

Semester I

MBT- 747: Macromolecules and Basic Enzymology (M.Sc.; Paper-I)

M. M. 70

Unit I

Properties of water, pH, Henderson Hasselbalch equation, buffer, physiological buffer & its significance; Carbohydrates: Classification, structure, function and properties, Glycoconjugates: glycolipids, glycoproteins, proteoglycans, Glycosaminoglycans.

Unit II

Lipids: Classification, structure, function and properties, Sterols, Lipoproteins, Vitamins (fat soluble and water soluble), structure, properties, deficiency diseases.

Unit III

Nucleic Acids: types, structure, properties, Porphyrins, DNA sequencing, DNA polymorphism, Supramolecular assemblies: molecular assemblies like membranes, ribosomes, extracellular matrix, organization of macromolecular complexes-chromatin and ribosomes.

Unit IV

Proteins: Classification, hierarchy in structure: Primary, secondary, tertiary and quaternary structure, Ramachandran map, Protein folding: Biophysical and cellular aspects. Protein-protein and protein-ligand interactions and physical and chemical methods for their study. Sequencing of proteins, Protein denaturation.

Unit V

Introduction and Classification of enzymes: Kinetics and thermodynamic analysis, concept of Activation energy, Michaelis-Menten and Lineweaver Burk graphs for single substrate enzyme catalyzed reaction, unit of enzyme activity, Isozymes. Catalytic antibodies and functional proteins: Structure and drug targets (enzymes and receptors).

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**MBT- 748: Molecular Cell Biology
(M.Sc.; Paper-II)**

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Unit I

General structure of Cell, Historical origins of cell biology: The discovery of cell, development of the cell theory, the molecular evolution, Intercellular communication- Gap junctions, tight junction and Desmosomes.

Unit II

Structure of prokaryotic and eukaryotic cells: Isolation and growth of cells, Cellular organelles: Plasma membrane, cell wall, cytoskeleton, their structural organization, mitochondria, chloroplast, nucleus and other organelles and their organization, genetic constitution of mitochondria and chloroplast, lysosome, membrane models.

Unit III

Membrane transport: passive and facilitated diffusion, active transport, symport, antiport, transport of nutrients, ion and macromolecules across membranes, liposomes, molecular biology of some important pathogen of AIDS, malaria, hepatitis, tuberculosis, filaria, kalazar.

Unit-IV

Cell cycle: Molecular events and regulation in model systems, Genes for social control of cell, Cellular responses to environmental signals in bacteria, plants and animals: Mechanism of signal transduction, Exocrine, Endocrine, Paracrine and Synaptic strategies of chemical signaling, surface receptor mediated transduction (DAG, Ca^{+2} , c-AMP, G-Proteins), intracellular protein traffic, secretory and endocytic pathway.

Unit-V

Cellular basis of differentiation and development: Cell division, gametogenesis and fertilization, differential gene activity and cell differentiation, morphogenetic determinants in egg cytoplasm and programmed cell death- apoptosis, Heterocyclic compounds and secondary metabolites in living system: Nucleotides, pigments, isoprenoids

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MBT- 749: Microbial Physiology and Genetics
(M.Sc.; Paper-III)

M. M. 70

Unit I

History, development and scope of microbiology, Structure and function of prokaryotic cells, classification of bacteria: modern approaches of bacterial taxonomy (Numerical Taxonomy, 16S rRNA analysis), prokaryotic diversity, Bacteria: General properties, structure and classification, Viruses: General properties, structure and classification of viruses based on their genomes, bacterial viruses (phage Lambda), plant viruses (CaMV), animal viruses (Hepatitis A and B, retroviruses), viroids and prions.

Unit II

Methods in Microbiology: Theory and practice of sterilization, pure culture techniques, principles of microbial nutrition, construction of culture media, enrichment of culture techniques, isolation and culture of aerobic and anaerobic bacteria. Microbial growth: growth curve, measurement of growth and growth yields, synchronous growth, continuous culture, growth affected by environmental factors, culture collection, preservation and maintenance of cultures, Antibiotics and Chemotherapy: Antimicrobial agents, sulfa drugs, Penicillins and Cephalosporins, broad-spectrum antibiotics, antibiotics from prokaryotes, antifungal antibiotics, mode of action of antibiotics, resistance to antibiotics.

Unit III

Microbial diseases: Disease reservoirs, epidemiological terminologies, infectious disease transmission, respiratory infections caused by bacteria and viruses, tuberculosis, sexually transmitted diseases, diseases transmitted by animals (rabies, plague), insects and ticks (rickettosias, chlamydia and lyme diseases), food and water borne diseases, pathogenic fungi, Host-parasite relationships, normal microflora of skin, oral cavity, gastrointestinal tract, Entry of pathogens into the host: colonization and factors predisposing to infections. Types of toxins: Exotoxins, endotoxins, enterotoxins, their structure and mode of action, virulence and pathogenesis.

Unit IV

Overview of basic metabolism. Metabolic diversity among microorganisms. Photosynthesis in microorganisms: Role of chlorophylls, carotenoids and phycobilins, Calvin cycle. Chemolithotrophy, hydrogen-iron-nitrite-oxidizing bacteria, nitrate and sulphate reduction, methanogenesis and acetogenesis. Fermentation: Diversity, syntrophy and role of anoxic decompositions, nitrogen metabolism, nitrogen fixation, hydrocarbon transformation.

Unit V

Bacterial genetic system, recombination transformation, conjugation, transduction, plasmids and transposons, bacterial genetic map with reference to *E. coli*. Viruses and their genetic system, Phage I and its life cycle, RNA phages, RNA viruses, retroviruses, Genetic Systems of yeast and Neurospora, extra-chromosomal inheritance.

M.Sc. Biotechnology Course Programme (Effective from session 2018-19)

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MBT- 750: Bioanalytical Tools and Techniques
(M.Sc.; Paper-IV)

M. M. 70

Unit-I

Chromatography techniques: Paper chromatography, thin layer chromatography, column chromatography, gel filtration, ion exchange chromatography, affinity chromatography, gas chromatography and HPLC, Centrifugation: Concept of centrifugation, sedimentation coefficient, differential and density gradient centrifugation.

Unit-II

Spectroscopic Techniques: Theory and Application of UV and Visible Spectroscopy, Fluorescence Spectroscopy, Mass Spectroscopy, NMR, X-ray Spectroscopy, ORD and Circular dichorism, LASER.

Unit-III

Electrophoresis: Agarose gel electrophoresis, SDS polyacrylamide electrophoresis, Isoelectric focusing, pulse field gel electrophoresis, two-dimensional electrophoresis, Radioisotope Techniques, Autoradiography.

Unit-IV

Microscopic techniques for studying cell structure: Principles and applications of light, phase contrast, fluorescence, scanning and transmission electron microscopy, electron cryomicroscopy, scanning tunneling microscopy, cytophotometry and flow cytometry.

Unit-V

Statistical analysis of biochemical data: mean, median, mode, Standard deviation, variance, ANOVA, test of significance, Chi-square test, student's T-test. Introduction to commercial computers: internet application, softwares and databases and their uses in biological studies.

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MBT- 751: Biotechnology Lab course - I
(M.Sc.)

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1. Extraction and estimation of casein protein from milk
2. To titrate a strong acid (HCl) with standard NaOH by potentiometry
3. Experiment on amino acids and proteins
 - i. To perform Sodium Nitroprusside test with amino acids
 - ii. To perform Xanthoproteic test with amino acids and proteins
 - iii. To perform Millons and Nasse test with amino acids and proteins
 - iv. To perform ninhydrin test with amino acids and proteins
 - v. To perform Sakaguchi test with amino acids and proteins
4. Experiment on Carbohydrates
 - i. To perform Benedict's test with various carbohydrates
 - ii. To perform Bial's test with pentoses
 - iii. To perform Selivanoff's test with pentoses
 - iv. To perform Barfoed's test with mono and disaccharides
 - v. To perform iodine test on polysaccharides and to observe the effect of temperature, acid and alkali on the colour produced
 - vi. To perform Molosch's test with different carbohydrates
 - vii. To perform Fehling's test with different carbohydrates
5. Experiment on Lipids
 - i. To perform acrolein test for fat detection
 - ii. To perform Baudoin test with lipids
 - iii. To determine saponification value of oils
 - iv. To determine Acid number of oils
 - v. To determine Iodine value of oils
6. To plot a curve for estimation of glucose by phenol sulphuric acid and Nelson and Somogyi method
7. To separate amino acids by TLC using silica gel 'G' for identification and calculation of their respective R_f values
8. To determine blood group and Rh factor in a given sample of blood
9. To determine RBC and WBC count in a double oxalated blood sample
10. To extract nucleic acids from the given plant tissues
11. To estimate and quantify DNA and RNA in the given plant tissue by diphenylamine method and orcinol method respectively
12. To plot a curve for estimation of BSA by Biuret method and Folin-Lowry method

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MBT- 752: Biotechnology Lab course - II
(M.Sc.)

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1. To prepare suitable liquid media for the routine cultivation of bacterial culture
2. To prepare suitable solid media for the routine cultivation of bacterial culture
3. Isolation and maintenance of microorganisms from soil by the serial dilution-agar plating method
4. Isolation of Azotobacter species from soil
5. Isolation of algae from soil
6. To prepare suitable media for fungal culture
7. To prepare pure culture of microorganisms by streak plate method, pour plate method, spread plate method
8. Maintenance of pure cultures by paraffin method
9. Preparation of bacterial smear
10. Preparation of agar slants for culture of microorganisms
11. Measurement of bacterial growth by turbidity measurements (Spectrophotometric method) & preparation of growth curve
12. Measurement of bacterial population by serial dilution methods
13. Effect temperature & pH on growth of microorganisms
14. Microscopic examination of bacteria, yeast and moulds and study of organisms by simple stain, negative stain, gram stain, Acid fast stain and staining for spores
15. Bacteriological examination of water by multiple-tube fermentation test or multiple tube test (MPN)

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Semester II
MBT- 853: Immunology
(M.Sc.; Paper-I)

M. M. 70

Unit I

Immunology: Introduction, active and passive immunity, primary and secondary immune response and clonal nature of immune response, Antigens and super antigens.

Unit II

Structure of immune cells and organs, structure and function of immunoglobulins, B-lymphocytes, T-lymphocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cells, eosinophils, neutrophils and mast cells.

Unit III

Antigen-antibody interactions, BCR & TCR, Cell-mediated cytotoxicity: Mechanism of T-cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity.

Unit IV

Major Histocompatibility Complex: Antigen processing and presentation, complement system. Regulation of immune response: Generation of humoral and cell mediated immune responses, activation of B- and T- lymphocytes, cytokines and their role in immune regulation, immunological tolerance.

Unit V

Immunoprophylactic intervention: Basic concepts of vaccination and different types of vaccines. Hypersensitivity, autoimmune disorders, AIDS and other immunodeficiencies. Immunotechnology: Immudiffusion, immunoelectrophoresis, RIA, ELISA, Hybridoma technology and monoclonal antibodies, along with their applications.

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MBT- 854: Molecular Biology
(M.Sc.; Paper-II)

M. M. 70

Unit I

Introduction to molecular biology, DNA replication: Prokaryotic and eukaryotic DNA replication, mechanisms of DNA replication, enzymes and accessory proteins involved in DNA replication, DNA repair and recombination, Homologous Recombination: Holliday junction, FLP/FRT and Cre/Lox recombination, RecA and other recombinases.

Unit II

Transcription: Prokaryotic and eukaryotic transcription, RNA polymerase, general and specific transcription factors, regulatory elements and mechanisms of transcription regulation, transcriptional and post transcriptional gene silencing, Modifications in RNA: 5'-Cap formation, Transcription termination, 3'end processing and polyadenylation, splicing, editing, nuclear export of mRNA, mRNA stability.

Unit III

Translation: Prokaryotic and eukaryotic translation, the translation machinery, mechanisms of initiation, elongation and termination, regulation of translation, co- and post-translational modifications of proteins. Protein localization: Synthesis of secretory and membrane proteins, import into nucleus, mitochondria, chloroplast, receptor mediated endocytosis.

Unit IV

Biology of Cancer: Molecular biology and biochemistry of cancer, oncogenes, mutation, chemical carcinogenesis, viral and cellular oncogenes, tumor suppressor genes from humans, structure, function and mechanism of action of pRB and p53 tumor suppressor proteins. Antisense and Ribozyme Technology and their applications: Molecular mechanism of antisense molecules, inhibition of splicing and translation, disruption of RNA structure, biochemistry of ribozyme, hammer head, hairpin ribozymes, strategies for designing ribozymes.

Unit V

Molecular mapping of Genome: Genetic and physical maps, simple sequence repeat loci, Southern and FISH for genome analysis. Molecular markers in genome analysis: RFLP, RAPD analysis, molecular markers linked to disease resistance genes, application of RFLP in forensic, disease prognosis. Metagenomics, Proteomics and Phenomics.

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**MBT- 855: Genetic Engineering
(M.Sc.; Paper-III)**

M. M. 70

Unit I

Molecular tools and their application: Restriction endonucleases, polymerase nucleases, kinases, topoisomerases, gyrases, methylases, ligases and alkaline phosphatases. Nucleic Acid purification, amplification, yield analysis. Gene cloning, Gene cloning vectors: Plasmids, bacteriophages, cosmids, phagemids, artificial chromosomes. Construction of c-DNA, reverse transcriptase, DNA primers, linkers, adaptors, chemical synthesis of nucleic acids

Unit II

Nucleic acid hybridization: Principles and techniques. Polymerase chain reaction: Principles, variations and applications. Techniques of *in vitro* mutagenesis and protein engineering, restriction mapping of DNA fragments and map construction, nucleic Acid sequencing. Techniques for studying gene expression: DNA transfection, Northern and Western blotting, DNA footprinting, primer extension, SI mapping, Rnase protection, Reporter assays. Radioactive and non-radioactive labelling.

Unit III

Expression strategies for heterologous genes: Vector engineering and codon optimization, *in vitro* transcription and translation, expression in bacteria, yeast, insects, mammalian cells and plants. T-DNA and transposon tagging: Role of gene tagging in gene analysis and identification and isolation of genes through T-DNA or transposon tagging.

Unit IV

Genome Sequencing: Genome sizes, organelle genomes, genomic libraries and c-DNA libraries, YAC, BAC libraries, screening of libraries for selection of desired clones, strategies for sequencing genome, application of sequence information for identification of defective genes.

Unit V

Microarray: Printing of oligonucleotides and PCR products on glass slides, nitrocellulose paper. Genome analysis for global patterns of gene expression using fluorescent-labeled c-DNA or end-labeled RNA probes. Analysis of single nucleotide polymorphism using DNA chips.

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MBT- 856: Environmental Biotechnology
(M.Sc.; Paper-IV)

M. M. 70

Unit I

Environment: Basic concept and issues. Environment pollution: Types of pollution, methods for the measurement of pollution. Methodology of environmental management: The problem solving approach, its limitations. Air pollution, different pollutants, their monitoring and control. Water pollution and its control: Water as a scarce natural resource, need for water management, measurement of water pollution, sources of water pollution.

Unit II

Waste water treatment- physical, chemical and biological treatment processes. Aerobic process: Activated sludge, oxidation ditches, trickling filters, towers, rotating discs, rotating drums, oxidation ponds. Anaerobic processes: Anaerobic digestion, anaerobic filters, upflow, anaerobic sludge blanket reactors. Treatment schemes for waste waters from dairy, distillery, tannery, sugar, antibiotic industries.

Unit III

Biodegradation of Xenobiotics in environment: Ecological considerations, decay behaviour & degradative plasmids. Degradation of chlorinated hydrocarbons, substituted hydrocarbons, petrol, petroleum products, surfactants, pesticides and other industrial effluents. Solid waste management.

Unit IV

Bioremediation of contaminated soils and wasteland. Bioaccumulation, Biomagnification, Biostimulation, Biopesticides in integrated pest management, Rural Biotechnology with special reference to biofertilizers, biocomposting, organic farming, vermiculture and methane production.

Unit V

Global environmental problems: Ozone depletion, UV-B, green house effect and acid rain, their impact and biotechnological approaches for their management.

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MBT- 857: Biotechnology Lab course - III
(M.Sc.)

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1. Biochemical characterization of microbes
2. Determination of coliforms for determination of purity of potable water.
3. Determination of total dissolved solids of water.
4. Determination of dissolved oxygen (DO) concentration of water sample.
5. Determination of biological oxygen demand (BOD) of a sewage sample.
6. Determination of chemical oxygen demand (COD) of a sewage sample.
7. Isolation of xenobiont degrading bacteria by selective enrichment technique.
8. Isolation of Plasmids
9. To isolate plasmid DNA from bacterial culture by alkaline lyses method
10. To isolate plasmid DNA from bacterial culture by Quick method
11. To run polymerase chain reaction of bacterial genomic DNA
12. To separate and visualize various proteins in cell free homogenate of mouse/rat liver by SDS-PAGE
13. Colorimetric determination of pKa
14. To perform qualitative tests on urine for protein, sugar, creatine, urobilinogen, urea
15. To perform immunoelectrophoresis for BSA and egg albumin separately and their mixture
16. Radial immunodiffusion
17. Western blotting and ELISA
18. To visualize the precipitation line formed on the agar gel slide by Ouchterlony's double immuno-diffusion technique
19. Bacterial transformation
20. Southern blotting
21. RFLP analysis
22. To prepare competent cells of bacteria
23. To transform the competent cells
24. Test of the degradation of a aromatic hydrocarbon by bacteria.
25. Estimation of nitrate in drinking water.
26. Determine the efficiencies of removal of air pollutant using fibrous air filter
27. Effect of sulphur dioxide on crop plants
28. Estimation of heavy metals in water / soil by atomic absorption spectrophotometry
29. Study of biogenic methane production in different habitats

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MBT- 858: Seminar and Interactive Course - I
(M.Sc.)

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M.Sc. Biotechnology Course Programme (Effective from session 2018-19)