Semester – I

(THEORY)

MBT 101 **CHEMISTRY OF BIOMOLECULES** **MARKS: 50 (45 + 5)**

1. **Thermodynamics:**
   a) Principles: First and Second laws of thermodynamics, Details of thermodynamic variables and functions. Application of there laws in Life Science with examples.
   b) Bioenergetics: Energy rich bonds; Coupled reactions; Group transfer; Autotrophic and Heterotrophic Principle of Energy Transductions. Gibbs Free-Energy Calculation for Bio-redox Reactions. Thermodynamics of ligand bindings; Association and Dissociation Constant.

   12 L
2. **Bondings**: Weak and co-valent interactions [Van der Waals, Electrostatic, Hydrogen Bonding, Hydrophobic, Di-sulfide] in aqueous and extreme solution conditions. **6 L**
3. **Structure and Stability**:
   a) Proteins: Peptide bond; Ramachandran Plot; Calculation of conformation of different states of proteins; Properties of α-helix and β-sheets; Secondary structure prediction and determination; connectivities. Tertiary structure: Determination of state of tertiary structure; characteristic balance in rigidity and flexibility; Domain concept (α-,β-,α/β- and α+β-domains) and interacting motifs. Quaternary structure: Geometry, Symmetry and intermolecular interfaces.
   b) Carbohydrates: configuration and Conformation; Step Up and Step down reactions; Conversion of Aldos to Ketos and vice versa. Conformational stability ratings, Anomeric effect, Reverse anomeric effect; Structure and stability of polysaccharides, glycoproteins, glycolipids and proteoglycans.
   c) Nucleic acids: Structure and stability of Nucleic acids (DNA and RNA), topological structure, fine structure of DNA and its organization in genome. **20 L**
4. **Stereochemistry**: Configuration and conformation and stability; Elements of symmetry, Chirality; RS-, EZ-, DL- and dl- system of nomenclature; Stereo-specific and stereo-selective reactions; Determination of relative configuration by asymmetric synthesis. **7 L**

(THEORY)

MBT 102 **MOLECULAR BIOLOGY** **MARKS: 50 (45 + 5)**

1. **DNA:** Replication, DNA topology, DNA damage and repair in relation to aging and diseases. **6 L**
2. **RNA:** transcription, processing, regulation, post-transcriptional control and degeneration, gene silencing. **7 L**
3. **Translation**: protein synthesis and regulation in prokaryotes and eukaryotes, protein targeting, signal peptides. **7 L**
4. **Gene expression**: genetic code, principles of gene regulation; regulation of gene expression in prokaryotes and eukaryotes. **7 L**
5. **Biosignaling**: signal perception, molecular mechanisms of signal transduction and gated ion channels, regulation of signal transduction pathways. **6 L**
6. **Transposons and retrotransposons**: prokaryotic and eukaryotic transposable elements and their role in evolution. **6 L**
7. **Regulation of Gene Expression:** RNAi, Si RNA, Anti-sense RNA technology, Alternate pathways (Lytic vs. Lysigenic) **6 L**

(THEORY)

MBT 103 **CELL AND DEVELOPMENTAL BIOLOGY** **MARKS: 50 (45 + 5)**

1. Structure and function of a cell and its organelles. **6 L**
2. **Membrane system**: Biological membranes - architecture & kinetics (transport, ion channels, diffusion, Na-K pump, proton pump). **6 L**
3. **Protein localisazation**: Synthesis of secretory & membrance protein, import into nucleus, mitochondria, chloroplast & peroxisome; Receptor-mediated endocytosis. **6 L**
4. **Cell cycle**: phages, duration of different phages and the methods for their determination, Cell cycle synchronization, arrest and delay in case of diseases. **6 L**
5. **Cancer:** An elementary genomic insight, Apoptosis. **6 L**
6. **Genetic control of development**:
   a) Nuclear transplantation; organizer action; teratogenecity; mitochondrial gene-maternal inheritance; floral genes; phy-genes. **6 L**
   b) Zygotic genes (e.g. gap genes, segmental polarity and homeotic genes) in pattern formation, antero-posterior embryogenesis. **4 L**
   c) Homoetic gene expression in animals (*Drosophila*) and plants (*Arabidopsis*). **2 L**
   d) Hox-group of genes; organ regeneration. **3 L**

(THEORY)

MBT-104 BIOSTATISTICS AND COMPUTER APPLICATION MARKS-50

1. Brief description and tabulation of data and it's graphical representation. **6 L**
2. Measurement of central tendency: Mean Median, Mode, Range, Standard Deviation, and Variance, Idea of two types of error and its level of significance, Chi-Square Test, Simple linear regression and correlation, Probability Distribution (Binomial, Poisson, Gaussian). **15 L**
3. Introduction of digital computer: Low level and high-level language, the binary system. **2 L**
4. Programming in C: Data Types, Condition checking and looping, Function, Array, Pointer, String Handling. **14 L**
5. Introduction of R language and Bioconductor and their application in Bioinformatics. **4 L**
6. Computer oriented statistical techniques employing C language: Bubble Sorting, Computation of Median, Variance, Standard Deviation, and Correlation Coefficient. **4 L**

(PRACTICAL)

MBT 105 (CELL AND MOLECULAR BIOLOGY PRACTICAL) MARKS: 50

CELL BIOLOGY:

1. Study of different stages of mitosis; mitotic index & chromosome complement in *Allium cepa*
2. Study of different stages of meiosis in *Allium cepa* & grasshopper.
3. Preparation and analysis of giant chromosome.
4. Experiments for demonstration of Barr body & drumstick.

MOLECULAR BIOLOGY:

1. Isolation of genomic DNA from bacteria & plants.
2. Agarose gel electrophoresis.
3. Phage titration by plaque assay
4. SDS-PAGE of proteins

(**PRACTICAL**)

MBT 106 (BIOSTATISTICS AND COMPUTER APPLICATION) MARKS: 50

1.Computer Application: Programming for Solving a) Statistical problems (eg. Median, Std. Deviation, Correlation Coefficient) through C programming.
b) Sequence analysis.
2. Solving the problems of Biostatistics (Average, Median, Mode, Chi square, correlation coefficient, Normal/Poisson Distribution) through SPSS/MS- Excel.

Semester – II

(THEORY)

MBT 201 BIOCHEMISTRY MARKS: 50 (45 + 5)

1. **General Metabolism**: Glycolysis, TCA, Gluconeogenesis, Pentose phosphate pathway: Mechanism of selective reactions, Radioisotope distribution study and regulation. Glycogen metabolism: Break down, synthesis, hormone control and regulation. **7 L**
2. **Amino acids**: Catabolism of proteins and amino acids, Urea cycle, Fate of carbon skeleton of amino acids, Mechanism of selective reactions. Biosynthesis of amino acids: Nitrogen fixation, Biosynthesis of essential amino acids, and Mechanism of selective reactions, Regulation. Biomolecules obtained from amino acids. **9 L**
3. **Fatty acid:** oxidation (Even, odd, saturated and unsaturated) and Biosynthesis of fatty acids, tri-glycerides, phospholipids and sterols. Regulation of fatty acid metabolism. **6 L**
4. **Nucleic Acids:** Biosynthesis and degradation of purine and pyrimidine, nucleotides, Mechanism of selective reactions and regulation. **6 L**
5. **Enzymes:** Mechanism of actions, binding site and active site, Factors affecting the rate of enzymatic reaction, Enzyme kinetics for mono- and bi-substrate reactions, Inhibitions –competitive, uncompetitive mixed and non-competitive type, Allosteric regulation, covalent modifications, Isozymes, ribozymes, abzymes. **12 L**
6. **Protein:** Denaturation, Folding, outline of protein synthesis, Protein-ligand interactions. **5 L**

(THEORY)

MBT 202 IMMUNOLOGY MARKS: 50 (45 + 5)

1. **Introduction to immunology:** innate and acquired immunity, humoral and cell mediated immune response, organization and structure of lymphoid organs. **5 L**
2. **Antigens and immunogenicity**. **3 L**

3. **Immunoglobulins:** structure and function and application; the molecular genetics of antibody diversity monoclonal and polyclonal antibodies. **14 L**
4. **The major histocompatibility complex** (MHC), its associated predisposition to the diseases; transplantation immunology **6 L**
5. **Immune response mechanisms:** B-lymphocytes and the clonal selection theory; T-lymphocyte activation. **5 L**
6. **Interleukins and interferons** **3 L**
7. **Hypersensitivity:** immune tolerance and autoimmunity. **3 L**
8. **Tumor immunology**. **3 L**
9. **Immunity against infectious diseases**: immunization, epitope mapping, vaccine development. **3 L**

MBT 203 **MICROBIOLOGY** **MARKS: 50 (45 + 5)**

1. **Bacterial structure**: ultrastructure and chemistry of capsule, pili, flagella, flagellar movement, tactic movement, endospore. Cell wall of Archaebacteria, Gram positive and Gram negative bacteria; Outer membrane; different types of staining. Reserve materials and other cytoplasmic inclusions of bacteria. **10 L**
2. **Classification of prokaryotes and bacterial taxonomy**: short description of different groups under Archaebacteria (Thermophiles, Halophiles and Acidophiles), under Eubacteria (Myxobacteria, Mycoplasma, Actinomycetes, Rickettsias and Chlamydiae) and auxotrophs including Cyanobacteria. **5 L**
3. **Bacterial growth**: in liquid media, growth requirements, growth factors, kinetics of growth, continuous culture, synchronous culture, enrichment culture. **4 L**
4. **Bacterial mutation**: nature and basis of mutation, mode of action of mutagens, types of mutants and their selection; mutation rate. **4 L**
5. **Genetic recombinations**: in bacteria; operon concept, lac, ara and trp operons, attenuation; allosteric control and feedback inhibition; isozymes, catabolite repression and diauxic growth. **4 L**
6. **Nitrogen cycle**: nitrification, denitrification, biological nitrogen fixation. **4 L**
7. **Fermentation** of useful microbial products, alcohol and antibiotics **7 L**
8. **Classification and structural organization**: DNA and RNA viruses. Replication strategies of different viruses, viroids and virusoids, Prions. **5 L**
9. **Application of microbes** for probiotics, SCP and other beneficial purposes. **3 L**

(THEORY)

MBT 204 **MOLECULAR BIOPHYSICS** **MARKS: 50 (45 + 5)**

1. **Applications in biology.** Energy equations, free energy, chemical potential, Gibbs free energy, elementary idea of chemical thermodynamics and chemical kinetics, Arrhenius equation. **10 L**
2. **Basic atomic and radiation physics**, basic molecular physics. Interaction of UV, VIS and IR radiation and LASER with bio-molecules and living system, Bio- and chemi-luminescence, photochemical reaction. Thermal changes in cells and tissues, thermal modeling in biological tissues, Biological transport processes, Nernst potential and Donnan potential – surface potential and potential across bio-membranes, experimental determination, biological energy conversion. **14 L**
3. **Electromagnetic energy spectrum – their effects on the molecules and method of studying them**, Raman, NMR, NOESY and TOCSY, ESR spectroscopy and Mass spectrometry, and their biological applications, optical rotatory dispersion, fluorescence, phosphorescence spectroscopy, X-ray diffraction (structure of DNA, RNA and Proteins), ultrastructure determination, electron microscopy – transmission and scanning. **14 L**
4. **Radioactivity:** Radioactive transformation, detection and measurement of dose, autoradiography, G.M. counter, scintillation counter, radiation safety. **7 L**

(THEORY)

MBT 205 **MICROBIOLOGY AND IMMUNOLOGY** **MARKS: 50 (30 + 20)**

(PRACTICAL)

(a) Microbiology **(Marks: 30)**

1. Aseptic methods:
   (a) Use of autoclave, hot air oven and bacterial filter.
   (b) Preparation and sterilization of culture media.
   (c) Preparation of agar slants, pouring of plates, subculturing.
2. Pure culture methods: methods of isolation of microorganisms from air and soil.
3. Staining methods: simple staining by carbol fuchsin stain; differential staining – Gram staining.
4. Preparation of bacterial growth curve.
5. Assay of antibiotics by agar cup method and tube dilution method.
6. Determination of minimum inhibitory concentration (MIC) of antibiotic.
7. Enrichment culture for:
   Aerobic nitrogen fixing bacteria. Endospore forming bacteria, Sulphate reducing bacteria, Cellulose degrading microorganisms, Phosphate and potash solubilisers.
8. Physiological and biochemical tests for identification of bacteria. Tests for catalase, protease, amylase and oxidase . Indole production, Voges Proskauer test, acid and gas production after fermentation of glucose and lactose.

(b) Immunology **(Marks: 20)**

1. Lymphoid organs and their microscopic organization.
2. Immunization, collection of serum. ELISA, Dot-blot, Western blot.

(THEORY)

MBT 206 **(BIOCHEMISTRY)** **MARKS: 50**

(PRACTICAL)

1. Titration of amino acids.
2. Colorimetric determination of pK.
3. Tests for amino acids, sugars and lipids.
4. Quantification of DNA and RNA.
5. Quantification of proteins and sugars.
6. UV- Visible Absorption spectra.

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Semester – III

(THEORY)

MBT 301 **(PLANT & AGRICULTURAL BIOTECHNOLOGY)** **MARKS: 50 (45+ 5)**

1. **Plant cell, tissue and organ culture**:A brief idea about totipotency, somatic embryogenesis, organogenesis& somaclonal variation. **4 L**
2. Protoplast isolation, culture & fusion; selection of hybrid cells & regeneration of hybrid plants; symmetric & asymmetric hybrids **5 L**
3. **Pollen biotechnology**: Anther and pollen culture – role in crop improvement. An outline of pollen based gene transfer technology, self-incompatibility and pollen pistil interactions. **4 L**
4. **Micropropagation**: Technology and applications; *in vitro* propagation of horticultural and agricultural crops; *in vitro* propagation of tree. **5 L**
5. **Natural product synthesis by cell and tissue culture**: Secondary product accumulation by plant cell and suspension culture; role of differentiated cultures in product synthesis – shoot culture, hairy root culture, shooty teratomas, co-culture techniques. **4 L**
6. **Plant transformation**: The basis of tumor formation, hairy root,features of Ti & Ri plasmids ,mechanisms of DNA transfer,role of virulence gene,use of Ti & Ri plasmid as vectors, binary vectors, use of 35s &other promoters, genetic markers use of reporter gene, molecular farming, benefits & risks,long shelf life of fruits & flowers,use of ACC synthase, polygalacturonase, ACC oxidase; male sterile lines, bar & barnase system. **10 L**
7. **Chloroplast transformation:** Advantages, vectors, success with tobacco & potato. **2 L**
8. **Cryobiology of plant cell cultures and establishment of gene banks**: Introduction, technology of freeze preservation, factors influencing revival of frozen cells, prospects. **3 L**
9. **Biofertiliser and plant productivity**: Bacterial – Nitrogen fixers- symbiotic (*Rhizobium*), non-symbiotic (*Azotobacter*); Algal - symbiotic (*Azolla*); non-symbiotic (BGA), Fungal – phosphate solubiliser (*Trichoderma*) and phosphate mobiliser (VAM). **6 L**
7. **Technology for rapid enriched compost**: Microbial and vermi composting. **2 L**

(THEORY)

MBT 302 (ANIMAL BIOTECHNOLOGY) MARKS: 50 (45+ 5)

1. ***In vitro* fertilization**: superovulation, embryo culture and embryo transfer protocols (specially in farm animals), Assisted Reproductive Technology (ART). **10 L**
2. **Transfixion and transgenesis**: targeted gene replacement *in vitro* and *in vivo*. Stem cells (both embryo derived and adult) – application, tissue healing, therapy knock-out animal models of human diseases, pharmaceutical use of animal models. **10 L**
3. **Transgenic animals**: methods of transgenesis, transgenic animal models in drug discovery, bioreactors (production of foreign proteins in blood, milk and egg white). **6 L**
4. **Animal cloning**, Embryo splitting, **4 L**
5. **Vaccine preparation**: Hepatitis B virus, foot and mouth disease (cattle), bird flue, Chikangunya **8 L**
6. **Basic principles of animal**: cell and tissue culture (with special reference to mammals). Three-dimensional culture and tissue engineering. **7 L**

(THEORY)

MBT 303 (TECHNIQUES IN BIOTECHNOLOGY) MARKS: 50 (45+ 5)

1. **Microscopy**: light, fluorescence microscopy; electron microscopy, photomicrography, Confocal microscopy. **5 L**
2. **Chromatography** (gel filtration**,** ion-exchange, affinity, TLC, HPLC); electrophoresis**,** electrofocussing, centrifugation. **8 L**
3. **Sequencing procedures** (for nucleotides and amino acids). **6 L**
4. **Hybridization and blotting techniques**: PCR, ELISA, DNA finger printing and foot printing, chromosome walking, chromosome jumping, DNA micro arrays, DNA chips, radioimmunoassay. **8 L**
5. Serological and nucleic acid based diagnostic (authenticated) methods for detection of diseases. **18L**

(THEORY)

MBT 304 (MEDICAL BIOTECHNOLOGY) MARKS: 50 (45+ 5)

Part-I

1. **Diagnostic virology**: detection of HIV, HPV and HBV, herpes virus, polio virus. **5 L**
2. **Development of drugs**: mechanism of drug action of a few selective drugs, biotechnological approach of drug designing and drug resistance. **5 L**
3. **Biotechnological approach of drug designing** **4 L**
4. (a) Mechanism of oncogenesis.
   (b) Oncogene detection by DNA transfection assay.
   (c) Carcinogen/mutagen detection by Ames' *Salmonella* assay. **8 L**

Part-II

5. **Molecular diseases and diagnostic tools**: Detection of genomic changes by:
   (i) RFLP, (ii) VNTR, (iii) Haplotype, (iv) Probe, (v) Ligase mediated (single nucleotide polymorphism detection). **5 L**
6. Somatic Cell Genetics **2 L**
7. **Detection of** sickle cell anemia, thalasemia, cystic fibrosis, haemophilia, Duchenne muscular dystrophy, Parkinsons, Alzheimers, Huntington's Disease. **6 L**
8. **Gene therapy**: (a) Different strategies for gene therapy: targeted approach – killing of cells, mutation correction, inhibition of gene expression.
   (b) Approaches of gene delivery (i) *in vitro*, (ii) *in vivo*, and (iii) *ex vivo*.
   (c) Delivery systems: viral vectors, bacterial vectors, mechanical vectors, liposomes.
   (d) Human gene therapy: (i) ADA – SCID, (ii) TIL, (iii) Neoplastic disorder, (iv) Infectious diseases, (v) Brain tumor. **10 L**

(PRACTICAL)

MBT 305 (PLANT TISSUE CULTURE) MARKS: 50

1. General process of sterilization: Autoclaving,
2. Preparation of different culture media.
3. Initiation and maintenance of callus.
4. Suspension culture.
5. Study of organogenesis.
6. Shoot tip and node cultures.
7. Strategies of micropropagation.
8. Protoplast culture.

(PRACTICAL)

MBT 306 (TECHNIQUES FOR MACROMOLECULAR STUDY) MARKS: 50

1. Separation techniques – Centrifugation, Chromatography (Gel permeation, Ion exchange, TLC etc.) and Electrophoresis
2. Total Nitrogen estimation in different tissues of plants
3. Enzyme isolation from animal tissues, precipitation methods for purification of enzyme proteins.

Semester – IV
(THEORY)

MBT-401 (BIOINFORMATICS AND BIOETHICS) MARKS-50 (45+5)

1. Concept of Object Oriented Programming (C++) and PERL and their application in Bioinformatics. **5 L**

2. Some basic commands of UNIX, Concept of DBMS and SQL. Commands of SQL for database management using Oracle. **5 L**

3.Scoring matrices: PAM and BLOSUM series, Definition and significance of Pairwise and Multiple Sequence Alignment, Methods and algorithms used in Pairwise alignment: Dot Matrix, Dynammic Programming Algorithm and k-tuple. Methods for doing MSA: CLUSTALW and PILEUP, Scoring MSA. **10 L**

4.Algorithms used in Database similarity searching: BLAST and FASTA. Definition of Profile and Pattern. PSI-BLAST and PHI-BLAST. **8 L**

5. Phylogenetic analysis: Concept and method: Distance based (Fitch and Margoliash & UPGMA) and character based methods (Parsimony). **8 L**

6. Introduction of protein structure prediction and gene prediction. **4 L**
7. Ethical, legal and social implications of Biotechnological products. **2 L**
8. IPR and Patents. **2 L**
9. Genetically modified organisms and their acceptability. **1 L**

(THEORY)

MBT 402 (RECOMBINANT DNA TECHNOLOGY) MARKS: 50 (45+ 5)

1. **Gene Manipulation**: general concept of various tools and methods **5 L**

2. **Cloning in E-coli**: plasmids, bacteriophage, cosmid, phagemid vectors, cloning strategies and cDNA library, promoters, expression of cloned DNA and its analysis. **10 L**

3. **Cloning in yeast**: yeast vectors cloning and expression, yeast artificial chromosome. **6 L**

4. **Cloning in plants**: agrobacterium and genetic engineering in plants, Ti and Ri plasmids, binary vectors, plant specific promoters, incorporation of T-DNA into nuclear DNA of plant cells. Transformation strategies for transgenic plants for resistance, herbicide resistance, and tolerance, RFLP/AFLP/RAPD mapping in plant breeding. **15 L**

5. **Cloning in animals**: integration of DNA into mammalian cell, isolation of transgene from transformed animal cell culture. **9 L**

(THEORY)

MBT 403 (GENOMICS AND PROTEOMICS) MARKS: 50 (45+ 5)

Genomics

1. **Definition, classification, scope**. **3 L**
2. **Structural genomics**: E-coli, fruitfly, *Arabidopsis*, and human. **8 L**
3. **Chromosome specific libraries**: ordering genomic clones into contigs by FISH, clone finger-prints, STSs (Sequence Tagged Sites), ESTs (Expressed Sequence Tags), etc. **5 L**
4. **Location–oriented entities**: SINEs and LINEs, Repeats. **4 L**
5. **Applied genomics**: DNA chips, robotics, microarray protection for ecological ravages. **4 L**

Proteomics

6. **Definition, classification, scope**. **3 L**
7. **The emergence of proteome concept**: structural and functional proteomes, protein structure related to functional kinetics, e.g. prions, bridging genomics to proteomics. **6 L**
8. **Transcriptomes**: measurement of gene expression. **3 L**
9. **Proteome analysis**: by methods, 2-D PAGE including protein detection on electro-blot membrane, mass spectrometry and phosphorylation site analysis. **6 L**
10. **Proteomics in relation to animal and plant health and welfare**. **3 L**

(THEORY)

MBT 404 (ELECTIVE PAPER) MARKS: 50 (45+ 5)

In view of the expanding horizon of research over the last ten years, in the field of Biotechnology and Satellite areas, each student will suggest 3 areas/topics as the integral part of the comprehensive interactive course. The HOD

will select any one of the topics, or may suggest any topics other than the three suggested, on which candidate will be enrolled for the comprehensive study. The details of the procedure will be framed by the HOD in consultation with the member of the courses.

(PRACTICAL)

MBT-405 (BIOINFORMATICS AND RECOMBINANT DNA TECHNOLOGY) MARKS-50

BIOINFORMATICS: 20 Marks

1. Searching for a particular protein through PubMed.
2. Use of Public Domain Interfacees for downloading different DNA and Protein sequences from authenticated Databases (Using NCBI, SWISS-SPROT)
3. Performing BLAST and interpretation of the results.
4. Performing MSA by using CLUSTALW and presentation of the phylogenetic tree.

RECOMBIANT DNA TECHNOLOGY: 30 Marks

1. Isolation and purification of genomic DNA (plant / animal).
2. Restriction digestion of genomic DNA and its separation by agarose gel electrophoresis.
3. Ligation of a restricted fragment from genomic DNA into a suitable plasmid phage vector.
4. Transformation and selection of positive clones (colony blot) replica plating.
5. PCR amplification of a selected fragment and its separation of AGE/PAGE.
6. Restriction Map preparation of a selected genomic DNA fragment and RFLP pattern study.
7. Bacteriophage and its titration.

(PRACTICAL)

MBT-406 (PROJECT/TERM PAPER) Marks-50