limited, 1991.
5. Stanbury. P.F, Whittaker. A and Hall SJ, Principles of Fermentation Technology. 2<sup>nd</sup> Ed, Pergamon Press, Oxford, 1995.
6. Patel. A. H, Industrial Microbiology. 1st Ed, Macmillan India Limited, 1996.
7. Stanbury, P.F Allan Whitaker and Stephen J Hall, Principles of Fermentation Technology, 3rd Edition, 2015.

## **SEMESTER III**

### **PAPER CODE: MBB904SP1**

### **SPL 1: BIOMEDICAL GENETICS AND PERSONALIZED MEDICINE**

**CREDITS: 3+1+1**

### **Unit 1: Human cytogenetics**

Chromosome number and morphology, banding techniques, karyotype, idiogram, sex chromatin, normal variable chromosome features, numerical chromosome abnormalities, structural chromosome rearrangements, Turner females, Klinefelter syndrome, Down's syndrome and Philadelphia chromosome.

**5 Hours**

### **Unit 2: Organization of the Human Genome**

General features: Gene density, CpG islands, RNA-encoding genes. Gene clusters, Pseudogenes.

Types of repetitive DNA: LINES, SINES. Genetic markers and their applications.

**4 Hours**

**Unit 3: Biochemical genetics**

Inborn errors in metabolism; galactosemia, glycogen storage disease, lysosomal storage disorders, peroxisomal disorders, phenylketonuria.

**6 Hours**

**Unit 4: Human molecular genetics and associated disorders**

Molecular basis of genetic diseases: single gene disorders-cystic fibrosis, huntington's disease, Duchenne muscular dystrophy, hemophilia, thalassemia

Genetics of human infertility: the mutations in genes expressed in hypothalamus, pituitary, gonadal and outflow tract.

Cancer genetics: oncogenes, viral oncogenes, activation of proto-oncogenes by mutation, activation of proto-oncogenes by insertions, tumor suppressor genes, regulation of gene expression by oncoproteins, signal transduction by oncoproteins, gene-environment interaction, hereditary cancers.

**9 Hours**

**Unit 5: Genetic inheritance**

Single gene inheritance, multifactorial inheritance, chromosome abnormalities, mitochondrial inheritance.

**3 Hours**

**Unit 6: Genetic screening**

Identification of genetic disorders, biochemical markers associated with cystic fibrosis and beta thalassemia, prenatal diagnosis, and preimplantation genetic diagnosis.

**3 Hours**

**Unit 7: Gene therapy**

Concept, Somatic and germline gene therapy, gene therapy in adenine deaminase deficiency, cystic fibrosis and cancer, vectors used in gene therapy.

**4 Hours**

**Unit 8: Molecular epidemiology**

Concept of genetic epidemiology, genetic association study, disease susceptibility genes, gene – environment interactions.

**2 Hours**

**Unit 9: Basic aspects of personalized medicine**

Molecular diagnostics in personalized medicine, role of biomarkers in personalized medicine, basic concept of pharmacogenetics, pharmacogenomics, pharmacoproteomics, development of personalized medicine.

**4 Hours**

**Unit 10: Personalized biological therapies**

Personalized therapy of cancer; personalized management of infectious disease, neurological disorders, psychiatric disorders, cardiovascular disorders, pulmonary disorders, genetic disorders, immune disorders.

**6 Hours**

**Unit 11: Ethical and economic aspects**

Ethical aspects of personalized medicine; regulatory aspects, economics and future of personalized medicine.

**2 Hours**

**Practical**

1. Collection and processing of biomedical samples with ethical clearance; buccal swab and blood.
2. Analysis of idiogram and detection of chromosome anomaly.
3. DNA extraction from human blood and quantification of DNA.
4. Assessment of biochemical parameter using biomarker.
5. Detection of Single nucleotide polymorphism by PCR-RFLP.

### **Suggested Readings**

1. Jorde. L. B., Carey, J. C., White R. L., Medical Genetics, Mosby Press, 2002.
2. Scriver *et al.*, The metabolic and molecular basis of inherited disease. 8<sup>th</sup> Ed, McGraw-Hill, 2002
3. Strachan. T and Andrew, P, Human Molecular Genetics. John Wiley-New York, 2001.

**SEMESTER III**  
**PAPER: OPE 1**  
**PAPER CODE: MBBB905OE1**  
**ENVIRONMENTAL BIOTECHNOLOGY**  
**CREDITS: 3+1+0**

#### **Unit 1: Introduction**

Definition, scope and importance of environmental studies; Concept of ecosystem, structure and function; Ecosystem management; Renewable and non-renewable resources; Conservation of renewable resources.

**8 Hours**

#### **Unit 2: Environmental monitoring and sample analysis**

Sampling of air and water pollutants; Monitoring techniques and methodology, pH, Dissolved Oxygen (DO); Chemical oxygen demand (COD); Biological Oxygen Demand (BOD); Speculation of metals, Pesticide residue.

**10 Hours**

#### **Unit 3: Bioremediation and environmental management**

Types of bioremediation; Biodegradation of hydrocarbons; green technology; Bio-plastic; Bio-composting; Bio-fertilizers; Phytoremediation; genetically modified organisms in bioremediation; Bioremediation of soil and ground water; Industrial waste water treatment.

**10 Hours**

#### **Unit 4: Biotechnology, health and society**

Recombinant therapeutic products in human healthcare; Genetically modified organisms; Gene and Environment; Metagenomics; Remote sensing and GIS in ecological mapping and environmental hazard prediction; Bioindicators and biosensors for food, environmental monitoring and healthcare; Environmental impact assessment (EIA).

**10 Hours**

#### **Unit 5: Biotechnology for management of resources**

Need for management of resources; Role of environmental biotechnology in management of resources; Reclamation of wasteland; Biogas and biofuel production; Development of environmentally friendly processes such as integrated waste management. Microorganism in mineral recovery, Microbes and Nutrient cycles.

**10 Hours**

#### **Suggested Readings:**

1. Evans.G. M., Judith.C and Furlong, Environmental Biotechnology: Theory and Application. 1<sup>st</sup> Ed., Wiley, 2000.
2. Bhattacharyya. B. C and Banerjee. R, Environmental Biotechnology. Oxford University Press., 2007.
3. Abbasi.S. A and Ramaswami. E, Biotechnological Methods of Pollution Control, 1<sup>st</sup> Ed. Universities Press, 1999.
4. Allsopp. D, Seal. K. J. and Gaylard.CC, Introduction to Biodeterioration .1<sup>st</sup> Ed, Cambridge Univ.Press, U. K, 2004.
5. Wainwright. M, An Introduction to Environmental Biotechnology. 1<sup>st</sup> Ed. Kluwer Academic Publishers, Springer, 1999.

6. Sharma, B.K., Environmental Chemistry, 6<sup>th</sup> Revised and Enlarged Ed, Goel Publishing House, 2001.
7. Alexander, M . Biodegradation and Bioremediation, 2nd edition, Academic Press, 1999.