Course Contents

of

M.Sc. Medical Biotechnology

(Semester system)

Centre for Biotechnology
Maharshi Dayanand University, Rohtak

M.Sc. Medical Biotechnology Semester--I

Course Title: Cell Biology MM. Th 80 + IA 20

Course No. MBT 121 **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. Medical Biotechnology **Semester--I**

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

Course No. MBT 122 **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, MMR, 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. MBT 123 **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 chemoautotrophs,' 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: Purple 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: Penicillins 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. Medical Biotechnology **Semester--I**

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

Course No. MBT 124 **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. Medical Biotechnology **Semester--I**

Course No. MBT 125 **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. Medical Biotechnology **Semester--I**

Course No. MBT 126

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. Medical Biotechnology **Semester--II**

Course Title: Immunology MM. Th 80 + IA 20

Course No. MBT 221 **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. Medical Biotechnology **Semester--II**

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

Course No. MBT 222 **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. Medical Biotechnology **Semester--II**

Course Title: Human Physiology and Developmental Genetics

MM. Th 80 + IA 20

Course No. MBT 223 **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: Genetic engineering **MM. Th 80 + IA 20**

Course No. MBT 224 **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)

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

Course Title: Animal Cell culture and Vaccinology

MM. Th 80 + IA 20

Course No. MBT 225 **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

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, Application of animal cell culture, Apoptosis

History of Vaccinology, conventional approaches to vaccine development, live attenuated and killed vaccines, adjuvants, quality control, preservation and monitoring of microorganisms in seed lot systems.

UNIT IV

Instruments related to monitoring of temperature, sterilization, environment, quality assurance and related areas, production techniques, growing the microorganisms in maximum titre, preservation techniques to maintain good antigen quality, freeze drying

UNIT V

Introduction to newer vaccine approaches namely- subunit vaccines, synthetic vaccines, DNA vaccines, virus like particles, recombinant vaccines, edible vaccines, nanoparticles in vaccine delivery systems

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

Inoculation of embryonated chicken eggs for cultivation of virus

Harvesting of virus from the inoculated embryo

Immunization of laboratory animals

Titration of antibodies against the recombinant protein

Suggested Readings

- Culture of Animal Cells- A manual of basic techniques by R.I. Freshney
- Barry R Bloom, Paul-Henri Lambert 2002. *The Vaccine Book.* Academic Press
- Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. *The new generation vaccines.* 3rd Ed. Informa Healthcare.
- Lowrie DB & Whalen R. 2000. *DNA Vaccines.* Humana Press.

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

Course Title: **Medical Microbiology and Biology of infectious diseases**
Time: 3h

Course No. MBT 321 **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

Bacteria: Representative diseases to be studied in detail are - tetanus, diphtheria, cholera, typhoid, tuberculosis, leprosy, plague, and syphilis. Infections caused by anaerobic bacteria, spirochetes, chlamydia, rickettsiae.

Viruses: Representative diseases to be studied in detail are - viral hepatitis, influenza, rabies, polio and AIDS and viral cancers.

Fungi: Diseases to be taken up in following categories: superficial, subcutaneous, systemic and opportunistic mycoses.

Protozoa: Diseases to be discussed are - amoebiasis, toxoplasmosis, trichomoniasis & leishmaniasis.

UNIT II

Disease burden : microbial, viral, fungal and parasitic.

Investigation of epidemics

Methods of culturing and assaying: bacterial, viral and parasitic.

Classification: fungal, protozoal, helminthic, bacterial and viral

Replication of DNA, RNA+ve and RNA-ve viruses, retroviruses

UNIT III

Viral vaccines: conventional: killed/attenuated; DNA; peptide; recombinant proteins.

Sterilization techniques: biohazard hoods; containment facilities, BSL 2, 3, 4.

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

Hospital-acquired infections (nosocomial), immune compromised states.

Water and waste management for water-borne diseases. . Modern approaches for diagnosis of infectious diseases: Basic concepts of gene probes, dot hybridization and PCR assays.

PRACTICALS

Staining techniques.

Haemagglutination test.

Commercial kits-based diagnosis.

Antibioticsensitivity(bacterial).

Electron microscopy (demo)

Bacterialculture

Agar gel diffusion

ELISA

Preparation of axenic cultures

Course Title: Stem Cell Biology & Somatic and Germ Cell Engineering

MM. Th 80 + IA 20

Course No. MBT 322 **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 stem cells - Embryonic Stem Cells, Adult stem cells, Molecular basis Pluripotentency and its application, Stem cell niches, Stem cell renewal, Cell cycles regulators in stem cells

UNIT II

Epigenetic mechanism of cellular memory, Germ line Stem Cells, Stem Cells and Cloning, Nuclear cloning and Epigenetic reprogramming; Growth Factors and Signal Cascades BMP, Nodal, Wnt, Notch and Retenoid signaling during gastrulation

UNIT III

Tissue and organ development- Differentiation in early development, Primordial germ cells in mouse and Human, Bone Marrow Mesenchymal Stem Cells , Hematopoietic Stem Cells: Identification, Characterization, Assays and Cell Lineages,

UNIT IV

Applications- Neurons Stem Cells and Potential Therapies, Spinal cord injury, Strategies Using Cell Therapy to Induce Cardiomyocyte Regeneration in Adults with Heart Disease, Stem cell therapy: Current State and Future Perspectives, Embryo culture, transplantation and teratogenesis.

UNIT V

Teratomas. Organ culture. Artificialblood.Amniocentesis-karyology and biochemical diagnostics-genetic counselling.Mammalian embryo fusion-allopheny. Transgenesis-gene transfers, knock-outs. Somatic cell fusion and somatic cell genetics.

PRACTICALS

Animal cell tissue culture – sterile working techniques.

Chick embryo fibroblast primary cell cultures and mouse chorionic villus cells.

Induced ovulation in mouse, collection of oviducal eggs and in vitro fertilization, culture in *vitro* of mouse embryos to the blastocyst state.

Transferring a foreign gene (e.g., chicken globin gene) into mouse fertilized eggs and transplantation of transformed mouse blastocysts in foster females.5. Microinjection or electroporation of ES cells with foreign DNA (e.g., chicken globin gene, transplantation into mouse blastocyst and transfer to foster females.

Diagnosing tail DNA of chimeric mouse pups for transferred genes fusing HeLa and chicken erythrocyte cells in vitro for heterokaryons.

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

Course Title: Human Genetics and Human Genome **MM. Th 80 + IA 20**
Course No. MBT 323 **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 and development of human genetics; organization of the human genome.

Genes and chromosome-structure, function and inheritance.

Repetitive DNA in human genome-Alu and SINE repeats.

Functional organization of centromeres and telomeres, telomerases and centrosomes

Methods for genetic study in man – pedigree analysis, chromosomal analysis, biochemical analysis.

UNIT II

Somatic cell genetics (somatic cell hybrids, radiation hybrids, monochromosome hybrid panels, gene mapping, hybridoma technology, polyclonal and monoclonal antibodies), molecular genetic analysis.

Tissue culture techniques, long-term and shorts-term cultures,

lymphoblastoid cell lines; congenital abnormalities; clinical aspects of autosomal and sex chromosomal disorders; inborn errors of metabolism, haemoglobinopathies.

UNIT III

Human genome mapping – genetic mapping, physical mapping-restriction fragment length polymorphism, pulse field gel electrophoresis, yeast artificial chromosomes, bacterial artificial chromosomes, P1 derived artificial chromosomes, expressed sequence tags, sequence-tagged sites, microsatellites and single nucleotide polymorphisms.

UNIT IV

Inherited human diseases-single gene diseases, complex traits.

Identification and isolation of disease genes – positional cloning, functional cloning, DNA and cDNA microarrays.

UNIT V

Yeast two-hybrid system.

Statistical methods for genetic analysis of complex traits.

Cancer genetics. Immunogenetics; pre-natal diagnosis-chorionic villus sampling, amniocentesis Pre-implantation diagnosis.

Genetic counselling.Gene therapy-concept, vectors, gene targeting and tissue-specific expression

Ethics and human genetics. Introduction to pharmacogenomics and toxicogenomics.

PRACTICALS

Pedigree analysis

Chromosome preparations-PHA-stimulated short-term blood cultures, air-dried chromosome preparations.

G-banding of chromosomes.

Karyotype preparation.

In situ hybridization-FISH (example with centromeric and telomeric probes).

Polyacrylamide gel electrophoresis-detection of enzyme (for example-G6PD, an X-linked enzyme)

RFLP-radioactive and non-radioactive probes (for example with actin gene).

PCR-PAGE (radioactive/non-radioactive) for microsatellite marker for linkage analysis.

PCR-RFLP-based genotyping.

PCR-SSCP for mutation detection.

Single nucleotide polymorphism typing.

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

Course Title: Molecular Modeling and Drug Designing MM. Th 80 + IA 20

Course No. MBT 324 **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

Concept of external and internal coordinates and algorithms for their interconversion. Different representations of molecular structures and their relative merits and demerits.

UNIT II

Experimental Methods for Molecular Structure Determination:

Brief account of structure determination by X-ray crystallography and NMR spectroscopy. Validation of experimentally obtained NMR structures. The Protein Data Bank (PDB) and the Nucleic Acid Data Bank (NDB). The PDB and the mmCIF file formats for the storage and dissemination of molecular structures.

UNIT III

Conformational Analysis:

Concept of free energy of molecules. Introduction to various force fields and their relative merits and demerits. Techniques for Molecular energy minimization, Monte Carlo and Molecular Dynamics simulation.

UNIT IV

Molecular Modelling:

Methods of molecular modeling including homology modeling, threading and ab initio protein structure prediction together with their relative merits and demerits. Methods for structure structure comparison of macromolecules with special reference to proteins.

UNIT V

Drug Design:

General ideas of drug designing, 2D and 3D QASR, concept of a pharmacophore and pharmacophore based searches of ligand databases. Concepts of COMFA. Methods for simulated docking.

Practical Syllabus for Molecular Modeling and Drug designing

1. **Introduction to computational software used in dru design.**
2. **Sketching and energy minimization of drug molecules**
3. **Computation of molecular properties of drug molecules**
4. **Development of linear regression models**
5. **Development of MLR models**
6. **Development of QSAR models by using training and test sets**
7. **Development of multi-target QSAR models**
8. **Development of NLR models**

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

Course No. MBT 325 **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

Quality control, GMP and GLP, records.
Biochemical disorders

Immune disorders

Infectious diseases

Parasitic diseases

Genetic disorders chromosomal disorders, single cell disorders and complex traits.

UNIT II

Chromosomal disorders : autosomal; sex chromosomal; karyotype analysis.

G-banding, in *situ* hybridization (FISH and on-FISH), and comparative genomic hybridization (CGH).Cancer cytogenetics: spectral karyotyping.

UNIT III

DNA diagnostics: PCR based diagnostics; ligation chain reaction, southern blot diagnostics, array-based diagnostics, DNA sequencing, genetic profiling, single nucleotide polymorphism.

Haemoglobinopathies.

UNIT- IV

Neuro developmental disorders.

Neuro degenerative disorders.

Dynamic mutations.

Biochemical diagnostics: inborn errors of metabolism, haemoglobinopathies, mucopolysaccharidoses, lipidoses, and glycogen storage disorders.

UNIT V

Immunodiagnostics: diagnosis of infectious diseases, respiratory diseases (influenza, etc.)Viral diseases-HIV etc., bacterial diseases, enteric diseases, parasitic diseases and mycobacterium diseases., Phage display, immunoarrays, FACs.

PRACTICALS

G-banded chromosomal preparations for detection of autosomes of autosomal/sex chromosomal disorders. (translocation, deletion, Down's syndrome, Klumefelter syndrome, Turner's syndrome, etc.), FISH for detections of : translocations, inversions (using appropriate probes) (e.g., chro 9-22 translocation; X-Y translocation)

PCR bases diagnosis (e.g. fragile-X syndrome; SRY in sex chromosomal anomalies).

Southern blot-based diagnosis (e.g. trinucleoide expansions in fragile-X syndrome, SCA, etc.) ,DNA sequencing of representative clones to detect mutation(s)

PCR-SSCP to detect mutations (e.g., sickle cell anemia, thalassemia)

SNP analysis for known SNPs., PAGE: band detection of enzyme variants.

Immunodiagnostics. Production of monoclonal antibodies.

Immunogenetics of mice-fusion of myeloma cells.

Selection of hybrid-use of MoAb in diagnostics of TB.

Avidin biotin technique in immunocytochemical staining.

Immunofluorescence technique. Immunoblot analysis of antigens and allergens.

ELISA for detection of *Salmonella* in food, antibodies to AIDS viruses.

Semester--IV

Course Title: Management Issues in Biotechnology
MM- Th 80 + IA 20
Course No. MBT 421 **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

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

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

Course No. MBT 422 **MM. Th 80 + IA 2** **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

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. Religious consideration in stem cell therapy

UNIT III

Ethical: somatic and germ line gene therapy, clinical trials, the right to information, ethics committee function. Social and ethical issues Ethics in human stem cell research FDA product and regulatory considerations in stem cell

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*,

PRACTICAL

Survey and preparation of data sheet 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.