M.Sc. Bioinformatics **Semester--I**

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

Course No.**BIN 131** 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. Bioinformatics **Semester--I**

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

Course No**. BIN 132** 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. Bioinformatics **Semester--I**

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

Course No. **BIN 133** 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. Bioinformatics **Semester--I**

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

Course No.**MBT 134** 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. Bioinformatics **Semester--I**

Choice Based Paper

Course No. BIN 135 ***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. Bioinformatics **Semester--I**

Course No. BIN 136 *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. Bioinformatics **Semester--II**

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

Course No. **BIN 231** 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. Bioinformatics **Semester--II**

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

Course No**.** **BIN 232** 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. Bioinformatics **Semester--II**

MM. Th 80 + IA 20

Course Title**: Human Physiology and Developmental Genetics**
Course No. **MBT 233** 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

M.Sc. Bioinformatics **Semester--II**

Course Title: **Biophysics**

Course No. MBT 234 ***MM. Th 80 + IA 20***

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 1: Molecular forces in biological structures

The Coulomb potential, Electrostatic self-energy, Image forces, Charge–dipole interactions, Induced dipoles, Cation–pi interactions, Dispersion forces, Hydrophobic forces, Hydration forces, Hydrogen bonds, Steric repulsions, Bond flexing and harmonic potentials, Stabilizing forces in proteins, Protein force fields, Stabilizing forces in nucleic acids, Lipid bilayers and membrane proteins, Macroscopic diffusion: Fick's laws Microscopic diffusion – random walks

Unit 2: Conformations of macromolecules

n-Butane Configurational partition functions and polymer chains, Statistics of random coils, Effective segment length, Non-ideal polymer chains and theta solvents, Probability distributions of conformations, Loop formation, Stretching a random coil, Backbone rotations in proteins: secondary structure, The entropy of protein denaturation, The helix–coil transition, Protein folding, Cooperativity in protein folding

Unit 3: Global transitions in proteins

Defining a global state, Equilibrium between two global states, Global transitions induced by temperature, Lysozyme unfolding, Steepness and enthalpy, Cooperativity and thermal transitions, Transitions induced by other variables, Transitions induced by voltage,

Unit 4: Molecular associations

Association equilibrium in solution, Cooperativity, Concerted binding, Sequential binding, Nearest neighbour interactions, Thermodynamics of associations, Contact formation, Translational free energy, Rotational free energy, Vibrational free energy, Solvation effects, Configurational free energy, Protein association in membranes – reduction of dimensionality, Binding to membranes

Unit 5: Allosteric interactions

The allosteric transition, The simplest case: one binding site and one allosteric transition, Binding and response, Energy balance in the one-site model, G-protein coupled receptors, Binding site interactions, The Monod–Wyman–Changeux (MWC) model, Honorary enzyme - Hemoglobin

M.Sc. Bioinformatics **Semester--II**

Course Title: **Fundamental of Computer and Algorithms**

Course No. MBT 235 ***MM. Th 80 + IA 20***

Time: 3h

Unit-I

:

Computer Architecture

Instruction and instructions Codes, Computer instructions, Timing and Control, Instruction Cycle, Memory Reference Instructions, Input-output and Interrupts; Complete Computer Description. Central Processing Unit- General Register Organization Stack Organization Instruction Formats, Addressing Modes, Data and Transfer Manipulation, Program Control, Reduced Instruction Set Computer, Pipeline and Vector Processing parallel processing pipelining, Arithmetic Pipeline, Arrays Processors. Input-Output Organization Peripheral Devices, Input-Output interface, Asynchronous Data Transfer, Modes of Transfer, Priority interrupt, Direct Memory Access (DMA), input-output processors (IOP), Serial communication multiprocessors, Inter-connection structures, Inter-processor Communication and Synchronization, Cache Coherence.

Unit-II

Computer Networking:

Concept of data transfer and computer networking, Introduction to network topology LAN, WAN, Network reference Models: Layered architecture, protocol hierarchies, interface and services; ISO-OSI reference model, TCP/IP reference model; Novel Netware, Internet protocol stacks.

Unit-III

Programming Logic

Algorithm development, Techniques or problem solving, Flow-charting, Step-wise refinement, Algorithms for searching, sorting (exchange and insertion), merging of ordered lists, Programming, Representation of integers, characters, real Data types: constants and variables; Arithmetic Expressions, Assignment statement, Logical expression, Sequencing, Alteration and iteration; ring

processing; Sub programs, Recursion, Files and pointers; Structured programming concepts; Top down Design, Development of efficient program; program correctness; Debugging and testing of Programs.

Unit-IV

Advanced Programming in Perl

Introduction to PERI, Control structures, Arrays & Hashes, Sub routines & functions, Introduction to CGI, Regular expressions, String manipulations, File processing, File & Directory manipulations, Formatting.

Unit-V

Programming in PYTHON

Introduction to Python, Working with Data, Program Organization and Functions, Modules and Libraries, Classes and Obejects, Inside the Python Object System, Testing Debugging, Iterators and Generators, Working with Text, Binary Data Handling, Working with Processes, Python Integration Primer.

References

1. Beginning PERL for Bioinformatics
2. Mastering PERL for Bioinformatics
3. Python cookbook

M.Sc. Bioinformatics **SEMESTER -III**

BIM. 331 (T+P) *Genomics and proteomics*

Theory

Syllabus:

Unit 1:
Counting: DNA-Microarrays, Obtaining and Evaluating Gene Expression Profiles with cDNA Microarrays, Large Scale Expression Screening, Identification of Molecular Pathways and Predicts Gene Function, The Glean Machine: What Can We Learn from DNA Sequence Polymorphisms?

Unit 2:
Automatic Assembly and Editing of Genomic Data, QUEST: An Iterated Sequence Databank Search Method, An Essay on Individual Sequence Variation in Expressed Sequence Tags(ESTs), Sequence Similarity Based Gene Prediction. Is Human Genetics Becoming Dangerous to Society?

Unit 3:

Functional Proteomics, Protein Phenotypes - A polygenic trait, From Sequence to Structure and Function: Modelling and Simulation of Light-Activated Membrane Proteins, SHOX Homeobox Gene and Turner Syndrome

Unit 4:
The Genome As a Flexible Polymer Chain: Recent Results from, Simulations and Experiments, Chromosome Territory Architecture in the Human Cell Nucleus: Overview of Data from a Collaborative Study

Unit 5:
A Feature-Based Approach to Discrimination and Prediction of Protein Folding, Linking Structural Biology with Genome Research: The Berlin "Protein Structure Factory" Initiative, G Protein-coupled Receptors, or the Power of Data; Distributed Application Management in Bioinformatics

Practicals

Syllabus:

• Analysis of a sample microarray data.

• Expression profile identification and pathway identification

• Assembling and editing of Genomic data

• Gene prediction

• From Sequence to stucture: large scale structure prediction

• Functional genomics: Assigning functions to genes through structural bioinformatics

M.Sc. Bioinformatics **SEMESTER -III**

BIM 332 (T) Object Oriented and Relational Databases

Theory

Syllabus:

Unit 1

Basic Concepts

- o Database System Concepts and Architecture
- o Entity-Relationship Model
- o EER and Object Modeling

Relational Databases

- o Relational Model, Algebra, Calculus
- o ER- and EER-to-Relational Mapping
- o Relational languages SQL and QBE
- o RDBMS Systems: SQL server and MS Access

Unit-2

• Object-Oriented Database Systems

- o Object-oriented concepts
- o Object Modeling
- o Object-Oriented Databases
- o Object Database Languages
- o Object Database Design
- o Object-Relational and Extended Relational Database Systems

• Database Design

- o Functional Dependencies
- o Normalization
- o Design Algorithms and Further Dependencies

Unit-3

• Part 5: System Implementation Techniques

- o Query Processing and Optimization
- o Transaction Processing
- o Concurrency Control
- o Recovery
- o Security and Authorization

• Distributed Databases and Client-Server Architecture

- o Distributed Database Architecture
- o Data Fragmentation, Replication, and Allocation
- o Distributed Query Processing
- o Distributed Concurrency Control
- o Client-Server Architecture

Unit-4

• Active Databases

- Event Languages, Event Detection and Delivery
- Rule Processing
- Applications of Active Databases
- Data Management in Mobile Computing
- Caching and Prefetching
- Data Replication
- Speculative Data Dissemination and Broadcast Disk
- Mobile and Distributed Query Processing
- Mobile Transactions

Unit-5

• Multimedia Databases
  - Multimedia Networking
  - Multimedia Storage and Indexing
  - Content-based Multimedia Information Retrieval
• Data Warehousing and Data Mining
  - Data Warehousing
  - Data Mining
  - OLAP
• Database Systems and the World-Wide-Web)
  - Connecting Database to the Web
  - Web Search
  - XML and the New Generation Web

References:

• Database Management and Design by G.W. Hansen and J.V. Hansen; Prentice-Hall of India
• Database System Concepts by A. Silberschatz, H.F. Korth and S. Sudarshan; McGraw-Hill
• Database Systems: The Complete Book by Garcia-Molina, J. D. Ullman, and J. Widom; Prentice Hall.
• Fundamentals of Database Systems by Ramez Elmasri and Shamkant B. Navathe, Addison-Wesley.
• Database Management Systems by R. Ramakrishnan and J. Gehrke; McGraw-Hill
• Database Systems by T. Connolly and C. Begg.; Addison-Wesley.
• Database Management Systems by A.K. Majumdar and P. Bhattacharyya; Tata McGraw-Hill
• An Introduction to Database Systems by C.J. Date, Addison-Wesley.
• Fundamentals of Database Systems by R. Elmasri and S.B. Navathe; Addision-Wesley.
• Modern Database Management by R.F. McFadden and J.A. Hoffer, Benjamin-Cummins (Narosa).
• Data structures, algorithms, and object oriented programming by Heileman, G.L New Delhi, Tata McGraw-Hill Publishing Company Limited, 2002.

M.Sc. Bioinformatics **SEMESTER -III**

BIM 333(T+P) Tools & Techniques for biological data mining

Theory
Syllabus:

Unit-1

• Quality of Biological Data & Data Accuracy

• General issues regarding Biological Databases; Representation of errors due to (machines, 3D structural and sequence data of proteins and nucleic acid, Proteomics and Microarray data)

Unit-2

- Optimization Techniques
- Steepest Descent, Conjugate Gradient, Newton-Raphson
- Simulated annealing in Biomolecular Structure Optimization

• Genetic Algorithms
• *Ab initio* methods for structure prediction
o Lattice, SOM, etc.
o Information theory, entropy and relative entropy
o Stochastic Grammars & Linguistics

Unit-3

• Clustering & Classification Algorithms
o Hierarchical and non-hierarchical Clustering
o K-Means clustering
o Grid based clustering
o Analysis of MD trajectories
o Microarray and Protein Array data Analysis

Unit-4

• Dynamic Programming & application in
o Sequence Alignments
o Structure Alignments
• Foundations for Machine learning Techniques:
o Hidden Markov Model
o Neural Network
o Bayesian modeling
o The Cox-Jaynes Axiomes

Unit-5

• Support Vector machine & Ant colony optimization applied to
o Multiple Sequence Alignments
o Biomolecular Structure Prediction
• Fuzzy logic system & application in
o Clustering and classifications
o Microarray and Protein Array data Analysis

Practicals
Syllabus:

• Neural networks:
o Use of neural network tools like BrainBox, MATLAB etc.
o Estimator of transition probabilities for markov models based on various sample sizes.
o Hidden Markov model implementation in C/ Java.
o Ant colony algorithm for the Travelling salesman problem (TSP) & Implementation of SVM
• Optimization Algorithms:
o Programming in 'C' for implementation of Golden section algorithm, Steepest descent, Newton Raphson, Conjugate gradient etc for energy minimization applications.
o Implementation of random walk and Monte Carlo algorithm.
o Simulated Annealing algorithm for energy minimization.

References*:*

• Data Mining: Concepts and Techniques by Han and Kamber, Morgan Kaufmann.
• Machine Learning by Tom Mitchell, McGraw Hill.
• Data Mining: Practical Machine Learning Tools and Techniques by Witten and Frank, Elsevier.
• Biological Sequence Analysis: probabilistic models of proteins and nucleic acids by Durbin, R., Eddy, S., Krogh, A. & Mitchison, G.Cambridge Univ. Press, 1998.
• Optimization Theory and Application by Rao, S.S., 1984.
• Discrete optimization by Parker, R. G. & Rardin, R. L., 1988.
• Stochastic simulation by Repley, Brian D, Wiley series, 1987.
• Methods of microarray data analysis III by Johnson, K.F. & Lin, S.M. Boston. Kluwer academic publishers, 2003.
• Exploration and analysis of DNA microarray and protein array data by Amaratunga, D. & Cabrera, J.New Jersey. John Wiley & Sons Inc., 2004.
• Ant colony optimization by Dorigo, Marco & Stutzle, Thomas New Delhi, Prentice-Hall of India Pvt Ltd, 2004.
• Data mining: introductory and advanced topics by Dunham, M.H.:New Delhi, Pearson Education, 2003.
• An introduction to bioinformatics algorithms by Jones, Neil.C. & Pevzner, Pavel A. New Delhi, Anne Books, 2005.

M.Sc. Bioinformatics **SEMESTER -III**

BIM 334 (T+P): Biological Databases and Data Analysis

Theory
Syllabus:

Unit-1

• Nature of biological data

• Overview of available Bioinformatics resources on the web

o NCBI/EBI/EXPASY etc

• Biological Databases: Nucleic acid sequence databases

o GenBank/EMBL/DDBJ

• Biological Databases: Protein sequence databases

o PIR-PSD

o SwissProt, UniProtKB

Unit-2

• Database search engines

o Entrez

o SRS

• Overview/concepts in sequence analysis

• Pairwise sequence alignment algorithms

o Needleman & Wunsch

o Smith & waterman

Unit-3

• Scoring matrices for Nucleic acids and proteins

o MDM

o BLOSUM

o CSW

• Database Similarity Searches
    - o BLAST
    - o FASTA

Unit-4

• Multiple sequence alignment
    - o PRAS
    - o CLUSTALW

• Biological databases: Genome & genetic disorders
    - o Genome databases: Human, model organisms, microbes & viral
    - o OMIM

Unit-5

• Biological databases: structural databases
    - o PDB
    - o NDB
    - o CCSD

• Derived databases
    - o Prosite
    - o BLOCKS
    - o Pfam/Prodom

Practicals
Syllabus:

• Exploring the integrated database system at NCBI server and querying the PUBMED and GenBank databases using the ENTREZ search engine

• Exploring the integrated database system at EBI server and searching the EMBL Nucleotide database using the SRS search engine

• Exploring & querying SWISSPROT & UniProtKB

• Exploring and querying the PIR database

• Pair-wise global alignments of protein and DNA sequences using Needleman-Wunsch algorithm & interpretation of results to deduce homology between the sequences, use of scoring matrices

• Pair-wise local alignments of protein and DNA sequences using Smith-Waterman algorithm and interpretation of results

• Database (homology) searches using different versions of BLAST and interpretation of the results to derive the biologically significant relationships of the query sequences (proteins/DNA) with the database sequences

• Database (homology) searches using different versions of FASTA & interpretation of the results to derive the biologically significant relationships of the query sequences (proteins/DNA) with the database sequences.

• Multiple sequence alignments of sets of sequences using web-based and stand-alone version of CLUSTAL. Interpretation of results to identify conserved and variable regions and correlate them with physico-chemical & structural properties .

• Studying the format & content of structural databases & visualization of structures using Rasmol, Cn3D and other utilities.

References:

• Bioinformatics: A Practical Guide to the analysis of Genes and Proteins (2nd Ed.) by Baxevanis, A.D. & Ouellettee, B., F. F., New York, John Wiley & Sons, Inc. Publications, 2002.

• Introduction to Bioinformatics by Attwood, T.K. & Parry-Smith, D.J., Delhi, Pearson Education (Singapore) Pte.Ltd., 2001.

• Bioinformatics: Sequence and Genome Analysis by Mount, David, New York, Cold Spring Harbor Laboratory Press, 2004.

BIM 335 (T + P) Drug design and Chemo informatics
Theory
Syllabus:

Unit-1

• Role of Chemoinformatics in pharmaceutical/chemical research
- •Integrated databases
- •HTS analysis
- •Ligand based design of compounds
- •Structure based design of compounds
- • Structure representation systems, 2D and 3D structures
- • General introduction to chemical structure-hybridization, tetrahedron geometry etc
- • The degeneracy of isomeric SMILES and introduction to unique SMILES. Reaction transformations notation like SMIRKS.

Unit-2

•Introduction to graph theory, vertex partitioning algorithms- Morgan's and CANGEN algorithms and canonical labeling of the symmetrical vertex

• Introduction to conformation generating methods. Various ring conformation (sugar) and ring closure problem. Method to identify SSR (smallest subset of ring)

• Internal co-ordinates and introduction to calculation of Z matrix of simple small organic molecules.

Unit-3

• Chemical Databases – Design, Storage and Retrieval methods

• Introduction to database filters, property based & (drug-like)-Lipinski Rule of Five

• Search techniques, similarity searches and clustering

Introduction to molecular pattern finding language- SMARTS

o Introduction to distance measurement methods from the bit-strings of fingerprints- Tanimoto index and Tversky Index

o General introduction to clustering- K means and Hierarchical clustering of chemical database

o Diversity analysis- BCUT descriptors

Unit-4

- Modeling of small molecules and methods for interaction mapping
- Chemical properties 2D and 3D
    - o Introduction to adjacency, distance matrix and use of these matrices for calculating Weiner Index, Hosoya Index, Balban Index, Shultz Index, Randic Index .
    - o Introduction to shape indices- Kappa Shape index and calculation of molecular shape.
- Characterization of chemicals by Class & by Pharmacophore.
    - o Introduction to pharmocophore
    - o Identification of pharmacophore features
    - o Building pharmacophore hypothesis
    - o Searching databases using pharmocophores

Unit-5

- Design & Analysis of combinatorial libraries
    - o Reagent and product base combinatorial library generation
    - o Focus library and HTS library
- Chemoinformatics tools for drug discovery
    - o Integration of active drugs
    - o Optimization techniques
    - o Filtering chemicals
    - o In silico ADMET; QSAR approach, Knowledge-based approach

Practicals

Syllabus:

• Importance of storing chemical in the form of graph, linear notation (SMILES,WLN, ROSDAL- with special emphasis on SMILES and stereochemistry- both optical and geometrical isomerism), connection tables-sd and mol files. (1)

• Graph data structure and its implementation in the context of chemistry.

• Importance of 3D structure and methods available for 3D structure generation- CORINA and CONCORD

• A brief introduction to database (ISIS Base) with special emphasis on the storage of chemical in the database format.

References:

• Chemoinformatics by Johann Gasteiger and Thomas Engel, 2004.

• An introduction to Chemoinformatics by Andrew R. Leach and Valerie J. Gillet, Kluwer Academic Publisher, 2003.

• Handbook of Chemoinformatics. From Data to Knowledge by Johann Gasteiger.

• Chemometrics and Chemoinformatics by Barry K. Lavine, ACS Symposium series 894.

• Molecular modelling and prediction of bioactivity by Gundertofte, K. & Jorgensen, F.S. New York. Kluwer academic publishers, 2000.

Semester-IV

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: 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: 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: 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.