M.Sc. Biotechnology **Semester--I**

Course Title: Cell Biology

MM. Th 80 + IA 20

Course No. **MBT 111** Time: 3h

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

Diversity of cell size and shape.
Cell Theory.
Structure of Prokaryotic and Eukaryotic cells- Isolation and growth of cells.
Microscopic techniques for study of cells.
Sub-cellular fractionation and criteria of functional integrity

UNIT II

Cellular organelles- Plasma membrane, cell wall, their structural organization Mitochondria, Chloroplast; Nucleus and other organelles and their organization.
Transport of nutrients, ions and macromolecules across membrane.

UNIT III

Cellular energy transactions - role of mitochondria and chloroplast
Cell cycle - molecular events and model systems
Cellular responses to environmental signals in plants and animals- mechanisms of signal transduction

UNIT IV

Cell motility - cilia, flagella of eukaryotes and prokaryotes
Biology of cancer
Metabolite pathways and their regulation
Biosynthesis of proteins in Eukaryotic cell, Co- and post-translational modification, intracellular protein traffic.

UNIT V

Cellular basis of differentiation and development-mitosis, gametogenesis and fertilization. Development in Drosophila and Arabidopsis, Spatial and temporal regulation of Gene expression.
Brief introduction to the Life Cycle and Molecular Biology of some important pathogen of AIDS, Malaria, Hepatitis, Tuberculosis, Filaria, Kalazar.

Practicals

Microscopy: Bright field, phase contrast & Fluorescence Microscopy.
Microtomy
Instrumental methods for Cell Biology
Sub cellular fractionation and marker enzymes.
Histochemical techniques
Mitosis & Meiosis

M.Sc. Biotechnology **Semester--I**

Course Title: ***Biomolecules and metabolism*** *MM. Th 80 + IA 20*

Course No**. MBT 112** Time: 3h

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

Chemical foundations of Biology –pH, pK, acids, bases, buffers, weak bonds, covalent bonds. Principles of thermodynamics. Classes of organic compounds and functional groups-atomic and molecular dimensions, space filling and ball and stick models. Macro molecular and supra molecular assemblies.

UNIT I I

Amino acids and peptides-classification, chemical reactions and physical properties
Sugars - classification and reactions
Heterocyclic compounds-and secondary metabolites in living systems - nucleotides, pigments, isoprenoids
Separation techniques for different biomolecules

UNIT III

Physical techniques in proteins, nucleic acids and polysaccharides structure analysis (UV, IR, NMR, LASER, MASS, Fluorescence spectroscopy, Differential calorimetry,
X - ray Crystallography, Ultra Centrifugation, Electron cryomicrography, Scanning Tunneling microscopy.

UNIT IV

Lipids- classification, structure and functions
Proteins-protein and protein legand interactions, end group analysis, hierarchy in structure, Ramachandran map.
Conformational properties of polynucleotides, Polysaccharides - types, secondary and tertiary structural features, analysis- theoretical and experimental;
Protein folding – biophysical and cellular aspects.

UNIT V

Water and its properties, enzymes coenzymes, metabolism of carbohydrate, amino acids and lipids, in born errors of metabolism.
Bio-energetics and oxidative phosphorylation. Blood clotting – biochemistry, body fluids – pH and acid base balance and their importance in clinical biochemistry, muscle contraction. Techniques in the study of proteins, carbohydrates and lipids.

Practicals

Titration of amino acids
Colorimetric determination of pK
Model building using space filling/ball and stick models
Reactions of amino acids, sugars and lipids
Isolation, purity determination and quantitation of cholesterol, DNA and mRNA
Quantitation of Proteins and Sugars
Analysis of oils-iodine number, saponification value, acid number
UV, Visible, Fluorescence and IR spectroscopy, Absorption spectra
Separation techniques - Centrifugation, Chromatography (Gel permeation, Ion exchange, TLC etc. and Electrophoresis

M.Sc. Medical Biotechnology **Semester--I**

Course Title: Microbiology *MM. Th 80 + IA 20*

Course No. M**BT 113** Time: 3h

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

The Beginning of Microbiology Discovery of the microbial world by Antony van Leeuwenhoek: Controversy over spontaneous generation, Role of microorganisms in transformation of organic matter and in the causation of diseases Development of pure culture methods Enrichment culture methods, developments of microbiology in the twentieth century.Methods in Microbiology Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition Construction of culture media; Enrichment culture techniques for isolation of chamoautotrophs,' chemoheterotrophs and photosynthetic microorganisms. Microbial Evolution, Systematic and Taxonomy, Evolution of earth and earlier life forms; Primitive organisms and their metabolic strategies and molecular coding; New approaches to bacterial taxonomy classification including ribotypeing Ribosomal RNA sequencing; Characteristics of primary domains Taxonomy, Nomenclature and Bergey's Manual

UNIT II

Microbial Growth The definition of growth, mathematical expression of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture; Growth as affected by environmental factors like temperature, acidity, alkalinity, water availability and oxygen; Culture collection and maintenance of cultures

Overview of Basic Metabolism & Microbial Nutrition
Metabolic Diversity among Microorganisms Photosynthesis in microorganisms; Role of Chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen - iron - nitrite - oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis; Fermentations - diversity, syntrophy, role of anoxic decompositions; Nitrogen metabolism;" Nitrogen fixation; Hydrocarbon transformation

UNIT III

Prokaryotic Diversity Bacteria: Purpl and green bacteria; Cyanobacteria; Homoacetogenic bacteria; Acetic acid bacteria; Budding and appendaged bacteria; Spirilla; Spirochaetes; Gliding and sheathed bacteria; Pseudomonads; Lactic and propionic acid bacteria; Endospore forming rods and cocci: Mycobacteria: Rickettsias, Chlamydies and Mycoplasma. Archaea: Archaea as earliest Life forms: Halophiles; Methanogens;' Hyperthermophilic urchaea; Thermoplasma
Eukaryotic : Algae, Fungi, Slime molds and Protozoa.

UNIT IV

Viruses: Bacterial, Plant, Animal and Tumor viruses; Discovery, classification and structure of viruses; Lysogeny: DNA viruses: Positive strand Negative strand, and double stranded RNA viruses; Replication: Examples of Herpes, Pox, Adenoviruses, Retroviruses, Viroids and Prions

Prokaryotic Cells: Structure-function Cell walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of Gram negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like end spores, gas vesicles

Chemotherapy/Antibiotics

Antimicrobial agents; Sulfa drugs; Antibiotics: Pencillins and Cephalosporins; Broad spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics

UNIT V

Genes, Mutation and. Mutagenesis UV and chemical mutagenesis Types of mutation; Ames test for mutagenesis; Methods of genetic analysis

Bacterial Genetic System Transformation, Conjugation, Transduction, Recombination, Plasmids and Transposons, Bacterial genetics 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

Practicals

Preparation of liquid and solid media for growth of microorganisms

Isolation and maintenance .of organisms by plating, streaking and serial dilution methods. Slants and stab cultures. Storage of microorganisms

Isolation of pure cultures from soil and water

Growth; Growth curve; Measurement of bacterial' population by turbidometry and serial dilution methods. Effect of temperature, pH and carbon und nitrogen sources on growth.

Microscopic examination of bacteria, yeast and molds and study of organisms by Gram stain, Acid fast stain and staining for spores

Study of mutations by Ames test.

Assay of antibiotics und demonstration of antibiotic resistance

Analysis of water for potability and determination of MPN

Bacterial transformation

Biochemical characterization of selected microbes

Transduction

One step growth curve of coliphage

Isolation of Plasmids

$^{14}C0_2$ fixation by photosynthetic microbes

M.Sc. Biotechnology **Semester--I**

Course Title: ***Molecular Biology*** *MM. Th 80 + IA 20*

Course No.**MBT 114** Time: 3h

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

DNA Replication: Prokaryotic and eukaryotic DNA replication, Mechanics of DNA replication, enzymes and accessory proteins involved in DNA replication and DNA repair.
Transcription: Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Regulatory elements in 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 II

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 protein, Import into nucleus, mitochondria, chloroplast and peroxisomes, Receptor mediated endocytosis
Oncogenes and Tumor Suppressor Genes: Viral and cellular oncogenes, tumor suppressor genes from humans, Structure, Function and mechanism of action of pRB and p53 tumor suppressor proteins

UNIT III

Antisense and Ribozyme Technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme; hammer head, hairpin and other ribozymes, strategies for designing ribozymes, Applications of Antisense and ribozyme technologies

Homologous Recombination: Holliday junction, gene targeting, gene disruption, FLP/FRT and' Cre/Lox recombination, RecA and' other recombinases
Molecular Mapping of Genome: Genetic and physical maps,. physical mapping and map-based cloning, choice of mapping population, Simple sequence repeat loci, Southern and fluorescence in situ hybridization for genome analysis, Chromosome micro dissection and micro cloning.

UNIT IV

Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, Molecular markers linked to disease resistance genes, Application of RFLP in forensic, disease. prognosis, genetic counseling, Pedigree, varietal etc. Animal trafficking and poaching; Germplasm maintenance, taxonomy and Bio-diversity

UNIT V

Genome Sequencing: Genome sizes., organelle genomes, Genomic libraries, YAC, BAC libraries, Strategies for sequencing genome, Packaging, transfection and recovery of clones, Application of Sequencing sequence information for identification of defective genes

PRACTICALS

Isolation of genomic DNA
Southern blotting
RFLP analysis
Isolation of RNA
Isolation of polyA + RNA
Northern blotting
Preparation of probes
In vitro Transcription
In vitro translation
Metabolic labeling of proteins and immuno precipitation

M.Sc. Biotechnology **Semester--I**
Choice Based Paper

Course No. MBT 115 *MM. Th 80 + IA 20*

Course Title: **Biostatistics** Time: 3h

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

Unit I

Permutation and Combination, Functions, limits and continuity, Exponential and Logarithmic functions, Vector and Matrices, Algebra of matrices, Determinants and their simple properties, Rank of matrix, Consistency of system of linear equations and solution of linear system of equations. Characteristic equation, Eigen values and Eigen vectors,

Unit II

Differential Calculus, Rules of differentiation, Derivatives of implicit functions, Parametric differentiation, Higher derivatives Taylor's theorem, Maclaurin's theorem (without proofs), Maxima and minima, Partial differentiation
Integration, Integration by parts, Definite integral, Properties of definite integrals,
Differential Equations :, Separable variable, homogenous, exact and linear equations of second order.

Unit III

Concepts in statistics, Types of Data, presentation of data, types of graphics, relative frequency, cumulative frequency, Measurement of central tendency, Measures of variation, coefficient of variation, Measures of Skewness and Kurtosis, Probability and its applications, Laws of Addition and Multiplication, Compound probability, Baye's Theorem

Unit IV

Random Variables and Distributions. Binomial, Poisson, Exponential and Normal Distributions and their applications. Samples and Sampling Distribution, Standard Error, significance level, Degrees of freedom, Tests of significance, tests for proportion, t and F tests Confidence Intervals

Unit V

Contingency tables of χ^2 (Chi square) tests of goodness of fit and homogeneity.
Correlation: Simple, Partial and Multiple Correlation, Methods of averages and least squares, polynomial fitting, Regression Analysis. Analysis of variance for one and two way classification Design of experiments, randomization, replication local control, completely randomized and randomized block design.

PRACTICALS

Descriptive statistics: Systematic tabular summarization of data (before analysis),measures of central tendency, measures of dispersion, measures of skewness (using calculators).
Correlations (product-moment coefficient, Spearman's rank coefficient) and regression (linear regression, curve fitting).

Data presentation (tables/figures) : 1-D and 2-D bar charts, pie diagrams, graphs (using computer software packages).
Statistical distributions: fitting discrete uniform, binomial, Poisson and normal probability distributions to given data
Testing of hypotheses: Tests of significance (mean, standard deviation, correlation coefficient), chi-squared test for goodness of fit, test for independence of attributes, non-parametric tests (run test) using calculators and printed tables and using minitab sampling (drawing random samples using random numbers, tables, chits, computer programmes for random number generation), design of experiments, ANOVA (one-way and two-way).

M.Sc Biotechnology **Semester--I**

Course No. MBT 116 *MM. 25*

Course Title: **Communication Skills**

Time: 0.30min

NOTE: Seminars

Lectures: preparation, objective/s, concepts, contents, sequence, formal proof, interrelationships, logic, conclusions, time management, using audiovisual aids.
Giving a talk: body language: extempore and prepared talks.
Preparing for interviews, CV/biodata.
Vocabulary: word power, pronunciations, guessing the meaning of words from the context and body language and using a dictionary
Review of basic and grammar Punctuation marks: comma, colon, semicolon, full stop, inverted comma.
Avoiding repetitious statements, double positives, double negatives, circular arguments.
Dealing with questions: avoiding circumvention and circular arguments; answering after breaking down long questions into parts.
MS power point-based presentations.
Analysis of formal presentations in the course 3a in terms of actual presentations.

M.Sc. Biotechnology **Semester--II**

Course Title: Immunology *MM. Th 80 + IA 20*

Course No. **MBT 211** Time: 3h

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

Introduction
Phylogeny of Immune System-
Innate and acquired immunity
Clonal nature of immune response
Organization and structure of lymphoid organs
Nature and Biology of antigens and super antigens.

UNIT II

Antibody structure and function
Antigen - antibody interactions
Major histocompatibility complex
BCR & TCR, generation of diversity. Complement system
Cells of the Immune system: Hematopoiesis and differentiation

UNIT III

Lymphocyte trafficking, B-Iymphocytes, T-Iymphocytes, Macrophages, Dendritic cells, Natural killer and Lymphokine -activated killer cells, Eosinophils, Neutrophils and Mast Cells
Regulation of immune response:Antigen processing and presentation, generation of humoral and cell mediated immune responses:Activation of B- and T. Lymphocytes

UNIT IV

Cytokines and their role in immune regulation:T-cell regulation, HHC restriction Immunological tolerance
Cell - mediated cytotoxicity; Mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity
Hypersensitivity

UNIT V

Autoimmunity
Transplantation
Immunity to infectious agents (interacellular parasites, he1minthcs & viruses)
Tumor Immunology
AIDS and other Immunodeficiency
Hybridoma Technology and Monoc1onal antibodies

PRACTICALS

Blood film preparation and identification of cells
Lymphoid organs and their microscopic organization
Immunization, Collection of Serum
Double diffusion and Immune-electrophoresis
Radial Immuno diffusion
Purification of IgG from serum
Separation of mononuclear cells by Ficol1-Hypaque
Con-A induced proliferation of thymocytes (by MTT method)
Western-blotting
ELISA
Hapten Conjugation and quantitation
Immunodiagnostics (demonstration using commercial kits)

M.Sc. Biotechnology **Semester--II**

Course Title: Bioinformatics *MM. Th 80 + IA 20*

Course No**.** **MBT 212** Time: 3h

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

Computers

An overview of computers, microcomputers, VDUs and printer.
What is programming? Algorithms. Languages and packages: Introduction to MS Office, MS Access, Front Page and introduction to C, Java and SQL (structured querry language)
Handling arrays, procedures.
Colour, sound and graphics. Use of standard packages.

UNIT II

Introduction to PERL: Scalar variables, strings and numbers, Assignment statements, Arrays, Hashes, Operators, Input from file, Standard Input, Conditional and logical operators, loops, I/O, Input from file named in command line, Regular expression, Pattern matching, Meta symbols, Pattern modifiers, Subroutines.
Applications of PERL in Bioinformatics: Storing DNA sequence, DNA to RNA transcription, Finding motifs, Counting nucleotides, Generating random numbers, simulating DNA mutation, generating random DNA, Analyzing DNA

UNIT III

Biological Sequence Databases:
Overview of various primary and secondary databases that deal with protein and nucleic acid sequences. Databases to be covered in detail are GenBank, EMBL, DDBJ, Swiss Prot, PIR, and MIPS for primary sequences. Various specialized databases like TIGR, Hovergen, TAIR, PlasmoDB, ECDC etc., will also be discussed. Preliminary ideas of query and analysis of sequence information.

UNIT IV

Sequence Comparison Methods:
Method for the comparison of two sequences viz., Dot matrix plots, NeedlemanWusch & SmithWaterman algorithms. Analysis of computational complexities and the relative merits and demerits of each method. Theory of scoring matrices and their use for sequence comparison.

UNIT V

Database Search Algorithms:

Methods for searching sequence databases like FASTA and BLAST algorithms.
Statistical analysis and evaluation of BLAST results.

Pattern Recognition Methods in Sequence Analysis:

Concept of a sequence pattern, regular expression based patterns. The use of pattern databases like PROSITE and PRINTS. Concept of position specific weight matrices and their use in sequence analysis. Theory of profiles and their use with special reference to PSIBLAst. Markov chains and Markov models and their use in gene finding. Concept of HMMS, the Forward backward and the Viterbi algorithm. The Baum Welch algorithm for training a HMM. Use of profile HMM for protein family classification.

Practical: Computational modeling of genomic proteomic, evolutionary tree designing on databases, network search on genomic and proteomic databases.

M.Sc. Biotechnology **Semester--III**

Course Title: **Plant Physiology and Developmental biology** Time: 3h

Course No. BT 213 *MM. Th 80 + IA 20*

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

UNIT I

Photosynthesis: Light harvesting complexes; mechanisms of electron transport; photo protective mechanisms; CO_2 fixation-C_3, C_4 and CAM pathways.
Respiration and Photorespiration: Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photo respiratory pathway.

UNIT II

Nitrogen Metabolism: Nitrate and ammonium assimilation; amino acid biosynthesis.
Plant Hormones: Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action. Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks.
Solute Transport and Photoassimilate Translocation: Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem.

UNIT III

Cellular Movements and Body Plan –Laying of body axis planes; Differentiation of germ layers; Cellular polarity, cell wall and cell size and their importance in model plants like *Fucus* and *Volvox*; Concept of positional information and intercalation.

Embryonic Pattern Formation – Maternal gene effects; Zygotic gene effects; Homeotic gene effects in *Drosophila*; Embryogenesis and early pattern formation in plants.

UNIT IV

Post-embryonic Development – Regeneration and totipotency; Organ differentiation and development; Cell lineages and developmental control genes in *Caenorhabditis* and maize. Oraganisaion of shoot apical meristem (SAM), cytological and molecular analysis of SAM. Organization of root apical meristem, plant stem cells.
Leaf growth and development, leaf initiation, phylotaxy cannot of leaf forms, differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll.

UNIT V

Flower initiation, control of flowering and plant architecture, Transcription factors and genetic control of plant development. Hormonal and environmental control of plant development.

Special Aspects of Plant Development and Differentiation – Pollen germination and pollen tube guidance; Phloem differentiation; Sex determination in plants; Self incompatibility, and its genetic control; Heterosis and apomixis.

M.Sc. Medical Biotechnology MM. Th 80 + IA 20

Course Title**: Human Physiology and Developmental Genetics**
Course No. **MBT 214** Time: 3h
NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

Introduction to brain and neurobiology.
Sight and perception, hearing and balance, smell, taste, touch, pain, analgesics. Skin, hair.Muscles, movement, rheumatoid disorders. nervous system, skin, glands.
Heart and blood circulation, blood clotting, microvasculature.
Lungs, surfactants.Body fluids, fluid balance, parenteral solutions, renal physiology.

UNIT II

Hormones and homeostasis.
Digestive system, reproductive system, nervous system.
Genital system, reproductive biology and contraception.
Diseases of the digestive system, breathing, circulation, Mechanisms of drug action

UNIT III

Structure, chemistry, dynamics and regulation of sperm locomotion, capacitation and egg-surface targeting
Molecular biology, cytology and biochemistry of ovogenesis: Synthesis and storage of maternal transcripts, proteins and cell organelles. rDNA amplification in amphibia; transcription on lampbrush chromosomes, ovulation and hormonal control in mammals.

UNIT IV

Molecular and cellular biology of fertilization: acrosome reaction and signal transduction, monospermy and species-specificity.
Egg activation, early cleavages and blastocyst formation in mammals and biochemical and cellular changes during the passage down the oviduct to the uterus.

UNIT V

Implantation and formation of the placenta in mammals
Gastrulation in mammals-formation of primitive streak, morphogenetic movements and neural induction. Organogenesis and foetal development
Pattern forming genes and expression in Drosophila and mammalian embryos
Development of the mammalian brain-cerebral cortex-cell lineages
Lens development-fibre differentiation, programmed morphogenetic histogenetic cell death (apoptosis). Erythropoeisis, myelopoeisis. Ageing

PRACTICALS

1. Culture in *vitro* of chick embryo by New's technique and neural induction by transplanted Hensen's node.

2. Filter-paper ring culture of chick embryos.

3. Chick embryo limb bud organ culture and observation of cell death in interdigital regions by neutral red staining.

4. Sex-linked inheritance in Drosophila.

5. Non-allelic and allelic interaction in Drosophila.

6. Linkage study in Drosophila.

7. Allelic and heterozygotic frequencies in human populations.

8. Analysis of quantitative traits: frequency distribution, standard deviation and variance.

9. Karyotyping human cells and chromosomal in situ localization of genes.

10.Cell division : mitosis and meiosis.
Mutants of Drosophila. Sex liked lethals in Drosophila

Course Title: Microbial Technology *MM. Th 80 + IA 20*

Course No. ***BT 215*** *Time: 3h*

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

History of microbial exploitation in Industry for production of drug, Nutraceuticals and cosmetics. Microbes in food industries: Microbial growth pattern, physical and chemical factors influencing destruction of micro-organisms. Types of micro-organism normally associated with food-mold, yeast, and bacteria. Micro-organisms in natural food products and their control. Contaminants of foods-stuffs, vegetables, cereals, pulses, oilseeds, milk and meat during handling and processing.

UNIT II

Biochemical changes caused by micro-organisms, deterioration of various types of food product. Food poisoning and microbial toxins, microbial food fermentation, standards for different foods.

UNIT III

Microbial pharmaceutical industries: Production of antibiotics like penicillin, streptomycin, tetracycline, immunosupressor.
Microbial production of anti-cancer and antioxidant drug: production of CoQ10, beta-caretonid, astaxatine, demethylated cholochine and its derivative, gycosaamine.
Microbial production of alcohol , methanol and unsaturated fatty acid.
Use of microbe in mineral recovery.

UNIT IV

Bacterial and viral vectors
Biological warfare agents
Mode of action of antibiotics and antiviral: molecular mechanism of drug resistance (MDR)
Anti-viral chemotherapy. Anti-fungal chemotherapy.

UNIT V

Viral vaccines: conventional: killed/attenuated; DNA; peptide; recombinant proteins.
Sterilization techniques: biohazard hoods; containment facilities, BSL 2, 3, 4.

Practical

Production of antibiotics at shake flask level:
Production of alcohol at shake flask level.
Operation of bioreactor.
Isolation of antibiotics from microbial broth
Isolation of antioxidants from microbial broth.
Microbial transfer technique.

M.Sc.Biotechnologhy **Semester--III**

Course Title: ***Bioprocess Engineering.*** ***MM****. Th 80 + IA 20*

Course No. **BT 311** Time: 3h

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

Engineering units, state of a system, density, concentration, temperature pressure, enthalpy, material balances thermodynamics energy, and energy balance in open and closed system.
Fluid flow in biomass processing, liquid transport system, properties, handling system for Newtonian liquids, energy equation for steady flow of fluids, pump selection and performance, flow measurement, flow characteristics of Newtonian fluids, measurement of viscosity.

UNIT II

Energy for biotechnology industry: generation of steam fuel utilization, electric power utilization. Concept on heat transfer in biomass processing: type of heat exchanger mode of heat transfer, steady and unsteady state heat transfer. Microwave heating.
Preservation process for biological products: influence of external agents, thermal death point, spoilage probability, pasteurization, and commercial sterilization.

UNIT III

Concept on refrigeration system used in biotechnology industry, freezing, storage of food and biopolymers, biological products through freezing, concentration of broth through various type of evaporator.
Concept on Mass transfer of Biological product during processing i.e., steady state diffusion of gaseous through solid, convective mass transfer, laminar flow past a flat plate, turbulent flow in a past a flat plate

UNIT IV

Membrane separation process for separation of biological products, basis concept on dehydration, dehydration systems, dehydration system design.
Types of fermentation processes: Analysis of batch, Fed batch and continuous bioreactions, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors(pulsed, flui1ized, photobioreactors etc)

UNIT V

Measurement and control of bioprocess parameters,
Downstream Processing: Introduction, Removal of microbial cells and solid mater, foam reparation, precipitation filtration, centrifugation, cell disruptions, liquid- liquid extraction, chromatography, Effluent treatment: D.O.C. and C.O.D treatment and disposal of effluents

Practical

Isolation of industrially important microorganisms for microbial processes
Determination of thermal death point (TDP) and thermal death time (TOT) of microorganism for design of a sterilizer

(a) Determination of growth curve of a supplied microorganism and also determine substrate degradation profile.

(b) Compute specific growth rate (m), growth yield (Yx/s) from the above Comparative studies of Ethanol production using different substrates Microbial production of Citric acid usin Aspergillus niger. Microbial production of antibiotics (Penicillin) Production and estimation of Alkaline Protease Sauer Krant fermentation

M.Sc. Biotechnology **Semester--III**

Course Title: ***Plant Biotechnology*** *MM. Th 80 + IA 20*

Course No. **BT 312** Time: 3h

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

Conventional Plant Breeding, Introduction to cell and Tissue Culture, tissue culture as a technique to produce novel plant and hybrids. Tissue culture media (composition and preparation), Initiation and maintenance of callus and suspension cultures; single cell clones, Organogenesis; somatic embryogenesis; transfer and establishment of whole plants in soil. Shoot-tip culture: rapid clonal propagation and production of virus-free plants. Embryo culture and embryo rescue

UNIT II

Protoplast isolation; culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids, Anther, pollen and ovary culture for production of haploid plants and homozygooes lines, Cryopreservation, slow growth and DNA banking for germ plasm conservation

UNIT III

Plant Transformation Technology: basis of tumour formation, hairy root features of Ti and Ri plasmids, mechanisms of DNA transfer, role of virulence genes, use of Ti and Ri as vectors, binary vectors, use of 35S and other promoters, genetic Markers, use of reporter genes, repoter gene with introns, use of scaffold attachment region methods of nuclear transformation, viral vectors and their applications, multiple gene transfer, Vectors-less or direct DNA transfer, particle bombardment, electroporation, microinjection, transformation of monocots. Transgene stability .and gene silencing.

Chloroplast Transformation: advantages, vectors, success with tobacco and potato.

UNIT IV

Basic Techniques in rDNA Technology Application of Plant Transformation for productivity and performance: Herbicide resistance, phosphoinothricin, glyphosate, sulfonyl urea, atrazine, insect resistance Bt genes, Non-Bt like protease inhibitors, alpha amylase inhibitor, virus resistance, coat protein mediated, nucleocapsid gene, disease resistance, chitinase, 1-3beta glucanase, RIP, antifungal proteins, thionins, PR proteins,nematode resistance, abiotic stress, post-harvest losses, long shelf life of fruits and flowers, use of ACC synthase, Polygalacturanase,ACC oxidase, male sterile lines, bar and barnase systems.

UNIT V

Molecular Marker-aided Breeding: RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR (sequence characterized amplified regions), SSCP (single strand conformational polymorphism), AFLP, QTL, map based cloning, molecular marker assisted selection, Arid and semi-arid plant biotechnology, Green House and Green-Home technology

PRACTICALS

Preparation of media
Surface sterilization
Organ Culture
Callus propagation, organogenesis, transfer of plants to soil
Protoplast isolation and culture
Anther culture, production of Haploids
Cytological examination of regenerated plants
Agrobacterium culture, selection of transformants, reporter gene (GUS) assay.
Developing RFLP and RAPD maps

M.Sc. Biotechnology **Semester--IV**

Course Title: ***Animal Biotechnology*** *MM. Th 80 + IA 20*

Course No. ***BT 313*** *Time: 3hrs.*

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

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.

UNIT II

Role of serum and supplements
Serum & protein free defined media and their application
Measurement of viability and cytotoxicity
Biology and characterization of the cultured cells, measuring parameters of growth
Basic techniques of mammalian cell culture in vitro disaggregation of tissue and primary culture maintenance of cell culture cell separation

UNIT III

Scaling-up of animal cell culture
Cell synchronization
Cell cloning and micromanipulation
Cell transformation

UNIT IV

Application of animal cell culture
Stem cell cultures,' embryonic stem cells and their applications
Cell culture based vaccines.

UNIT V

Somatic cell genetics
Organ and histolypic cultures
Measurement of cell death
Apoptosis
Three dimensional culture & tissue engineering

Practicals

Preparation of tissue culture medium and membrane filtration
Preparation of single cell suspension from spleen and thymus
Cell counting and cell viability\
Macrophage monolayer from PEC, and measurement of phagocytic activity
Trypsinization of monolayer and sub culturing
Cryopreservation and thawing
Measurement of doubling time
Role of serum in cell culture
Preparation of metaphase chromosomes from cultured cells
Isolation of DNA and demonstration of apoptosis of DNA laddering
MTT assay for cell viability and growth
Cell fusion with PEG

Course Title: Genetic engineering *MM. Th 80 + IA 20*

Course No**. BT 314** Time: 3h

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

Scope of Genetic Engineering, Milestones in Genetic Engineering

Isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separation cloning, gene expression. Cloning and patenting of life forms. Genetic engineering guidelines, Molecular Tools and Their Applications, Restriction enzymes, modification enzymes, DNA and RNA markers

UNIT II

Nucleic Acid Purification, Yield Analysis, Nucleic Acid Amplification and its Applications, Gene Cloning Vectors, Restriction Mapping of DNA Fragments and Map Construction, Nucleic Acid Sequencing, cDNA Synthesis and Cloning , mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis, Library construction and screening, Alternative Strategies of Gene Cloning

UNIT III

Cloning interacting genes-Two-and three hybrid systems, cloning differentially 'expressed genes. Nucleic acid microarray arrays Site-directed Mutagenesis and Protein Engineering , How to Study Gene Regulation? DNA transfection, Northern blot, Primer extension, S1 mapping, RNase protection assay, Reporter assays

Expression strategies for heterologous genes, Vector engineering and codon optimization, host engineering,in vitro transcription and translation, expression in bacteria expression in yeast, expression in insect cells, expression in mammalian cells, expression in plants.

UNIT IV

Processing of recombinant proteins: Purification and refolding, characterization of recombinant proteins, stabilization of proteins.

Phage Display, T-DNA and Transposon Tagging

Role of gene tagging ingene analysis, T-DNA and Transposon Tagging, Identification and isolation of genes through T-DNA or Transposon.

UNIT V

Transgenic and gene knockout technologies

Targeted gene replacement, chromosome engineering.

Gene therapy: Vector engineering strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.

PRACTICALS

Bacterial culture and antibiotic selection medias. Prepration of competent cells.
Isolation of plasmid DNA.
Isolation of lambda phage DNA .
Quantitation of nucleic acids.
Agarose gel electrophoresis and restriction mapping of DNA
Construction of restriction map of plasmid DNA.
Cloning In plasmid/phagemid vectors.
Preparation, of helper phage and its titration\
Preparation of single stranded DNA template
DNA sequencing
Gene expression in E. coli and analysis of gene product
PCR and Reporter Gene assay (Gus/CAT/b-GAL)

Course Title: ***Environmental Biotechnology*** *MM. Th 80 + IA 20*

Course No. ***BT 315*** *Time: 3h*

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

UNIT I

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. Air pollution and its control through Biotechnology.

UNIT II

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 process. Microbiology of Waste Water Treatments, Aerobic Process; activated sludge, Oxidation ditches, trickling filter, towers, rotating discs, rotating drums oxidation ponds. Anaerobic Processes:

UNIT III

Anaerobic digestion, anaerobic filters Up flow anaerobic sludge blanket reactors.
Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries

UNIT IV

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

UNIT V

Biopesticides in integrated pest management. Solid wastes; sources and management (composting wormicu1ture and methane production)
Global Environmental Problems: Ozone depletion UV-Br green-house effect and acid rain their impact and biotechnological approaches for management

PRACTICALS

Detection of coliforms for determination of the purify of potable water
Determination of total dissolved solids of water
Determination of dissolved oxygen concentration of water sample.
Determination of biological oxygen demand (BOD) of a sewage sample.
Determination of chemical oxygen demand (COD) of sewage sample
Determine the efficiency of removal of air pollutant using fibrous air filter
Isolation of xenobiont degrading bacteria by selective enrichment techniques
Test for degradation of a aromatic hydrocarbons by bacteria
Survey of degradative plasmids in microbes growing in polluted environment
Effect of sulphur dioxide on crop plants
Estimation of heavy metals in water/soil by Atomic absorption spectrophotometry
Estimation of nitrate in drinking water
Study on biogenic methane production in different habitats

Choice Based Paper

Semester--IV

Course Title: Management Issues in Biotechnology **MM- Th 80 + IA 20**

Course No. ABT 411A **Time: 3hrs**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory

Unit I

Introduction to Biotechnology
, Structure of a Biotechnology Company
, Scientific Principles, Start-up of Biotechnology Company, New Product Development, Management Styles and Strategies,

Unit II

Sales & Marketing Principles, Sales & Marketing Principles, Intellectual Property
, Principles in Biotechnology
, Legal Issues in Biotechnology
, Moral Issues in Biotechnology
,

Unit III

Health Care Overview and Reimbursement in Biotechnology
(The concept of return investment), Business Communication, Managerial Economics Human Resource Management,

Unit IV

Management Information Systems,Logistics & Supply Chain Management, Decision Science,Sales and Distribution,Financial and Cost Accounting,

Unit V

Intellectual Property Rights,Fundamentals of Marketing,Research Methodology, Principles of Management,Marketing Management, Strategic Management

Semester--IV

Course Title: IPR and Biotechnology **MM- Th 80 + IA 20**

Course No. ABT 411 B **Time: 3hrs**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Unit-I

Intellectual property rights: Meaning,-Evolution-Classification and forms, Rationale for protection of IPRs- Importance of IPRs in the field of science and technology. Scientific and Commercial breakthroughs of Biotechnology at national and intellectual level.

Unit-II

Intellectual Property: A Copy Right & Industrial Properties, Trademarks, Designs, Geographical Indications; IPR & Technology transfer, Role of patentee & Licensor, Breakthroughs of IPR at National and International level.

Unit-III

Patents-Concepts and principles of patenting-Patentable subject matter; Procedure of obtaining patents- Rights of patents- Infingement of patent rights; Remedies for infringement of patent rights- Patentability and emerging issues.

Unit-IV

Patentability of life forms with special refernce to Microorganisms, Pharmaceutical industries Biodiversity, naturally occurring substances.

Unit-V

Human genome and IPR, in Public-Private partnership, Government Policies at National and International level in patenting IPR. Availability of Patent facilitating funds, Subtentative Patent Law Treaty, (SPLT), Word Patent, European Patent.

Course Title: Social, Ethical, Legal and management Issues in Biotechnology

Course No. ***BT 412*** *MM. Th 80 + IA 20*

Time: 3hrs.

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Theory:

UNIT I

IPR - patents and copyrights. Patentability of life forms with special reference to Microorganisms, Pharmaceutical industries, Biodiversity, Naturally occurring substances. Human genome and IPR. Issue on IPR in Public-Private partnership.
Availabilities of Patent facilitating funds, Substantive Patent Law Treaty (SPLT), Word patent, European Patent.

UNIT II

Social- genetic discrimination: insurance and employment, human cloning, foeticide, sex determination.

UNIT III

Ethical: somatic and germ line gene therapy, clinical trials, the right to information, ethics committee function. Social and ethical issues

UNIT IV

Biosafety - Definition, Requirement, Biosafety containment facilities, biohazards, genetically modified organisms (GMOs), living modified organisms (LMOs), Biosafety for human health and environment designing and management of laboratory and culture room as per the norm of GLP, GMP and FDA.

UNIT V

Management-Planning, Organizing, Leading & Controlling; Concepts and characteristics of information; Importance of MIS; Communication - type, channels & barriers; Financial management, planning and *control,* Characteristics of agricultural products; Problems of processed food marketing; Procurement & distribution systems; Location factors and other problems in processing of agricultural products;

Practical

Survey and preparation of datasheet social response for use of drug and bio-aids, developed through biotechnology means. Application of statistical methods in data analysis of social response in using drug and healthcare derived from transgenic bacteria, animal and transgenic plants.

Semester--IV

Course Title: Ethical, Legal, Social issues in Biotechnology

MM- Th 80 + IA 20

Course No. ABT 412 **Time: 3hrs**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Unit-I

Introduction- causes of unethical acts, ignorance of laws, codes, policies and Procedures, recognition, friendship, personal gains, Professional ethics-professional conduct.

Unit-II

Ethical decision making, ethical dilemmas good laboratory practices, good manufacturing practices, laboratory accreditation.

Unit-III

Social- genetic discrimination: insurance and employment, human cloning & its impart on feticide sex determination

Unit-IV

Ethical: somatic and germ line gene therapy, clinical trials, the right to information, ethics committee function. Social and ethical issues.

Unit-V

Biosafety- Definition, Requirement, Containment facilities, biohazards, genetically modified organisms (GMOs) living modified organisms (LMOs), Biosafety for human health and environment designing and management of laboratory and culture room as per the norm of GLP, GMO and FDA.

Semester--IV

Course Title: Bioentrepreneurship

MM- Th 80 + IA 20

Course No. ABT 412 **Time: 3hrs**

NOTE: In all ten questions will be set, two from each unit. Students are required to attempt five questions i.e. one from each unit.

Unit-I

Introduction: Creativity & Entrepreneurial personality and Entrepreneurship in Biotechnology, Concept and theories of Entrepreneurship, Entrepreneurial traits and motivation, Nature and importance of Entrepreneurs, Government schemes for commercialization of technology (Eg. Biotech Consortium)

Unit-II

Project management: Search for a business idea, concept of project and classification, project identification, project formulation, project design and network analysis, project report, project appraisal.

Unit-III

Financial analysis: Ratio analysis, Investment process, Break even analysis, Profitability analysis, Budget and planning process.

Unit-IV

Sources of finance: Source of development finance, Project financing, Institutional financing to Entrepreneurs, Financial institutions, Role of consultancy organizations.

Marketing channels: Methods of marketing, marketing channels, Marketing institutions and assistance.

Unit-V

Biotech enterprises: Setting up Small, Medium & Large scale industry, Quality control in Biotech industries, Location of an enterprise, steps for starting a small industry, incentives and subsidies, exploring export possibilities.

References:

1. Innovation and entrepreneurship in biotechnology: Concepts, theories & cases by D. Hyne & John Kapeleris, 2006.
2. The Buisiness of Biotechnology: From the Bench of the Street: By Richard Dana Ono Published Butterworth- Heinemann, 1991.
3. Entrepreneurship in Biotechnology: Managing for growth from start-up By Martin Gross mann, 2003.
4. Best Practices in Biotechnology Education: By Yali Friedman, Published by Logos Press, 2008. 356 pages.
5. Plant Development and Biotechnology: by Robert Nicholas Trigiano, Dennis John Gray; Published by CRC Press, 2004, 358 pages.
6. Dynamics of Entrepreneurial Development and Management, Vasant Desai, Himalaya Publishing House, 2005.
7. Projects: Planning Analysis, Selection, Implemantation & Review, Prasannan
8. Chandra, Tata Mc Graw-Hill Publishing Co. 12997.