Syllabus for M.Sc. (Bioinformatics)
M.Sc. course in four semesters

Semester I

Course code	Title	Credits
BIF 601	Basic Mathematics	3
BIF 611	Computer fundamentals and Biostatistics	3
BIF 621	Biomolecules	3
BIF 631	Cell and Developmental Biology	3
BIF 641	Practicals	12
	Comprehensive Viva Voce	4
	Total credits	28

Semester II

Course code	Title	Credits
BIF 602	Bioinformatics	3
BIF 612	Object Oriented Programming through 'C++'	3
BIF 622	Molecular Biology	3
BIF 632	Design and Analysis of algorithms	3
BIF 642	Internet and Web Based Programming (CGI PERL & HTML)	3
BIF 652	Practicals	12
	Seminars	2
	Comprehensive Viva Voce	4
	Total Credits	33

Semester III

Course code	Title	Credits
BIF 603	Bioinformatics II	3
BIF 613	Bioinformatics III	3
BIF 623	Database management System	3
BIF 633	Recombinant DNA Technology	3
BIF 643	Java Programming	3
BIF 653	Assignments/ Practical	12
	Comprehensive Viva Voce	4
	Total Credits	31

Semester IV

BIF 604	**Project Work**	**25**
	Comprehensive Viva Voce	**4**
	Total Credits	**29**

Total credits for all semester in two years	**121**

Semester I

M.Sc. Bioinformatics I Semester

BASIC MATHEMATICS : 3 credits

BASIC MATHEMATICS

UNIT 1

SET THEORY: Introduction, Examples of Sets, Representation of a set (Roaster form and Set builder form), Notation, Different types of sets- null set, singleton set, finite set, infinite set, sub set, proper and improper subsets, equal sets, equivalent sets, universal set, disjoint set, Set operations- Union, properties of union of sets, Intersection of sets, properties of insertion operation, De Morgan's Law, Complement of a set, Set Difference, Venn diagram, problem based on sets.

UNIT 2

Limits: Constants, Types of constants, Variables, Types of Variables, Function, Types of function, Right hand and left hand limits, Working rule for finding out the limit, problems based on limits.

Continuity: Define, point out discontinuity, Method of finding the continuity, Continuity from right and from left, Problem based on continuity.

Differentiability: Basic concept of the derivatives of function, Definition of the derivative of function, right hand and left hand derivatives, Condition for differentiability of a function, Problem based on differentiability.

UNIT 3

The binomial theorem: Define, Binomial theorem for a positive integral index, Binomial Expansion, Finding middle term, general term, Binomial theorem for any index.

UNIT 4

Probability: Introduction, Events and types of events, Probability of events, Mutually exclusive events, favorable events, exhaustive events, independent events, addition theorem on probability, conditional probability, Multiplication theorem, Problem based on probability theorem, Baye's theorem, Problem based on Baye's theorem.

UNIT 5

Differentiation and Integration: Introduction, Basic concepts and problems related to differentiation and integration.

Text references:

COMPUTER FUNDAMENTALS AND BIOSTATISTICS: 3 credits

Unit I

Fundamental concepts in applied probability; Exploratory data analysis and statistical inference; Probability and analysis of one and two way samples; discrete and continuous probability models; Expectation and variance; Central limit theorem; Inference; Hypothesis; Critical region and error probabilities; Tests for proportion; Equality of proportions; equality of means of normal populations(variance known, variance unknown); Chi-square test for independence; P-value of the statistic; Confidence limits; Introduction to one way and two-way analysis of variance; Data transformations

Unit II

Elements of programming languages - C and PERL; Data base concept; Database management system; Database browsing and Data retrieval; Sequence database and genome database; Data Structures and Databases; Databases such as GenBank; EMBL; DDBJ; Swissprot; PIR; MIPS; TIGR; Hovergen; TAIR; PlasmoDB; ECDC; Searching for sequence database like FASTA and BLAST algorithm.

Unit III

Cluster analysis; Phylogenetic clustering by simple matching coefficients; Sequence Comparison; Sequence pattern; Regular expression based pattern; Theory of profiles and their use in sequence analysis; Markov models; Concept of HMMS; Baum-Welch algorithm; Use of profile HMM for protein family classification; Pattern recognition methods

Unit IV

Goals of a Microarray experiment; Normalization of Miroarray data; Detecting differential gene expression; Principal component analysis; Clustering of microarray data; Structure determination by X-ray crystallography; NMR spectroscopy; PDB (Protein Data Bank) and NDB (Nucleic Acid Data Bank); File formats for storage and dissemination of molecular structure.

Unit V

Methods for modeling; Homology modeling; Threading and protein structure prediction; Structure-structure comparison of macromolecules with reference to proteins; Force fields; Molecular energy minimization; Monte Carlo and molecular dynamics simulation

Practicals

Introduction to MS EXCEL-Use of worksheet to enter data, edit data, copy data, move data. Use of in-built statistical functions for computations of Mean, S.D., Correlation, regression coefficients etc. Use of bar diagram, histogram, scatter plots, etc. graphical tools in EXCEL for presentation of data. Introduction to SYSTAT package. Searching PubMed , Introduction to NCBI, NCBI data bases, BLAST BLASTn, BLASTp, PSI-BLAST, Sequence manipulation Suite, Multiple sequence alignment, Primer designing, Phylogenetic Analysis. Protein Modeling, Protein structure Analysis, Docking, Ligplot interactions.

Texts/References

1. Wayne W. Daniel, Biostatistics : A foundation for Analysis in the Health Sciences, 8th Edition, Wiley, 2004.
2. Prem S. Mann, Introductory Statistics, 6th Edition, Wiley, 2006.
3. John A. Rice, Mathematical Statistics and Data Analysis, 3rd Edition, John A. Rice, Duxbury Press, 2006.
4. Campbell and Heyer, Discovering Genomics, Proteomics, & Bioinformatics, 2nd Edition, Benjamin Cummings, 2002.
5. Cynthia Gibas and Per Jambeck, Developing Bioinformatics Computer Skill, 1st Edition, O'Reilly Publication, 2001.

Biomolecules - 3 Credits

Unit - I

Chemical basis of life; Composition of living matter; Water – properties, pH, ionization and hydrophobicity; Emergent properties of biomolecules in water; Biomolecular hierarchy; Macromolecules; Molecular assemblies; Structure-function relationships Amino acids – structure and functional group properties; Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Evolution of protein structure; Structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc.; Tools to characterize expressed proteins.

Unit - II

Enzyme catalysis – general principles of catalysis; Quantitation of enzyme activity and efficiency; Enzyme characterization and Michaelis-Menten kinetics; Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; Single substrate enzymes

Unit - III

Sugars - mono, di, and polysaccharides; Suitability in the context of their different functions-cellular structure, energy storage, signaling; Glycosylation of other biomolecules - glycoproteins and glycolipids; Lipids - structure and properties of important members of storage and membrane lipids; lipoproteins

Unit - IV

Biomembrane organization - sidedness and function; Membrane bound proteins - structure, properties and function; Transport phenomena Nucleosides, nucleotides, nucleic acids - structure, diversity and function; sequencing; Brief overview of central dogma

Unit - V

Bioenergetics-basic principles; Equilibria and concept of free energy; Coupled processes; Glycolytic pathway; Kreb’s cycle; Oxidative phosphorylation; Photosynthesis; Elucidation of metabolic pathways; Logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; Principles of metabolic regulation; Regulatory steps; Signals and second messengers.

Texts/References

1. V.Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
2. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.

Cell Biology and GENETICS- 3 Credits

Unit I

Cell Theory & Methods of Study

Microscope and its modifications – Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM), Electron tunneling and Atomic Force Microscopy, etc.

Membrane Structure and Function

Structural models; Composition and dynamics; Transport of ions and macromolecules; Pumps, carriers and channels; Endo- and Exocytosis; Membrane carbohydrates and their significance in cellular recognition; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata.

Unit II

Organelles

Nucleus – Structure and function of nuclear envelope, lamina and nucleolus; Macromolecular trafficking; Chromatin organization and packaging; Cell cycle and control mechanisms; Mitochondria – structure, organization of respiratory chain complexes, ATP synthase, Structure-function relationship; Mitochondrial DNA and male sterility; Origin and evolution; Chloroplast– Structure-function relationship; Chloroplast DNA and its significance; Chloroplast biogenesis; Origin and evolution.

Unit III

Endo-membrane System and Cellular Motility

Structure and function of microbodies, Golgi apparatus, Lysosomes and Endoplasmic Reticulum; Organization and role of microtubules and microfilaments; Cell shape and motility; Actin-binding proteins and their significance; Muscle organization and function; Molecular motors; Intermediate filaments; Extracellular matrix in plants and animals.

Unit IV

Cellular Movements and Pattern Formation

Laying of body axis planes; Differentiation of germ layers; Cellular polarity; Model plants like Fucus and Volvox; Maternal gene effects; Zygotic gene effects; Homeotic gene effects in Drosophila; Embryogenesis and early pattern formation in plants; Cell lineages and developmental control genes in Caenorhabditis.

Unit V

Differentiation of Specialized Cells

Stem cell differentiation; Blood cell formation; Fibroblasts and their differentiation; Cellular basis of immunity; Differentiation of cancerous cells and role of proto-oncogenes; Phase changes in Salmonella; Mating cell types in yeast; Surface antigen changes in Trypanosomes; Heterocyst differentiation in Anabaena; Sex determination in Drosophila.

Plant Meristem Organization and Differentiation

Organization of Shoot Apical Meristem(SAM); Organization of Root Apical Meristem(RAM); Pollen germination and pollen tube guidance; Phloem differentiation; Self-incompatibility and its genetic control; Embryo and endosperm development; Heterosis and apomixis.

Texts/References

1. Lodish et al., Molecular cell Biology, 4th Edition, W.H. Freeman & Company, 2000.
2. Smith & Wood, Cell Biology, 2nd Edition, Chapman & Hall, London, 1996.
3. Watson et al., Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall. USA, 2003.
4. B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley-Blackwell, 2002.
5. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.

M.Sc. Bioinformatics SEMESTER II

BIOINFORMATICS-I: **3 credits**

UNIT 1

Introduction and Bioinformatics Resources: Knowledge of various databases and bioinformatics tools available at these resources, the major content of the databases, Literature databases:

• Nucleic acid sequence databases: GenBank, EMBL, DDBJ
• Protein sequence databases: SWISS-PROT, TrEMBL, PIR, PDB
• Genome Databases at NCBI, EBI, TIGR, SANGER
• Other Databases of Patterns/Motifs/System Biology (Gene and protein network database and resources)

UNIT 2

Sequence analysis:

• Various file formats for bio-molecular sequences: genbank, fasta, gcg, msf, nbrf-pir etc.
• Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues.
• Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series.
• Sequence-based Database Searches: what are sequence-based database searches, BLAST and FASTA algorithms, various versions of basic BLAST and FASTA.

UNIT 3

Pairwise and Multiple sequence alignments: basic concepts of sequence alignment, Needleman & Wuncsh, Smith & Waterman algorithms for pairwise alignments, Progressive and hierarchical algorithms for MSA. Use of pairwise alignments and Multiple sequence alignment for analysis of Nucleic acid and protein sequences and interpretation of results.

UNIT 4

Phylogeny: Phylogenetic analysis, Definition and description of phylogenetic trees and various types of trees, Method of construction of Phylogenetic trees [distance based method (UPGMA, NJ), Maximum Parsimony and Maximum Likelihood method]

UNIT 5

Current Advancements in Bioinformatics: Introduction to System Biology, Structural Biology, Structural bioinformatics, Chemoinformatics, Immunoinformatics etc.

Texr References:

1. Introduction to Bioinformatics by Aurther M lesk
2. Developing Bioinformatics Computer Skills By: Cynthia Gibas, Per Jambeck
3. Structural Bioinformatics

Object Oriented Programming through 'c++' : 3 credits

UNIT-I

Overview of C++ : Object oriented programming, Introducing C++ classes, Concepts of object oriented programming. Classes & Objects : Classes, Structure & classes, Union & Classes, Friend function, Friend classes, Inline function, Scope resolution operator, Static class members: Static data member, Static member function, Passing objects to function, Returning objects, Object assignment.

UNIT-II

Array, Pointers references & The Dynamic Allocation operators : Array of objects, Pointers to object, Type checking C++ pointers, The This pointer, Pointer to derived types, Pointer to class members, References: Reference parameter, Passing references to objects, Returning reference, Independent reference, C++ 's dynamic allocation operators, Initializing allocated memory, Allocating Array, Allocating objects.
Constructor & Destructor : Introduction, Constructor, Parameterized constructor, Multiple constructor in a class, Constructor with default argument, Copy constructor, Default Argument, Constructing two dimensional Array, Destructor.

UNIT-III

Function & operator overloading : Function overloading, Overloading constructor function finding the address of an overloaded function, Operator Overloading: Creating a member operator function, Creating
Prefix & Postfix forms of the increment & decrement operation, Overloading the shorthand operation (i.e. +=,-= etc), Operator overloading restrictions, Operator overloading using friend function, Overloading New & Delete, Overloading some special operators, Overloading [ ], ( ), -, comma operator, Overloading << .

UNIT-IV

Inheritance : Base class Access control, Inheritance & protected members, Protected base class inheritance, Inheriting multiple base classes, Constructors, destructors & Inheritance, When constructor & destructor function are executed, Passing parameters to base class constructors, Granting access, Virtual base classes . Virtual functions & Polymorphism : Virtual function, Pure Virtual functions, Early Vs. late binding

UNIT-V

Creating string objects, manipulating string objects, relational operators, string characteristics, comparing and swapping

Molecular Biology - 3 Credits

Unit I

Genome organization

Organization of bacterial genome; Structure of eukaryotic chromosomes; Role of nuclear matrix in chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; DNA reassociation kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleosome phasing; DNase I hypersensitive regions; DNA methylation & Imprinting.

Unit II

DNA Structure; Replication; Repair & Recombination

Structure of DNA - A-,B-, Z- and triplex DNA; Measurement of properties-Spectrophotometric, CD, AFM and Electron microscope analysis of DNA structure; Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single stranded circular DNA; Gene stability and DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/Lox recombination.

Unit III

Prokaryotic & Eukaryotic Transcription

Prokaryotic Transcription; Transcription unit; Promoters- Constitutive and Inducible; Operators; Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and independent; Anti-termination; Transcriptional regulation-Positive and negative; Operon concept-lac, trp, ara, his, and gal operons; Transcriptional control in lambda phage; Transcript processing; Processing of tRNA and rRNA Eukaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase I, II, III; Eukaryotic promoters and enhancers; General Transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF); Activators and repressors; Transcriptional and post-transcriptionalgene silencing

Unit IV

Post Transcriptional Modifications

Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA.

Translation & Transport

Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; Isoaccepting tRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co- and post-translational modifications; Genetic code in mitochondria; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation

Unit V

Mutations; Oncogenes and Tumor suppressor genes

Nonsense, missense and point mutations; Intragenic and Intergenic suppression; Frameshift mutations; Physical, chemical and biological mutagens; Transposition - Transposable genetic elements in prokaryotes and eukaryotes; Mechanisms of transposition; Role of transposons in mutation; Viral and cellular oncogenes; Tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Activation of

oncogenes and dominant negative effect; Suppression of tumor suppressor genes; Oncogenes as transcriptional activators.

Text/References

1. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition,
Benjamin Cummings Publishing Company Inc, 2007.
3. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland, 2002.

DESIGN & ANALYSIS OF ALGORITHM : 3 credits

UNIT I

Basic Concepts of Algorithms

Introduction – Notion of Algorithm – Fundamentals of Algorithmic Solving – Important Problem types –Fundamentals of the Analysis Framework – Asymptotic Notations and Basic Efficiency Classes.

UNIT II

Mathematical Aspects and Analysis of Algorithms

Mathematical Analysis of Non-recursive Algorithm – Mathematical Analysis of Recursive Algorithm –
Example: Fibonacci Numbers – Empirical Analysis of Algorithms – Algorithm Visualization.

UNIT III

Analysis of Sorting and Searching Algorithms

Brute Force – Selection Sort and Bubble Sort – Sequential Search and Brute-force string matching – Divide and conquer – Merge sort – Quick Sort – Binary Search – Binary tree-Traversal and Related Properties – Decrease and Conquer – Insertion Sort – Depth first Search and Breadth First Search.

UNIT IV

Algorithmic Techniques

Transform and conquer – Presorting – Balanced Search trees – AVL Trees – Heaps and Heap sort – Dynamic Programming – Warshall's and Floyd's Algorithm – Optimal Binary Search trees – Greedy Techniques – Prim's Algorithm – Kruskal's Algorithm – Dijkstra's Algorithm – Huffman trees.

UNIT V

Algorithm Design Methods

Backtracking – n-Queen's Problem – Hamiltonian Circuit problem – Subset-Sum problem – Branch and bound– Assignment problem – Knapsack problem – Traveling salesman problem.

Text References:-

1. Design and analysis of algorithms by Horrowick
2. Design and analysis of algorithms by Corman
3. Data structure by Baluja

INTERNET & WEB BASED PROGRAMMING (CGI, PERL & HTML): 3 credits

UNIT I

Internet Basics
The Basics of the Internet, Concepts of a Domain, Networking concepts, IP Addressing, Resolving Domain Names, Structure of an IP address, Overview of TCP/IP and its services, The World Wide Web, FTP and Telnet.

UNIT II

Hyper text markup language (HTML)
How a Web Browser communicates with a web server, what is HTML and various HTML tags, Commonly used HTML commands, Lists, Adding Graphics to HTML documents, to create and use Tables, the concept of Hyperlink, Types of Hyperlinks, Introduction to Frames, Using the <Frameset> and the <Frame> tag. Other tags and versions of HTML such as DHTML and XML.

UNIT III

Common Gateway Interface (CGI)
The concept of CGI, Why CGI is used, How CGI works, The two methods of Data submissions, the differences in the two methods of submissions, the importance of Environment variables in a CGI program, the basic steps required to process from information in a CGI program, Why Perl is the language of choice for programming in CGI.

UNIT IV

Perl Language
The basics of the Perl Language, the concept of Perl Strings and their types, the values that can be stored in scalar variables, Arrays, how to extract information from both types of Arrays, the importance of the special Hash Array, Performing operations & Controlling program Flow, Perl Functions, File Handling.

UNIT IV

Perl applications for biological data: BioPerl.

Text Reference: text book of
1. HTML/PERL/JAVA – Ivan Bayross
2. Perl Black Book
3. Biggining Perl by Simon Cozens
4. Advance Perl Programming by Sriram Srinivasan
5. Writing CGI application with Perl by Kevin Meltzer and Brent Michalski

M.Sc. Bioinformatics SEMESTER III

BIOINFORMATICS – II: 3 credits

UNIT I

1. **Scoring Models and Matrices:**
Scoring models for gap penalties, computational aspects and generation of PAM and BLOSUM matrices. Applications of substitution matrices in protein sequence alignment and evolution.

UNIT II

Markov Chains & Hidden Markov Models:
Introduction to Markov chains and HMM using Markov chains for discrimination of biological sequences.
Forward and backward algorithms. Parameters estimation for HMMs. HMMs for pairwise and multiple sequence alignments. Profile HMMs.

UNIT III

Machine Learning and Bioinformatics:
Introduction to various Machine Learning techniques and their applications in Bioinformatics. Genetic algorithms, Support Vector Machine, Neural Networks and their practical applications towards the development of new models, methods and tools for Bioinformatics.

UNIT IV

Computational Models in Phylogenetics:
Various computational methods of phylogenetic and molecular evolutionary analysis. Bootstrap and its computational aspects. Tree of life and molecular clock. Probabilistic models of evolution. Likelihood and maximum likelihood algorithms and their applications.

UNIT V

Computational RNA Structure analysis:
Secondary and tertiary structure of RNA. Various algorithms of RNA folding and their analysis. Energy minimization in RNA folding. RNA sequence alignment based on secondary structure and its applications in functional genomics and phylogeny.

Text References:
1. Chemoinformatics: A Textbook by Johann Gasteiger.
2. Bioinformatics second edition by Devid M mount
3. Essential Bioinformatics by Jin Xiong
4. Bioinformatics: Concepts, Skills & Applications By R.S. Rastogi
5. Bioinformatics : Methods And Applications Genomics, Proteomics And Drug Discovery

BIOINFORMATICS-III: 3 credits

UNIT I

Prediction of protein structure

Secondary structure: algorithms of Chou Fasman, GOR methods.
Tertiary Structure: basic principles and protocols, Methods to study 3D structure.
Protein structure comparison and classification: classes, folds; the concepts in 3D structure comparison, purpose of structure comparison, algorithms such as FSSP, VAST and DALI.
Principles of protein folding and methods to study protein folding.

UNIT II

Visualization of structures using Rasmol or SPDBViewer or CHIME
Basic concepts in molecular modeling:, different types of computer representations of molecules.

UNIT III

Molecular Dynamics, Molecular modeling and simulations, Homology modeling

UNIT IV

Computer aided drug design (CADD), Molecular Docking.

UNIT V

Systems Biology
Macromolecular interactions: Protein – Protein, Protein – Nucleic acids, Protein – carbohydrates etc. Gene and protein networks. Top down and bottom up approaches in systems biology. Computational methods, tools, and databases in systems biology, their description, analysis and applications to the biological community. Sequence and structure based methods of predicting protein-protein interactions.

Text References:

1. Protein Structure Prediction: Methods and Protocols by David M Webster
2. 3. Essential Bioinformatics by Jin Xiong
4. Bioinformatics: Concepts, Skills & Applications By R.S. Rastogi
5. Bioinformatics : Methods And Applications Genomics, Proteomics And Drug Discovery

DATA BASE MANAGEMENT SYSTEMS: 3 credits

UNIT I

Introduction, data models- Entity Relationship Model, Relational Model

UNIT II

Relational Databases: SQL, Integrity and Security, Relational – Database designs

UNIT III

Data Storage and Querying: Storage and File Structure, Indexing and Hashing, Query Processing, Query Optimization

UNIT IV

 Transaction Management: Transactions, Concurrency Control, Recovery System

UNIT V

 Database System Architectures, Distributed Databases, Parallel Databases, Data Warehousing and Data Mining

RECOMBINANT DNA TECHNOLOGY

Unit I

Basics Concepts

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay; DNaseI footprinting; Methyl interference assay

Unit II

Cloning Vectors

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors

Unit III

Cloning Methodologies

Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression

Unit IV

PCR and Its Applications

Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; Tvectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)

Unit V

Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knock out mice; Disease model; Somatic and germ-line therapy- in vivo and ex-vivo; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

Text/References

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University
Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Selected papers from scientific journals.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

JAVA PROGRAMMING

UNIT–I

C++ Vs JAVA, JAVA and Internet and WWW, JAVA support systems, JAVA environment., JAVA program structure, Tokens, Statements, JAVA virtual machine, Constant & Variables, Data Types, Declaration of Variables, Scope of Variables, Symbolic Constants, Type Casting. Operators : Arithmetic, Relational, Logical Assignments, Increment and Decrement, Conditional, Bitwise, Special, Expressions & its evaluation. If statement, if…else… statement, Nesting of if…else… statements,
else…if Ladder, Switch, ? operators, Loops – While, Do, For, Jumps in
Loops, Labelled Loops.

UNIT–II

Defining a Class, Adding Variables and Methods, Creating Objects, Accessing Class Members, Constructors, Methods Overloading, Static Members, Nesting of Methods. Inheritance: Extending a Class, Overriding Methods, Final Variables and Methods, Final Classes, Finalize Methods, Abstract methods and
Classes, Visibility Control.

UNIT–III

Arrays: One Dimensional & two Dimensional, strings, Vectors, wrapper Classes, Defining Interface Extending Interface, Implementing Interface, Accessing Interface Variable, System Packages, Using System Package, Adding a Class to a Packages, Hiding Classes.

UNIT–IV

Creating Threads, Extending the Threads Class, Stopping and Blocking a Thread, Life Cycle of a Thread, Using Thread Methods, Thread Exceptions, Thread Priority, Synchronization, Implementing the Runnable Interface.

UNIT–V

Local and Remote Applets Vs Applications, Writing Applets, Applets Life Cycle, Creating an Executable Applet, Designing a Web Page, Applet Tag, Adding Applet to HTML File, Running the Applet, Passing
Parameters to Applets, Aligning the Display, HTML Tags & Applets, Getting Input from the User.

TEXT & REFERENCE BOOKS:

E. Balaguruswamy, “Programming in Java”, 2nd Edition, TMH Publications
 Peter Norton, “Peter Norton

SEMESTER IV

Project Work (Credit: 25)
Comprehensive Viva-Voce (Credit: 4)