THIRUVALLUVAR UNIVERSITY
MASTER OF SCIENCE
(With effect from 2022 – 2023)

The Course of Study and the Scheme of Examination

Sl. No.	*Study Components*		*ins. hrs / week*	*Credit*	*Title of the Paper*	*Maximum Marks*		
	Course Title					*CIA*	*Uni. Exam*	*Total*
SEMESTER I								
	Core			4	Basic Bioinformatics	25	75	100
	Core			4	Cell and Molecular Biology	25	75	100
	Core			4	Programming in C & C++	25	75	100
	Practical			0	Biochemistry, Biophysics and Molecular Biology (LAB)	25	75	100
	Practical			0	Sequence Analysis (LAB)			
	Practical			0	Programming in C & C++ (LAB)			
Internal Elective for same major students (Choose any one)								
	@ Core Elective	**Paper-1**		3	A. Mathematics & Statistical methods in Bioinformatics B. Biodiversity Informatics C. Genetics & Evolution	25	75	100
External Elective for other major students (Inter/multi disciplinary papers)								
	@ Open Elective	**Paper-1**		3	A. Biological Databases	25	75	100
			30	**18**				
SEMESTER II						*CIA*	*Uni. Exam*	*Total*
	Core			4	Genomics & Proteomics	25	75	100
	Core			4	Relational DBMS & MySQL	25	75	100
	Core			4	Structural Biology	25	75	100
	Practical			3	Biochemistry, Biophysics and Molecular Biology (LAB)	25	75	100
	Practical			3	Sequence Analysis (LAB)	25	75	100
	Practical			3	Programming in C & C++ (LAB)	25	75	100
Internal Elective for same major students (Choose any one)								
	@ Core Elective	**Paper-2**		3	A. Biophysics & Biochemistry B. Biological Algorithms C. Cheminformatics	25	75	100
External Elective for other major students (Inter/multi disciplinary papers)								
	@ Open Elective	**Paper-2**		3	A. Biological Sequence Analysis	25	75	100
	@ Field Study			2		100	-	100
	@ Compulsory Paper			2	**Human Rights & Duties**	25	75	100
			30	**22**				
S. No.	*Study Components*		*ins. hrs / week*	*Credit*	*Title of the Paper*	*Maximum Marks*		
	Course Title					*CIA*	*Uni. Exam*	*Total*
SEMESTER III								

	Core		6	4	Molecular Modeling & Drug Design	25	75	100
	Core		6	4	Systems Biology	25	75	100
	Core		6	4	Advanced Programming in Bioinformatics	25	75	100
	Practical			0	Molecular Modeling (LAB)			
	Practical			0	Perl & Python (LAB)			
Internal Elective for same major students (Choose any one)								
	@ Core Elective	**Paper-3**	6	3	A. Data warehouse & Data mining B. Genetic Engineering C. R Programming	25	75	100
External Elective for other major students (Inter/multi disciplinary papers)								
	@ Open Elective	**Paper-3**	6	3	A. Introduction to Drug Design & Discovery	25	75	100
	@MOOC Courses		-	2				100
			30	**20**				
SEMESTER IV						***CIA***	***Uni. Exam***	***Total***
	Core			4	A. Research Methodology	25	75	100
	Practical			3	B. Molecular Modeling (LAB)	25	75	100
	Practical			3	C. Perl & Python (LAB)	25	75	100
	@ Core	**Project Compulsory**		7	Project with *viva voce*	100 (75 Project +25 viva)		100
Internal Elective for same major students (Choose any one)								
	@ Core Elective	**Paper-4**		3	A. Bioethic, Biosafety & IPR B. Medical Biotechnology C. Big Data Analytics & NGS	25	75	100
External Elective for other major students (Inter/multi disciplinary papers)								
	@ Open Elective	**Paper-4**		3	A. Fundamental of Algorithms	25	75	100
			30	**23**				
				92				

THIRUVALLUVAR UNIVERSITY
M.Sc. BIOINFORMATICS

SYLLABUS
UNDER CBCS
(with effect from 2020-2021)
SEMESTER I
PAPER I

BASIC BIOINFORMATICS

Objective

To introduce classic bioinformatics theory to students by focusing on how computer techniques can be used for the storage, analysis, prediction and simulation of biological sequences (DNA, RNA and Proteins).

UNIT-I

Bioinformatics - Definition - Biological & Specialized Databases - Nucleic acid sequence databases: GenBank, EMBL, DDBJ - Protein sequence databases: SWISS-PROT, TrEMBL, PIR_PSD - Genome Databases at NCBI, EBI, TIGR, SANGER - Virtual Library.

UNIT-II

Bioinformatics servers - NCBI - EBI - GENOMENET - Bibliographic resources and literature databases - PUBMED, MEDLINE, AGRICOLA - Database Searching techniques - ENTREZ - Data Mining - techniques & tools - Data Warehousing - Top Down & Bottom up approaches.

UNIT-III

Sequence patterns & representation - consensus, regular expression, contigs, motifs and blocks - Sequence Analysis - FASTA - BLAST - Scoring matrices - PAM and BLOSUM - Pairwise alignments - Multiple sequence alignments - CLUSTALW and Pileup - dendrograms and its interpretation.

UNIT-IV

Phylogenetic analysis - taxonomy and phylogeny - molecular evolution - Data used in Taxonomy and Phylogeny - Phylogenic trees - Definition and description - types of trees - tree construction - tree analysis - homologous - orthologous - paralogous - Phylip and phylogenetic analysis.

UNIT-V

Application of Bioinformatics - Drug designing - Drug discovery cycle - Role of Bioinformatics in drug design - Target identification - lead discovery - Structure-based drug design - Modeling of target- small molecule interactions.

Text Books

1. Attwood, T.K. and Parrysmith, D.J. 2001. Introduction to Bioinformatics. Pearson Education (Singapore) Pvt. Ltd., New Delhi.
2. Mani, K. and Vijayaraj, N. 2004. Bioinformatics - A practical approach. Aparna Publications, New Delhi.
3. Harshawardhan Bal - Bioinformatics - Primciples and Applications, 1st Edition 2005, TMH, New Delhi.

References

1. Bryan Bergersen, M.D. 2003. Bioinformatics computing. Pearson Education (Singapore) Pvt. Ltd., New Delhi.
2. Rastogi, S.C., Menderatta, M. and Rastogi, P. 2004. Bioinformatics - concepts, skills and applications. CBS Publishers & Distributors, New Delhi.
3. Westhead, D. R., Parish, J. H. and Twyman, R.M. 2003. Bioinformatics. Viva Books Pvt. Ltd., New Delhi.
4. Sahai, S., 1999. Genomics and Proteomics: Functional and computational aspects. Viva Books Pvt. Ltd., New Delhi.
5. Mount, David W. 2001. Bioinformatics sequence and genome analysis. Cold Spring Harbor Laboratory Press, New Delhi.
6. Pennigton, S.R., and Dunn, M.J. 2002. Proteomics. Viva Books Pvt. Ltd., New Delhi.
7. Baxevanis, En Andreas D. and Francis Ouellette, B.F. 2003. Bioinformatics: A practical guide to the analysis of genes and proteins. John Wiley & Sons, New Delhi.

PAPER II

CELL AND MOLECULAR BIOLOGY

Objectives

To know the terminology and literature of cytogenetics; chromosome structure and function; cytogenetic techniques that can be employed in genetics and improvement of life systems.

UNIT-I

Prokaryotic and eukaryotic cells : Structure and function of extracellular matrix or ECM (cell wall) and membranes - Structure and function of cell organelles (chloroplasts, mitochondria, ER, ribosomes, endosomes, lysosomes, peroxisomes, hydrogenosome). - Nucleus, nucleolus, nuclear pore complex. Chromatin and nucleosome - Cell signalling and cell receptors - Signal transduction.

UNIT-II

Mitosis and meiosis; molecular basis of cell cycle - Phases of Cell Cycle, functional importance of each phase - Numerical and structural variations in chromosomes and their significance. Study of polytene, lampbrush and B-chromosomes - structure, behaviour and significance. Apoptosis- Role of different genes, cell organelles during apoptosis - genetic control of apoptosis.

UNIT-III

Molecular basis of life - DNA as the Genetic Material - Definitions and Chemistry of the Gene - Gene as the unit of mutation and recombination. Genome organizations and mechanism of replication in Prokaryotic and Eukaryotic cells, structure and function of DNA polymerases. Gene as the unit of expression Regulation of gene expression in Bacteria, yeast, mitochondria & chloroplast.

UNIT-IV

Concept of gene Central dogma, updated central dogma, molecular structure of nucleic acids – structure & forms of DNA & RNA. Transcription - components of transcription machinery, RNA polymerases, processing of RNA. Transcription in prokaryotes & eukaryotes, genetic code. Translation – mechanism, post-translational modification.

UNIT-V

Gene regulation in prokaryotes – Operon concept, Lactose, Histidine and Tryptophan operon, Gene regulation in eukaryotes – Transcriptional level, translational level control.

Text Books

1. De Robertis, E.D.P. and De Robertis, E.M.F. 1995. Cell and Molecular Biology. 8th end., B.I. Waverly Pvt. Ltd., New Delhi.

2. Kleinsmith, L.J. & Kish, V.M. 1995. Principles of Cell and Molecular Biology. 2nd edn., McLaughlin, S., Trost, K., Mac Elree, E. (eds)., Harper Collins Publishers, Newyork.

3. Karp, G. (2005) "Cell and Molecular Biology: Concepts and Experiments"; Fourth Edition, Wiley Publishing Co. USA

4. 4. Krieger, M. (2003) "Molecular Cell Biology"; Fifth Edition, W.H. Freeman and Co., New York.

Reference Books

1. Alberts. B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D. 1989. Molecular biology of the Cell (2nd edition). Garland Pub. Inc., New York.
2. Hartl, D. L. and Jones, E. W. 2001. Genetics: Principle and Analysis (4th edition). Jones & Bartlett Pub., USA.
3. Snustad. D. P.and Simmons M. J. 2000. Principles of Genetics (2nd edition). John Wiley and Sons, Inc., USA.

PAPER III

PROGRAMMING IN C & C++

Course Objectives:

- To make the students understand the basic aspects of programming.
- Develop an in-depth understanding of functional, logic, and object-oriented programming paradigms.
- Explain and be able to use fundamental programming constructs such as sequencing, decisions and iteration.
- To enhance problem solving and programming skills in C & C++

Syllabus

Unit-I: Introduction to Programming Languages

Introduction–Programming languages – Problem solving Technique: Algorithm, Flowchart, Compiling, Testing and Debugging, Documentation – Data structures – Array, Stack, Queue, Linked List concepts.

Unit-II: Programming in C

C language Introduction – Tokens – Keywords, Identifier, Variables, Constants, Operators – Expression – Data types –Operator precedence – Statement: Input statement, Output statement, Conditional and Unconditional Control Statement – Looping Statement: while, do–while, for – nested loop – Arrays.

Unit-III: Procedural Concepts in C

C – Procedural Concepts: Structured Programming – Built-in library function – User defined functions – Pointer introduction – Passing pointer in a function – Structure – Union – File handle: Read and Write character from a file.

Unit-IV: Object Oriented Programming and C++

Basic concepts of OOPS– Data hiding–Encapsulation–Inheritance, Polymorphism – Introduction to C++, C vs C++ – data types, variables, constants, operators and statements in C++ – Conditional and looping statements.

Unit-V: Programming and C++

C++ classes - Classes & Objects – Functions in C++ – function prototype-definition–Different forms of Constructor – Destructor – Copy constructor – Inheritance –Single, Multiple and Multi level inheritance – Function & operator overloading –inline functions – Friend and virtual functions – Overloaded functions.

Reference Books:

- B.W.Kernighan and D.M. Ritchie, "The C Programming Language", 2nd Edition. Prentice Hall of India.
- Byron Gottfried, - "Programming with C" (Schaum's Outline Series) - Tata McGraw Hill Publishing Company – 1998
- E. Balagurusamy - "Programming in C++ " - Tata McGraw Hill Edition
- Robert Laffore -"Object oriented programming with C++" -Waite series.

SEMESTER I

CORE PRACTICAL I

BIOCHEMISTRY, BIOPHYSICS AND MOLECULAR BIOLOGY

BIOCHEMISTRY

1. Estimation of reducing sugar.
2. Estimation of lipids.
3. Separation of amino acids and lipids using TLC and Paper chromatography.
4. Extraction of secondary metabolites from medicinal plants - Cold percolation method
5. Extraction of secondary metabolites from medicinal plants - Soxhlet method
6. Preliminary Phytochemical analysis of plant extracts
7. Antibiotic bioassay-inhibitory activity (Disc Diffusion)
8. Tissue culture - cell suspension culture
9. Separation of a mixture of proteins (2 or 3) using column chromatography.
10. Estimation of proteins using Bradford and Lowry's methods.
11. Blood analysis, estimation of RBC count, WBC count

BIOPHYSICS

12. Microscopy: Bright field, Phase contrast & Fluorescence microscopy
13. To verify the Lambert Beer's law.
14. Protein crystallization using hanging drop and sitting drop methods.
15. Casting the Gel for SDS-PAGE.
16. Separation of protein and molecular weight determination using SDS-PAGE.
17 . Staining the gel with CBB.

MOLECULAR BIOLOGY

18. Sterilization techniques and Media preparation
19. Preparation and Maintenance of Microbial Culture
20. Plasmid and Chromosomal DNA Preparation from E. coli
21. Pure microbial culture techniques
22. pH measurements and preparation of buffers
23. Spectrophotometric Analysis of DNA
24. Agarose Gel Electrophoretic Analysis of DNA
25. Restriction digestion of bacterial genomic DNA and plasmid DNA
26. Ligation of DNA fragment with plasmid DNA
27. Microbial genomic DNA isolation

20. Microbial plasmid isolation
21. Plant genomic DNA isolation.
22. Agarose Gel electrophoresis and gel documentation.
23. DNA amplification using Thermocycler.
24.Blotting Techniques - Southern, Northern & Western.
25. Hybridization - Autoradiography - Demonstration

SEMESTER I

CORE PRACTICAL II

SEQEUNCE ANALYSIS

1. Biological databases (sequence, structure and specialized databases)
2. Data retrieval using ENTREZ
3. Database file formats
4. Gene structure and function prediction (Genscan , GeneMark)
5. Sequence similarity searching (NCBI BLAST)
6. Protein sequence analysis (ExPASy proteomics tools)
7. Multiple sequence alignment (Clustal)
8. Molecular phylogeny (PHYLIP)
9. Analysis of protein and nucleic acids sequences,
10. Sequence analysis using EMBOSS or GCG Wisconsin Package
11. Sequence comparison
12. Structure analysis
13. Pattern recognition
14. Proteome analysis using tools
15. Exon finding
16. Genome homology

SEMESTER I

CORE PRACTICAL II

PROGRAMMING IN C & C++

1. Basic arithmetic operations using c program
2. Identification of prime number using c program
3. Sorting biggest of the given numbers using c program
4. Sorting even numbers from a range of numbers using c program
5. Sorting odd numbers from a range of numbers using c program
6. Factorial of a given number using c program
7. Identification of palindrome using c program.
8. Sorting a range of numbers using c program.
9. Sorting given numbers using c program.
10. Factorial using recursion function of the c program.

C++ Programs

1. C++ Program to Display Prime Numbers Between Two Intervals Using Functions
2. C++ Program to Check Prime Number By Creating a Function
3. C++ Program to Check Whether a Number can be Express as Sum of Two Prime Numbers
4. C++ program to Find Sum of Natural Numbers using Recursion
5. C++ program to Calculate Factorial of a Number Using Recursion
6. C++ Program to Convert Binary Number to Decimal and vice-versa
7. C++ Program to Convert Octal Number to Decimal and vice-versa
8. C++ Program to Convert Binary Number to Octal and vice-versa
9. C++ Program to Calculate Average of Numbers Using Arrays
10. C++ Program to Find Largest Element of an Array
11. C++ Program to Calculate Standard Deviation
12. C++ Program to Add Two Matrix Using Multi-dimensional Arrays
13. C++ Program to Multiply Two Matrix Using Multi-dimensional Arrays
14. C++ Program to Find Transpose of a Matrix
15. C++ Program to Multiply two Matrices by Passing Matrix to Function
16. C++ Program to Access Elements of an Array Using Pointer
17. C++ Program to Swap Numbers in Cyclic Order Using Call by Reference
18. C++ Program to Find the Frequency of Characters in a String
19. C++ Program to Remove all Characters in a String Except Alphabets.

20. C++ Program to Find the Length of a String
21. C++ Program to Concatenate Two Strings
22. C++ Program to Store Information of a Student in a Structure
23. C++ Program to Copy Strings

CORE ELECTIVE PAPER - I

A. MATHEMATICAL AND STATISTICAL METHODS IN BIOINFORMATICS

Objective

To introduce the students in mathematical and statistical tools and techniques.

UNIT-I

Role of statistics in Biology and Bioinformatics - Collection and Representation of Experimental data - Measures of Central Tendency and Location: Arithmetic Mean, Median, Mode, Position of averages, Geometric Mean, Harmonic mean and percentile - Measures of Dispersion: Range, Interquartile range, mean deviation, variance and standard deviation.

UNIT-II

Correlation and Regression: Correlation coefficient - Types of correlation - Regression equation - Principles of least squares - Linear regression - Biological significance of correlation and regression - Tests of significance: Basis of statistical inference - Student's 't' test for mean, difference of means and test for correlation and regression coefficients – Chi - square test - Analysis of Variance

UNIT-III

Basic concepts of Probability - Sample space and Events - The use of counting methods in probability - Addition law - Conditional probability - Simple problems involving the estimation of probabilities - Normal Distribution and Binomial and Poisson distributions - Z-score, P-value and E-value - Hidden Markov Models - Neural Networks - Applications of probability concepts in Bioinformatics

UNIT-IV

Matrices: Matrix algebra - Types of matrices - determinant - inverse, rank of matrix - solution of simultaneous equations - rotation matrices and co-ordinate transformation

Vectors: Vector algebra - addition and subtraction of vectors - product of vectors, dot & cross products - scalar triple product - vector calculus - gradient, divergence, curl of a vector & identities - applications.

UNIT-V

Basic differentiation of algebraic and trigonometric functions - Maxima and Minima - Integration of simple functions - Definite and non-definite integrals - Table of integrals - Numerical methods for differentiation and integration - applications to systems biology

Text Books

1. Gupta, S.C. and Kapoor, V.K. 2002.Fundamentals of Mathematical Statistics, 11th Edition, Sultan Chand & Sons, New Delhi.
2. Jordan, D.W. and Smith, P. 2002. Mathematical Techniques, 3rd Edn, Oxford University Press, New Delhi.

3. Forthofer, L. 1995. Introduction to Biostatistics, Academic Press, New York.
4. Sokal, Robert R. and Rohlf, F.J. 1987. Introduction to Biostatistics (Biology-Statistics Series), W.H. Freeman & Company, New York..
5. Batschelet, E. 1991. Introduction to Mathematics for Life Scientists, 2nd Edn., Springer International Student Edn., Narosa Publishing House, New Delhi.

CORE ELECTIVE PAPER - I

B. BIODIVERSITY INFORMATICS

Objective

To aware of digitized biodiversity data resource available nationally and internationally and to utilize the same effectively to conserve biodiversity.

UNIT-I

Biological diversity of life - Methods for species identification & classification - Information needs in biodiversity assessments and inventorying programmes - Role of information technology in distributing biodiversity information.

UNIT-II

Introduction to Biodiversity Informatics - Assessing, analyzing and documenting biodiversity - Morphological and molecular characterization of biodiversity - Introduction to biodiversity database: endangered animals, endemism and Red data books - Biodiversity registers.

UNIT-III

Designing information systems to support biodiversity conservation - Networks for distributing information - Distributed Databases and Web -Accessible Resources - Species 2000 and Tree of life.

UNIT-IV

Software for identification of Accessing existing biodiversity databases on the World - wide Web-Probabilistic and deterministic identification, Delta, MicroIS, AVIS, ICTV.

UNIT-V

Global biodiversity information system - Overview of the UNEP/GEF biodiversity data management project (BDM) - CBD and bioethics - General agreement on trade and tariffs.

Text Books

1. Kevin J. Gaston and John I. Spicer. Biodiversity - An introduction
2. Agarwal., K.C., Biodiversity

References

1. Global Biodiversity : Status of the Earth's Living Resources. Water Conservation Monitoring Centre (1992), Chapman & Hall, London.
2. Systematics and Conservation Evaluation - Forey, P.L., C.J. Humphries and R.I Vane-Wright (eds) (1994), Clarendon Press, Oxford.
3. Biodivesity: Measurement & Estimation - Hawkswoth, D.I. (Ed.) (1995), Chapman & Hall, London.
4. Alice , 1990. A Bio-Diversity database system. Alice Software Partnership. Cnhos, D.A.L. Canhos, V.P. and Kirsop, B.E (eds) 1994. Linking Mechanisms for biodiversity Information, Tropical Foundation, Campinas, Brazil.
5. Uhlir, P.F,. 1980. The Public international law of Civilian remote sensing: an overview. In: Mink, P.D. (ed), American Enter Prise, The law, and the commercial use of spece, Vol II. National Legal Center for the Public Interest, Washington, Dc.
6. Heywood, V.H., Watson, R.T. 1995. Global Biodiversity Assessment. Published for the United Nations Environment Programme, Cambridge University Press, Cambridge.

Web Resource

www. Biodiv.org

www.wri.org/wri/biodiv/

www.wcmc.org.uk/

CORE ELECTIVE PAPER - I

C. GENETICS & EVOLUTION

Course Objectives

The course is intended, to provide knowledge on the structure and functions of genes and chromosomes, to understand the concepts of mutations, genetic aberrations, and changes due to regular cellular propagations to understand the types of changes and the consequences leading to evolution to understand the process of genetic evolution to be familiar with some of the approaches for assessment of genetic variability and evolution

Unit-1:

Genes and inheritance, laws of inheritance, Mendalian hypothesis and tests, Concept of alleles, dominance, complementation, epistasis, recombination, gene mapping in prokaryotes and eukaryotes, sex-linked inheritance, chromosomes, mitosis and meiosis and evolution.

Unit-2:

Structure of DNA, DNA mutations, types, mechanisms of repair, origin of genetic variability; types of mutagens; allelic variation and gene functions, euploidy, aneuploidy, polyploidy; chromosomal rearrangements - deletion, duplication, inversion, and translocation; linkage, recombination, cross-over and evolution.

Unit-3:

Genetic code; replication and fidelity of DNA polymerase, transcription, alternative splicing, translation; gene-protein relationships; and the transfer of genetic information between generations, Gene transfer in bacteria and viruses, horizontal and vertical transfer of DNA, transposable elements and transposon mutagenesis, jumping genes.

Unit-4:

Structure of genome of eukaryotes, prokaryotes and archaea; evolution of mitochondrial and chloroplast genomes, evolution of nuclear genome and the origin of eukaryotic cells, sequence diversity of chromosomes across taxa, genome duplication, large-scale chromosomal alterations, Genome-wide association studies, Inbreeding, Evolution of sex chromosomes, Evolution of human DNA sequence families.

Unit-5:

Inheritance of complex traits, analysis of quantitative traits and statistics, estimation of heritability, Hardy-Weinberg equilibrium, natural selection and random genetic drift, phylogenetics and phylogenetic estimation, phylogenetic trees, cladograms, clustering methods, similarity and distance tables, Maximum likelihood and maximum parsimony methods, dotplot, dynamic programming, pairwise and multiple sequence alignment, methods of BLAST.

Text Books

1. Peter D. Snustad and Michael J. Simmons. Principles of Genetics. 6th edition, John Wiley & Sons, Inc., 2012
2. Watson JD, Baker TA, Bell, SP, Gann A, Levine M and Losick R, Molecular Biology of the Gene, 5th Edition, CSHL Press, 2004
3. Subramanian C. Genomic Bioinformatics, Dominant Publishers and Distributors, New Delhi, 1st edition 2009.

Reference Items: books, Journal

1. Brooker RJ. Genetics – analysis and principles, 4th edition. McGrawHill publications, 2012

OPEN ELECTIVE

PAPER I

BIOLOGICAL DATABASES

Unit-1

Nature of biological data, Overview of available Bioinformatics resources on the web NCBI/EBI/EXPASY etc, Biological Databases: Nucleic acid sequence databases GenBank/EMBL/DDBJ, Biological Databases: Protein sequence databases - PIR-PSD, SwissProt, UniProtKB

Unit-2

Database search engines Entrez, 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 MDM BLOSUM CSW • Database Similarity Searches BLAST, FASTA

Unit-4

Multiple sequence alignment PRAS CLUSTALW • Biological databases: Genome & genetic disorders Genome databases: Human, model organisms, microbes & viral OMIM

Unit-5

Biological databases: structural databases PDB NDB CCSD • Derived databases Prosite BLOCKS Pfam/Prodom.

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

SEMESTER-II

CORE PAPER I

GENOMICS & PROTEOMICS

Subject description :
This paper deals with genome map, comparative genomics, structural genomics, functional genomics, protein structure prediction and function and various tools for analysis of proteins.

Goals:
To make the students to familiar with genome map, comparative genomics, structural and functional genomics and Proteomics —extensively used in drug discovery, and in learning various tools for analysis of proteins.

Objectives:
To understand the genome architecture and extracting information like gene function, gene regulation, protein evolution and targets for drug designing.

UNIT I

Annotation of the Genome

Various approaches in gene prediction, ORF prediction, Gene prediction in prokaryotes, Gene prediction in eukaryotes, Pattern discrimination, Evaluation of gene prediction method, Prediction of promoter sequences.

Genome analysis

Chromosome rearrangement, Compositional analysis, Clustering of genes, Composite genes.

UNIT II

Functional Genomics

Gene expression analysis by cDNA micro arrays, SAGE, Strategies for generating ESTs and full length inserts; EST clustering and assembly; EST databases (DBEST, UNIGENE); Expression and regulation of entire set of genes, Sporulation Vs Vegetative condition in yeast and *Bacillus.*

UNIT III

Comparative Genomics

Purpose and Methods of comparison

Methods of comparison, Comparison at Nucleotide level, Breakpoints level, Gene cluster level.

Applications of comparative Genomics

Predicting function, Predicting regulatory elements, Analysis of conserved strings.

UNIT-IV

Principles of Protein classification:

Based on Structural features, Phylogenetic relationship, CATH - Classification by Class, Architecture, Topology, Homology, SCOP - Structural Classification Of Protein, FSSP - Fold classification based on structure - structure alignment, MMDB - Molecular Modeling Database, SARF - Spatial arrangement of backbone fragments.

UNIT - V

Proteome analysis

2D Electrophoresis**,** Immobilized pH gradient, Sample preparation, First dimension criteria, second dimension criteria, Stabilization, Detecting protein on gel, Electro blot, Image analysis, Digital imaging, Spot detection and quantification, Gel matching.

REFERENCES

1. Bioinformatics Sequence and Genome Analysis. 2001. David W. Mount. Cold Spring Harbor laboratory Press.
2. Inna Dubchak et al. 2000, Active conservation of noncoding sequences revealed by three way species comparisons. *Genome Research*. **10**, 1304-1306
3. Proteomics. S.R. Pennigton and M.J. Dunn. 2002. Viva Books Private Limited. New Delhi. (for Units III and IV and V.)
4. Introduction to Protein Structure. Carl Branden and John Tooze 1999. Garland Publishing. New York. (for Units I and II)
5. Protein Evolution by Laszlo Patthy 1999. Blackwell Science
6. Shanmughavel, P. 2005. Principles of Bioinformatics, Pointer Publishers, Jaipur, India

SEMESTER-II

CORE PAPER II

RELATIONAL DATABASE MANAGEMENT SYSTEM AND MySQL

Objective

The primary goal of this subject is to provide the knowledge on relational database. It imparts the skill on normalization and database design. It inculcates the knowledge on management of databases.

UNIT-I

Introduction - History of database systems - Applications of database systems - Database systems vs. file systems - View of data: Data abstraction - Instances and Schema - Database system structure - Database architecture - Database administrators and users - Transaction - Homogenous and Heterogeneous data - Advantages and disadvantages.

UNIT-II

Types of data models - Relational model - Relational algebra and calculus - Relational databases - Relational languages - Relational-database design - Object-Relational databases and other hybrid databases; Integrity and security - Constraints - Normalization - Indexing and hashing.

UNIT-III

SQL languages: Data Definition Language (DDL) - Data Manipulation Language (DML) - Transaction Control Language (TCL) - Data Control Language (DCL) - Basics of SQL - MySQL datatypes - MySQL operators - MySQL Functions.

UNIT-IV

Working with databases using MySQL commands - Working with tables using MySQL commands - Working with datas using MySQL commands - Joins - Subqueries - Transactions.

Basics of PL SQL and simple PL SQL programs.

UNIT-V

Managing scientific data: Introduction - Challenges faced in the integration of biological information - Data management and data integration in Bioinformatics - Issues to address while

designing a biological information system - SRS: An integration platform for database and analysis tools in bioinformatics - An integration challenges in gene expression data management - discovery link

Text Books

1. Silberschatz, Korth and Sudarshan, Database System concepts, Tata McGraw-Hill, New Delhi, 2006.
2. Vikram vaswani, The complete reference for MySQL, Tata McGraw-Hill, New Delhi, 2004.
3. Lacroix Critchlow, Bioinformatics - Managing scientific data, Elsevier, New Delhi, 2003.

SEMESTER-II

CORE PAPER III

STRUCTURAL BIOLOGY

UNIT 1

Levels of molecular organization, Brief discussions on: Amino acids, Nucleic acids, Adenylates, Carbohydrates, Lipids, Cofactors, Vitamins, and Hormones. Composition and primary structures of proteins, Conformational analysis and forces that determine protein structures, geometries, phi, psi, omega angles, Ramachandran or steric contour diagram, allowed chi angles of side chains in proteins, hydrogen bonding, disulphide bonds, hydrophobic interactions, vanderwaals forces, potential energy calculations, alpha helices, beta sheets, helix to coil transition, general features and thermodynamic aspects of protein folding, folding kinetics, protein-ligand interactions, Scatchard plot, cooperative interactions, allosteric effects, Hill constant; Relationship between the primary, secondary, and tertiary structure of proteins. Structure of IgG, fibrous proteins (structure of collagen, keratin). Quaternary structures - dimers, homo & hetero dimers, trimers, tetramers; Protein folds, structural families and classes, multifunctional domains.

UNIT 2

General characteristics of nucleic acid structures (A, T, G, C, U), forces and stabilizing geometries, glycosidic bond, rotational isomers. Stabilizing ordered forms of DNA (A, B and Z), base pairing types, base stacking, tertiary structure of DNA (Supercoiled DNA), Melting of the DNA double helix (Hyperchromicity), Interaction with small ions and small molecules. Ribose puckering and Tertiary structure of tRNA. Structure and conformational properties of cell membranes, Singer and Nicholson model, integral proteins in membranes, conformational variations during ion transport, Signal transduction and molecular reception.

UNIT 3

Rayleigh scattering, ultra-centrifugation, viscometry. Electron microscopy (SEM-TEM, AFM), luminescence (fluorescence & phosphorescence), Calorimetry, DSC, Mass spectrometry, LCMS, MALDI-TOF, Voltage Clamp and Patch Clamp (measurements of membrane potentials).

UNIT 4

X-ray diffraction: structure determination via single crystal diffraction, fibre diffraction; Neutron diffraction. XAFS. NMR spectroscopy (structure determination). ORD/CD, UV, IR, Laser Raman, ESR/EPR.

UNIT 5

Association of macromolecules, molecular conjugates, supramolecular interactions, protein-protein interactions, protein-nucleic acid interactions, lipid/membrane-protein interactions. Molecular mechanics and dynamics (Newtonian and Monte Carlo simulations), theoretical principles and its importance towards insilico simulations, results of molecular dynamics calculations and their implications to biological function.

REFERENCE BOOKS

1. Biophysical Chemistry by Cantor R. and Schimmel P.R, W. H. Freeman.

2. Physical Biochemistry by David Freifelder, W H Freeman and Company.

3. Biophysical Principles of Structure & Function by Fred M. Snell & Sidney Shulman.

4. Introduction to Protein Structure by Carl Branden and John Tooze, Garland Publishing.

5. Proteins Structure – A Practical Approach by Creighton, Oxford University Press.

6. Physical Chemistry: Principles and Applications in Biological Sciences by Tinoco and others, Prentice Hall.

CORE PRACTICAL I

BIOCHEMISTRY, BIOPHYSICS AND MOLECULAR BIOLOGY

BIOCHEMISTRY

1. Estimation of reducing sugar.
2. Estimation of lipids.
3. Separation of amino acids and lipids using TLC and Paper chromatography.
4. Separation of a mixture of proteins (2 or 3) using column chromatography.
5. Estimation of proteins using Bradford and Lowry's methods.
6. Extraction of proteins from microbes and plants.
7. Blood analysis, estimation of RBC count, WBC count

BIOPHYSICS

8. Microscopy: Bright field, Phase contrast & Fluorescence microscopy
9. To verify the Lambert Beer's law.
10. Protein crystallization using hanging drop and sitting drop methods.
11. Casting the Gel for SDS-PAGE.
12. Separation of protein and molecular weight determination using SDS-PAGE.
13. Staining the gel with CBB.

MOLECULAR BIOLOGY

14. Histochemical techniques for Plant cells and tissues.
15. Mitosis - Onion root tip squash with heamatoxylin staining.
16. Meiosis - Tradeschantia anther squash with Acetocarmine staining
17. Isolation of Mitochondria
18. Isolation of Chloroplast
19. Microbial genomic DNA isolation
20. Microbial plasmid isolation
21. Plant genomic DNA isolation.
22. Agarose Gel electrophoresis and gel documentation.
23. DNA amplification using Thermocycler.
24. Blotting Techniques - Southern, Northern & Western.
25. Hybridization - Autoradiography - Demonstration

CORE PRACTICAL II

SEQEUNCE ANALYSIS

1. Biological databases (sequence, structure and specialized databases)
2. Data retrieval using ENTREZ
3. Database file formats
4. Gene finding (Genscan)
5. Protein prediction
6. Sequence search
7. Sequence alignment
8. Phylogenetic tree construction
9. Sequence comparison
10. Structure analysis
11. Pattern recognition
12. Proteome analysis using tools
13. Exon finding
14. Genome homology
15. Molecular visualization using Rasmol

CORE PRACTICAL III

PROGRAMMING IN C & C++

I. Character array manipulations

1) Read and Display a character array

2) Reverse print the array (Sting Reverse)

3) Length of the array

4) Copying the contents of one array to another (String Copy)

5) Copy the Uppercase character of one array as Lowercase character to another array

6) Checking whether a string is a palindrome or not

7) Copy the left „n‟ characters of one array to another

8) Copy the last „n‟ characters of one array to another

9) Copy the middle „n‟ characters of one array to another

10) Concatenate two character arrays (String Concatenate)

11) Counting the numbers of Words, Lines and characters in an array

12) Counting the numbers of Uppercase and Lowercase Alphabets, Digits and special characters in an array

13) Check the number of occurrences of a pattern

14) Check the occurrences of a pattern and skip the same.

15) Check the occurrences of a pattern and replace it with a different pattern

II. Pointers and Character Array

16) Pattern Counting

17) Pattern Skipping

18) Pattern Replacing

III. Files and Command Line Arguments

19) Read data from the keyboard and write it in the file (char by char)

20) Read data from the file and display it on the screen (char by char)

21) Display the content of all the files (Cat all the files)

C++ PROGRAMS

1) C++ Program to Add Two Numbers
2) C++ Program to Check Whether Number is Even or Odd
3) C++ Program to Find Largest Number Among Three Numbers
4) C++ Program to Find All Roots of a Quadratic Equation
5) C++ Program to Calculate Sum of Natural Numbers

6) C++ Program to Check Leap Year
7) C++ Program to Find Factorial
8) C++ Program to Generate Multiplication Table
9) C++ Program to Reverse a Number
10) C++ Program to Multiply two Numbers
11) C++ Program to Check Whether a Number is Palindrome or Not
12) C++ Program to Check Whether a Number is Prime or Not
13) C++ Program to Display Prime Numbers Between Two Intervals
14) C++ Program to Display Armstrong Number Between Two Intervals
15) C++ Program to Display Factors of a Number
16) C++ Program to Display Prime Numbers Between Two Intervals Using Functions
17) C++ Program to Check Prime Number By Creating a Function
18) C++ Program to Check Whether a Number can be Express as Sum of Two Prime Numbers
19) C++ program to Find Sum of Natural Numbers using Recursion
20) C++ program to Calculate Factorial of a Number Using Recursion

CORE ELECTIVE - PAPER 2

A) BIOPHYSICS AND BIOCHEMISTRY

Objective

To impart knowledge to the candidates on structural, functional and dynamic aspects of biological components

UNIT-I

Classification, Structure, Properties and Biological role of Carbohydrates. Carbohydrate Biosynthesis, Metabolism - Glycolysis, TCA cycle and ATP bioenergetics.

UNIT-II

Structure, classification. Properties and Biological role of Lipids. Storage of fatty acids. Lipid, Biosynthesis, Metabolism. Utilization of fatty acids for energy production - β Oxidation**.**

UNIT-III

Introduction to protein structure - Composition and dynamic structural properties, primary and higher level protein organization. Structural components of Nucleic acids. DNA structure, function and sequence. Properties, structure and types of RNA. Nucleic acid Metabolism - Conformational properties of proteins - Ramachandran, Chandrasekaran and Sasisekaran plots, secondary, super secondary, tertiary and quaternary structure of protein.

UNIT-IV

Biophysics - Introduction - Thermodynamics - Laws of thermodynamics - Energy states - Ground and Excited states - Electromagnetic spectrum - Absorption of light by atoms & molecules - Paulis exclusion principle - Coupling of chemical reactions - Endergonic and exergonic coupling - Redox reactions - Hydrogen half cell.

UNIT-V

ATP synthesis - ETC in chloroplast and mitochondria - Oxygen electrode - Classification, Characteristics of enzymes - Biological role - Enzyme Kinetics, Regulation of enzyme activity and Factors affecting enzyme kinetics - Formulation and significance of Michaelis - Menton Equation.

Text Books

1. Berg, J.M., Tymoczko, J. L. and Stryer, L. 2002. Biochemistry. 5th Edn. W.H Freeman and Company, New York.
2. Devlin, T. M. 2002. Text book of Biochemistry - with clinical correlations. 5th Edn. John

Wiley & Sons Inc., New York, USA.

3. Freifelder, D. and Malcinski, G.M. 1993. Essentials of Molecular Biology, 2nd Edn. Jones & Bartletl Publishers Inc., London.

4. Nelson, D.L. and Cox, M.M. 2005. Lehninger's Principles of Biochemistry, 4th Edn. Replika Press Pvt. Ltd., New Delhi.

5. Voet, D. and Voet, J.G. 1990. Biochemistry. John Wiley and Sons Inc., New York.

References

1. Atherly, A.G., Girton, J.R. and McDonald, J.F. 1999. The science of Genetics – Saunders College Publishers, New Delhi.
2. Bickerstaff, G.F.1997. Immobilization of Enzymes and Cells. Humana Press, New Jersey, USA.
3. Bray, A., Raff, L. and Watson, R. 1994. Molecular biology of the Cell. 3rd Edn. Garland Publishing Company, New York.
4. Click, B.R. and Pastumak, J.J. 1998. Molecular Biotechnology - Principles and application of recombinant DNA. American Society of Microbiologists Press, Washington.
5. Cooper, G.M. and Hausman, R. E. 2004. The Cell: A Molecular Approach, 3rd Edn. American Society of Microbiologists Press, Washington.
6. Karp, G. 1996. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons, New York.
7. Micklos, D.A., Freyerr, G. A. and Crotty, D. A. 2003. DNA Science, 2nd Edn. Cold Spring Harbor Laboratory Press, New York.
8. Primrose, S. B. 1994. Molecular Biotechnology, 2nd Edn. Blackwell Scientific Publishers, Oxford.

CORE ELECTIVE - PAPER 2

B. BIOLOGICAL ALGORITHMS IN COMPUTATIONAL BIOLOGY

COURSE OBJECTIVES: To make the students understand the application of Artificial Intelligence in Biocomputing.

Unit 1 DNA computing: Motivation, DNA structure, processing and computational operations, steps involved in DNA computation, Filtering models: Adleman's experiment, Lipton's solution, Scope and Applications of DNA computing. Search Algorithms: Hill climbing, Simulated annealing:-introduction, Simulated annealing algorithm,

Unit 2 Combinatorial Pattern Matching: Hash Tables, Repeat Finding, Exact Pattern Matching; Genetic Algorithm: Basic Concepts, Reproduction, Cross over, Mutation, Fitness Value, Optimization using GAs; Applications of GA in bioinformatics.

Unit 3 Hidden Markov Model: Markov processes and Markov Models, Hidden Markov Models. Forward and Backward Algorithms, Most probable state path: Viterbi algorithm, Parameter Estimation for HMMs:-Baum-Welch Algorithm, Applications of profile HMMs for multiple alignment of proteins and for finding genes in the DNA.

Unit 4 Support Vector Machines: Introduction, hyperplane separation (maximum and soft margin hyperplanes), linear classifier, Kernel functions, Large Margin Classification, Optimization problem with SVM, Applications of SVM in bioinformatics. Bayesian network: Bayes Theorem, Inference and learning of Bayesian network, BN and Other Probabilistic Models.

Unit 5 Artificial Neural Network: Historic evolution – Perceptron, characteristics of neural networks terminology, models of neuron Mc Culloch – Pitts model, Perceptron, Adaline model, Basic learning laws, Topology of neural network architecture, single layer ANN, multilayer perceptron, back propagation learning, input - hidden and output layer computation, back propagation algorithm, Applications of ANN.

Text Books:

1. An introduction to bioinformatics algorithms by Neil C. Jones, Pavel Pevzner. MIT Press.2004
2. Biological sequence analysis: Probabilistic models of proteins and nucleic acids by Richard Durbin, Eddy, Anders Krogh, 1998
3. Algorithms for Molecular Biology by Ron Shamir Lecture, Fall Semester, 2001
4. Neural Networks: A Systematic Introduction by Raul Rojas. Springer. 1996
5. Artificial Intelligence and Games by Georgios N. Yannakakis and Julian Togelius, Springer 2018

Reference Books:

1. Bioinformatics: the machine learning approach by Pierre Baldi, SørenBrunak. MIT Press.2001.
2. Bioinformatics: Sequence and Genome Analysis: by David Mount, University of Arizona,Tucson. 2005

3. Fundamentals of natural computing : Basic concepts, Algorithms and Applications, Chapman & Hall / CRC, Taylor & Francis group, 2006

COURSE OUTCOME: Students are trained in the application of Artificial Intelligence in Biocomputing

CORE ELECTIVE - PAPER 2
C. CHEMINFORMATICS

Course Objectives:

- To make the students understand the basics of cheminformatics and their application.
- To aware the various chemical information sources.
- To analyze the pharmacokinetic properties of small molecules using ADMET calculation.
- To understand the steps in pro drug design.
- To utilize the bioinformatics tools and software in different aspects.

Syllabus

Unit-I: Basic Mathematics and Statistics

Graph theory and molecular numerology; Logic, sets and functions; Algorithms, integers and matrices; Mathematical reasoning, induction and recursion; Counting; graphs, trees and sets, basic probability and statistics; Markov processes.

Unit-II: Foundations of Chemistry and Biology

Basic Stereochemistry, Group Theory, Amino acids and Proteins and Properties; pKa, pH and ionization of acids and bases; Protein structure - Primary structure, Secondary structure - helix & sheet; Tertiary structure; Quaternary structure; covalent and non-covalent forces that maintain structures. Physical properties of proteins - charge, size, hydrophobic, protein binding – structural aspects; antibodies; transport; nucleotide binding; catalytic enzymes; basic concepts of combinatorial chemistry. Introduction to drug action, pro drug design and applications.

Unit-III: Chemical information sources

History of scientific information communication-chemical literature-chemical information chemical information search-chemical information sources-chemical name and formula searching-analytical chemistry-chemical history-biography-directories and industry sources.

Unit-IV: Bioinformatics

Introduction; Experimental sources of biological data; Publicly available databases; Gene expression monitoring; Genomics and Proteomics; Metabolomics; Visualisation of sequence data; Visualization of structures using Rasmol or SPDB Viewer or CHIME; Genetic basis of disease; Personalised medicine and gene-based diagnostics; Legal, ethical and commercial ramifications of bioinformatics.

Unit-V: Pharmaceutical applications of molecular modeling

Introduction to drugs, structure-based drug design. QSAR and 3D-QSAR Methods. Pharmacophore Design, Ligand-Based Design and De Novo Drug Design Virtual screening/docking of ligands. Protein structure. Drug action enzymes. Drug action receptors. Drug design target interaction. Prediction of Binding Modes, Protein–ligand binding free energies, Fragment-Based Drug Design; Absorption, Distribution, Metabolism, Excretion & Toxicology (ADMET) prediction; Calculation of Physico-Chemical Properties, Biological and Physico-Chemical Predictive Model Building.

References:

- "Mathematical Methods for Physicists" Arfken, Academic Press 1985
- Schaum's Outline of Probability and Statistics, Murray R Spiegel, John J. Schiller, R. Alu Srinivasan
- Stereochemistry, by David G. Morris, Eddie Abel
- Introduction to Protein Structure: Second Edition ,Carl Branden , John Tooze
- Combinatorial Chemistry and Molecular Diversity in Drug Discovery, Eric M. Gordon , James F. Kerwin
- Computer-Aided Drug Design: Methods and Applications, T.J. Perun C.L. Propst
- Chemical Information Sources (Mcgraw-Hill Series in Advanced Chemistry) ,Gary Wiggins
- Introduction to Bioinformatics, Teresa K. Attwood, David Parry-Smith
- Molecular Modeling: Basic Principles and Applications, 3rd Edition,Hans-Dieter Höltje, Wolfgang Sippl, Didier Rognan, GerdFolkers

OPEN ELECTIVE PAPER 2

BIOLOGICAL SEQUENCE ANALYSIS

Subject description :
This paper describes how to acquire information from biological databases, use of computational approaches to analyze this information, and interpret the results as a guide to experiments in biology.

Goals: The goal of this course is to introduce the main principles of bioinformatics. The coverage will include concepts like sequence alignments, phylogenetic trees, and structure prediction.

Objectives: Understand Genomic data acquisition and analysis, comparative and predictive analysis of DNA and protein sequence, Phylogenetic inference etc

UNIT-I
Introduction to bioinformatics, Classification of biological databases, Biological data formats, Application of bioinformatics in various fields. Introduction to single letter code of aminoacids, symbols used in nucleotides, data retrieval- Entrez and SRS.

UNIT-II
Introduction to Sequence alignment. Substitution matrices, Scoring matrices – PAM and BLOSUM. Local and Global alignment concepts, Dot plot. Dynamic programming methodology: Needleman and Wunsch algorithm. Smith–Waterman algorithm. Statistics of alignment score. Multiple sequence alignment. Progressive alignment. Database search for similar sequences using FASTA and BLAST Programs.

UNIT-III
Evolutionary analysis: distances, Cladistic and Phenetic methods. Clustering Methods. Rooted and Unrooted tree representation. Bootstrapping strategies, Use of Clustal and PHYLIP.

UNIT-IV
Gene finding methods. Gene prediction: Analysis and prediction of regulatory regions. Fragment assembly. Genome sequence assembly, Restriction Mapping, Repeat Sequence finder.

UNIT-V
Concepts of secondary structure prediction of RNA and Protein. Probabilistic models: Markov chain, Hidden Markov Models-other applications.

REFERENCES

1. **Bioinformatics – Concepts, Skills, Applications".** S.C. Rastogi, Namita Mendiratta, Parag Rastogi.
2. **Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.** Andréa's D. Baxevanis, B.F. Francis Ouellette.
3. **Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids.** Richard Durbin et al.
4. **Computer Methods for Macromolecular Sequence Analysis**. Doolittle R.F. (Ed.) (Methods in Enzymology, VOl. 266).
5. Shanmughavel, P. 2005. **Principles of Bioinformatics,** Pointer Publishers, Jaipur, India.
6. **DNA and Protein Sequence Analysis. A Practical approach.** Bishop M.J. Rawlings C.J. (Eds.).
7. **Introduction to Bioinformatics.** Teresa. K. Atwood and David J. Parry-Smith.

COMPULSORY PAPER

HUMAN RIGHTS

UNIT-I

Definition of Human Rights - Nature, Content, Legitimacy and Priority - Theories on Human Rights - Historical Development of Human Rights.

UNIT-II

International Human Rights - Prescription and Enforcement upto World War II - Human Rights and the U .N .O. - Universal Declaration of Human Rights - International Covenant on Civil and Political Rights - International Convenant on Economic, Social and Cultural Rights and Optional Protocol.

UNIT-III

Human Rights Declarations - U.N. Human Rights Declarations - U.N. Human Commissioner.

UNIT-IV

Amnesty International - Human Rights and Helsinki Process - Regional Developments - European Human Rights System - African Human Rights System - International Human Rights in Domestic courts.

UNIT-V

Contemporary Issues on Human Rights: Children's Rights - Women's Rights - Dalit's Rights - Bonded Labour and Wages - Refugees - Capital Punishment. Fundamental Rights in the Indian Constitution - Directive Principles of State Policy - Fundamental Duties - National Human Rights Commission.

Books for Reference:

1. International Bill of Human Rights, Amnesty International Publication, 1988.
2. Human Rights, Questions and Answers, UNESCO, 1982
3. Mausice Cranston - What is Human Rights
4. Desai, A.R. - Violation of Democratic Rights in India

5. Pandey - Constitutional Law.
6. Timm. R.W. - Working for Justice and Human Rights.
7. Human Rights, A Selected Bibliography, USIS.
8. J.C.Johari - Human Rights and New World Order.
9. G.S. Bajwa - Human Rights in India.
10. Amnesty International, Human Rights in India.
11. P.C.Sinha & - International Encyclopedia of Peace, Security K. Cheous (Ed) Social Justice and Human Rights (Vols 1-7).
12. Devasia, V.V. - Human Rights and Victimology.

Magazines:

1. The Lawyer, Bombay
2. Human Rights Today, Columbia University
3. International Instruments of Human Rights, UN Publication
4. Human Rights Quarterly, John Hopkins University, U.S.A.

SEMESTER III

MOLECULAR MODELING AND DRUG DESIGNING

Objective

To familiarize the students in using computer techniques for molecular modeling and drug designing.

UNIT-I

Introduction to drug action. Physico-chemical properties and drug action. Pharmacological approaches of modern medicine. Historical approaches in drug discovery. Pro drug design. New approaches in drug discovery: combinatorial chemistry, high throughput screening, ultra high throughput screening and high content screening, technologies for high throughput screening, pharmacogenomics, proteomics and array technology.

UNIT-II

Quantitative analysis of Structure Activity Relationships (QSAR): Introduction, Parameters, quantitative models, design of test series in QSAR, Applications of Hansch Analysis, Applications of Free Wilson Analysis and related models, 3D QSAR approaches-COMFA (Comparative Molecular Field Analysis).

UNIT-III

Molecular Modeling in Drug Design: Introduction, Background and methods-molecular mechanics, quantum mechanics, Known receptors - Definition of site, site characterization, Design of ligands, affinity calculation, multiple binding modes, homology modeling, Unknown receptors - Pharmacophore versus binding site models, searching for similarity, molecular comparisons, field effects, volume mapping, Directionality, Locus maps. Vector maps, Conformational mimicry. Finding the common pattern - Constrained minimization, systematic search and active analog approach, alternative approach, receptor mapping, model receptor sites.

UNIT-IV

Natural products as Leads for New pharmaceuticals: Introduction. Drugs affecting the Central Nervous System - Morphine alkaloids, Cannabinoids, Asperlicine. Neuromuscular blocking drugs such as Curare, decamethonium, atracurium. Anticancer Drugs-*Catharanthus* (vinca alkaloids), Taxol and Taxotere, Podophyllotoxin, Etoposide and teniposide. Antibiotics - Beta lactams, Erythromycin macrolides, Echinocardins. Cardiovascular drugs - Lovastatin, Simvastatin, Pravastatin, Teproside, Captopril, Dicoumarol, Warfarin. Antiparasitic drugs - quinine, chloroquin, mefloquine, Artemisinin, artemether and arteether.

UNIT-V

Intellectual Property in Drug Discovery and Biotechnology: Patent protection and strategy - patent strategy, first to invent versus first to file, absolute novelty. Requirements for patents - patentable subject matter in the United States, patentable subject matter outside the United States. Patent specifications - written description, enablement, best made claims, procedure for obtaining patents in US, interference proceedings, correlation of patents. Worldwide patent protection - International agreements, PCT patent practice, other aspects of patent laws in other countries. Trademarks-trademarks as marketing tools, selection of trademarks, registration process, worldwide trade mark rights. Trade secrets-definition, requirements for protection of trade secrets, enforcement of relationship of trade secrets and patents, freedom of information act, trade secret protection outside the United States.

Text Books

1. Bohlin, L. and Bruhn, J.G. 1999. Bioassay methods in Natural Product research and Drug Development. Kluwer Academic Publishers, Netherlands.
2. Busse, W. D. and Ganellin, C. R. 1993. Views from Industry on the Medicinal Chemistry Curriculum: Answers to a Questionnaire. In Trends in Drug Research, (Ed.) V. Claassen, Pharmacochemistry Library, 20, Elsevier, Amsterdam.
3. Kulkarni V.M.1995. Drug Design. Nirali Prakashan, New Delhi.
4. Lawrence, D.R. and Bacharach, A.L. 1980. Evaluation of Drug activities: Pharmacometrics Vol. 1, 5th Edn. Academic Press, New York.
5. Vogel, G. H. 2002. Drug Discovery and Evaluation: Pharmacological Assays, 2nd Edn. Springler-Verlag, Berlin Heidelberg, Germany.
6. Wolff, M.E. 1995. Burgers's Medical Chemistry and drug discovery, Vol. 1: principles and practice, 5th Edn. John Wiley & Sons, New York.

SEMESTER III

SYSTEMS BIOLOGY

Objective

The Objective of this subject is to understand the basics of systems biology and associated network approaches, databases and software tools.

UNIT-I

Introduction to Systems Biology: What is Systems Biology? Integrating Networks approaches, Dynamic Analysis, Organization of living cells, Components vs. Systems, Links and functional states, Links to Networks.

UNIT-II

Biochemical Reaction Kinetics – Rate equation approach, Biochemical Reaction Modeling, Basics principles and assumptions, elementary reactions, complex reaction, Michaelis-Menten equation for EK, Stochastic Modelling and Simulation, Modelling of Cell communication networks

UNIT-III

Reconstruction of Biochemical Networks : Basic features, Reconstruction methods, Organism specific source of information, Strategies relating to In silico Modeling of biological processes, Metabolic Networks, Regulation of metabolic networks, Signaling Networks.

UNIT-IV

Database and Software for Systems Biology: KEGG, EMP, MetaCyc, Gene expression and microarray databases related to systems biology, Cytoscape and Cell Designer.

UNIT-V

Software for Modeling and Simulation. E-CELL, V-CELL and GROMOS.

REFERENCES

1. Foundation of Systems Biology – Hi Roaki Kitano

2. Introduction to Systems Biology – Sangdun Choi

SEMESTER III

ADVANCED PROGRAMMING IN BIOINFORMATICS

Objective

To enable the students to acquire advanced training in Java, BioJava, Perl, Bioperl, Python

UNIT-I

JAVA - Introduction to object oriented programming - Basic Syntax - Control Structures - Arrays - Strings - Files and Streams - Applets; Introduction to JDBC (Java Database Conectivity) - JDBC Architecture, JDBC Drivers, Connecting to Database and accessing databases - Threads - Java beans.

UNIT-II

BIOJAVA: Introduction - Sequence Manipulation. Translation: DNA to Protein, Codon to amino acid, Six frame translation. Proteomics: mass and pI of a peptide - Sequence File Format conversions, Locations and Features. BLAST and FASTA parsing, Weight Matrices and Dynamic Programming

UNIT-III

PERL: Modules:- defining, storing and using modules; Data and control structures:- Operators and Control Flow, Data Types & structure, Function/Subroutines - File handling; Regular Expressions:- patterns - grouping and anchoring - string matching; Object oriented programming:- Classes, Objects, Methods.

BIOPERL: General Bioperl Classes, Sequences, Sequence Manipulation, Features and Location Classes. Alignments: AlignIO. Analysis: Blast, Genscan; Databases: Database Classes, Accessing a local database.

UNIT-IV

Common Gateway Interface:- HTML form elements, GET, POST & HEAD Method, CGI Environment Variables, Handling forms, Passing Parameters via CGI, Debugging CGI programs.

WEB DESIGNING & XML: HTML Specifications and Syntax, XML Basics, Style Sheets, XML Applications, Java Script.

UNIT-V

PYTHON: Overview, Data structures, Control Flow, Modules, Basic I/O, Regular Expressions, File Manipulation, Classes, Standard library.

Text Books

1. Herbertz Schildt, The complete Reference Java J2SE 5 Edition, Mc Graw Hill, Osborne, 2005.
2. E Balaguruswamy, Programming with Java, Tata Mc Graw Hill, New Delhi, 1999.
3. Larry Wall, Tom Christiansen & John Orwant, Programming Perl –3rd ed, O'Reilly, 2000.
4. James D. Tisdall, Beginning Perl for Bioinformatics, O'Reilly, 2001
5. Mark Lutz , Programming Python - 2nd Ed., O' Reilly, 2003.
6. Eric Ladd, J.O'Donnell, Using HTML 4, XML and JAVA, Prentice Hall of India QUE, 1999.
7. Brown, The complete reference - Perl, Tata Mc Graw Hill, New Delhi, 2004.

SEMESTER III

PRACTICAL I

MOLECULAR MODELING

1. Simple Genetic algorithm
2. Genetic algorithm and problem solving
3. Genetic algorithm in scientific models
4. Sequence alignment algorithm
5. Structure prediction - HM Model
6. Determination of Partition coefficient of established drugs by shake flask method to find out the distribution of drug.(2 to 3 experiments)
7. QSAR related experiments - calculation of molecular connectivity index values for Ibuprofen, Atropine, Propranalol, Epinephrine and methadone (Minimum of 3 experiments will be given for work out).
8. Molecular modeling experiments- Molecular Graphics (3D structure) - conformational analysis to correlate physicochemical parameters with biological activity using various molecular modeling software such as AMBER, CAMSEQ, FRODO and SYBL (minimum of 5 experiments will be given).
9. Study of Pharmacophore models by using software(2 experiments)
10. Designing a novel molecule and fitting with receptor for invitro activity evaluation - experiments related to this is given (minimum of 3 experiments)
11. Calculation of F and R substituent constants (2 experiments)

CORE PRACTICAL II

PERL & PHYTON

1. Program to store a DNA sequence using Perl
2. Program to concatenate DNA fragments using Perl
3. Program to convert DNA to RNA using Perl
4. Program to calculate reverse compliment of DNA sequence using Perl
5. Program to read protein sequence data from a file using Perl
6. Program to find motifs in a protein sequence using Perl
7. Program to count nucleotides in a sequence using Perl
8. Program to find the percentage of hydrophobic amino acids in a sequence using Perl
9. Program to find the percentage of G and C in a DNA sequence using Perl
10. Program to append ATGC to a DNA sequence using subroutines using Perl
11. Counting Letters in DNA Strings using Phyton
12. Python Program to find sum of array
13. Python Program to find largest element in an array
14. Efficiency Assessment using Phyton
15. Verifying the Implementations using Phyton
16. Computing Frequencies using Phyton
17. Analyzing the Frequency Matrix using Phyton
18. Dot Plots from Pair of DNA Sequences using Phyton
19. Finding Base Frequencies using Phyton
20. Translating Genes into Proteins using Phyton
21. Random Mutations of Genes using Phyton

CORE ELECTIVE PAPER 3

DATA WAREHOUSING AND DATA MINING

Objective: To learn the classification and clustering techniques that help to extract hidden knowledge in a domain.

UNIT-I

INTRODUCTION: Relation to Statistics, Databases - Data Mining Functionalities - Steps In Data Mining Process-Architecture Of A Typical Data Mining Systems- Classification Of Data Mining Systems - Overview Of Data Mining Techniques.

UNIT-II

DATA PREPROCESSING AND ASSOCIATION RULES: Data Preprocessing -Data Cleaning, Integration, Transformation, Reduction, Discretization Concept Hierarchies-Concept Description: Data Generalization And Summarization Based Characterization- Mining Association Rules In Large Databases.

UNIT-III

PREDICTIVE MODELING: Classification And Prediction: Issues Regarding Classification And Prediction - Classification By Decision Tree Induction - Bayesian Classification - Other Classification Methods – Prediction - Clusters Analysis: Types Of Data In Cluster Analysis - Categorization Of Major Clustering Methods: Partitioning Methods -Hierarchical Methods

UNIT IV

DATA WAREHOUSING: Data Warehousing Components - Multi Dimensional Data Model - Data Warehouse Architecture - Data Warehouse Implementation - Mapping The Data Warehouse To Multiprocessor Architecture - OLAP -Need - Categorization Of OLAP Tools.

UNIT-V

APPLICATIONS: Applications of Data Mining - Social Impacts Of Data Mining - Tools - An Introduction To DB Miner - Case Studies-Mining WWW - Mining Text Database - Mining Spatial Databases.

Text Books

1. Jiawei Han, Micheline Kamber, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, 2002.

2. Alex Berson,Stephen J. Smith, “Data Warehousing, Data Mining,& OLAP”, Tata Mcgraw-Hill, 2004.
3. Mohanty - Data warehousing, 2006, TMH, New Delhi.

References

1. Usama M.Fayyad, Gregory Piatetsky - Shapiro, Padhrai Smyth And Ramasamy Uthurusamy, "Advances In Knowledge Discovery And Data Mining", The M.I.T Press, 1996.
2. Ralph Kimball, "The Data Warehouse Life Cycle Toolkit", John Wiley & Sons Inc., 1998.
3. Sean Kelly, "Data Warehousing In Action", John Wiley & Sons Inc., 1997.

CORE ELECTIVE PAPER 3

GENETIC ENGINEERING

Unit 1: Role of genes within cells, genetic code, genetic elements that control gene expression, Method of creating recombinant DNA molecules, Types, biology and salient features of vectors in recombinant DNA technology–I: Plasmids, Phages, Cosmids, Fosmids, Phagemids, and Artificial chromosomes, Safety guidelines for recombinant DNA research, Control of spills and mechanism of implementation of biosafety guidelines

Unit 2: Enzymes in genetic engineering: Restriction nucleases: exo & endo nucleases, Enzymes in modification- Polynucleotide phosphorylase, DNase and their mechanism of action, Enzymes in modification- Methylases and phosphatases and their mechanism of action, Enzymes in modification- Polynucleotide kinase, Ligases, RNase and their mechanism of action.

Unit 3: Methods of nucleic acid detection, Polymerase chain reaction (PCR) and its applications, Variations in PCR and their applications, Methods of nucleic acid hybridization, Probe and target sequences, Nucleic acid mutagenesis in vivo and in vitro

Unit 4: Isolation and purification of nucleic acid (genomic/plasmid DNA and RNA), Quantification and storage of nucleic acids, Construction of cDNA library, Construction of Genomic library, Screening and preservation of DNA libraries, DNA Sequencing and cloning strategies.

Unit 5: Gene transfer techniques: biological methods, Gene transfer techniques: chemical methods, Gene transfer techniques: physical or mechanical methods,Agrobacterium- mediated gene transfer in plants, Chloroplast transformation Gene therapy: Introduction and Methods, Gene targeting and silencing, Gene therapy in the treatment of diseases, Challenges and future of gene therapy

Texts & References:

1) Fundamental Molecular Biology ; Allison LA; 2007

2) Recombinant DNA, Watson et al ; 5th Ed; 2006

3) Techniques for Engineering Genes ; Curell BR et al;2004

4) Techniques for Molecular Biology ; Tagu D & Moussard C; INRA; 2006

5) Gene Cloning and DNA Analysis ; 5th Ed ; Brown TA ; 2006

6) Analysis of Genes and Genomes ; Reece RJ ; Wiley; 2004

7) Recombinant DNA and Biotechnology ; 2nd Ed ; Kreuzer H and Massey A ;ASM;2006

8) Human Genetics and Genomics ; Korf BR ; 3rd Ed ; Blackwell; 2007

9) Molecular Cloning; 3rd Ed; Sambrook & Russel : Cold Spring Harbour Laboratory press, NY ; 2001

10) ICRF Handbook of Genome Analysis ; Spurr NK , Young BD , Bryant SP;1998 MSGEN-302 : Genomics, Proteomics & Bioinformatics Module I : GENOMICS (14 Periods)

CORE ELECTIVE PAPER 3

R PROGRAMMING

COURSE OBJECTIVE: The main goal of this course is to introduce the student with the R environment for biological big data analysis using various statistical methods.

Unit 1 Overview of the R language: Defining the R project, Obtaining R, Generating R codes, Scripts, Text editors for R, Graphical User Interfaces (GUIs) for R, Packages.

Unit 2 R Objects and data structures: Variable classes, Vectors and matrices, Data frames and lists, Data sets included in R packages, Summarizing and exploring data, Reading data from external files, Storing data to external files, Creating and storing R workspaces.

Unit 3 Manipulating objects in R: Mathematical operations (recycling rules, propagation of names, dimensional attributes, NA handling), Basic matrix computation (element-wise multiplication, matrix multiplication, outer product, transpose, eigenvalues, eigenvectors), Textual operations, Basic graphics (high-level plotting, low-level plotting, interacting with graphics).

Unit 4 Hypothesis testing and data handling: Hypothesis testing, Parametric and nonparametric tests, Chi-square test, t-tests, ANOVA, Correlation and regression, Principal component Analysis

Unit 5 Big Data Analytics in Bioinformatics using R: Introduction to Big data: Characteristics, data structures and data repositories; exploratory analysis of big data in R environment, Bioconductor, Microarray and next-generation sequencing (NGS) data analysis in R environment.

Text Books:

1. Paul Gerrard and Radia M. Johnson. Mastering Scientific Computing with R. Packt Publishing, UK, 2015.

2. P.P. Sinha. Bioinformatics with R Cookbook. Packt Publishing, UK, 2014.

Reference Books:

1. Florian Hahne, Wolfgang Huber, Robert Gentleman, Seth Falcon. Bioconductor case studies. Springer, 2008.

2. Paul D. Lewis, R for Medicine and Biology, Jones and Bartlett Series, 2010.

COURSE OUTCOME: The student will have an understanding of various statistical methods employed in biological data analysis. He/she will be able to perform statistical modelling and analysis of microarray and next-generation data in the R environment.

OPEN ELECTIVE PAPER 3

INTRODUCTION TO DRUG DESIGN AND DISCOVERY

Course Objectives:

- To utilize the available sequences to model the target and use computational tools and software to design a drug.
- To acquire knowledge on the computational software to visualize and compare the protein structure and sequences.
- To analyze the conformational properties of protein using Ramachandran plot.

SYLLABUS

Unit-I: Introduction to drug discovery History of drug design, Drug properties, likeness; Principles of Protein structure - Helix, Sheet, Strand, Loop and Coil, Torsion angles, Active site, Domains, Fold, Motif, PSSM; Structural databases- PDB, CATH, SCOP; Chemical Databases – ZINC, Pubchem, Chembl.

Unit-II: Macromolecular modeling Ab initio modeling; Homology Modeling; Threading; Fold Recognition. Model refinement and validation – Ramachandran Plot, PROCHECK. Prediction of Binding site; ADME prediction; Rasmol viewer.

Unit-III: Quantitative Structure Activity Relationship (QSAR) SAR, QSAR, Types of physicochemical parameters, experimental and theoretical approaches for the determination of physicochemical parameters. 3D-QSAR software COMFA.

Unit-IV: Molecular docking and Virtual screening Structure-based drug design and Ligand based drug design; Virtual Screening, Pharmacophore design and identification. Molecular docking- AutoDock, Drug-receptor interaction.

Unit-V: Molecular mechanics and dynamics General features of molecular mechanics; Energy Minimization - local and global energy minima, applications. Molecular dynamics simulation.

REFERENCE BOOKS:

- Molecular Modeling: Basic Principles and Applications, 3rd Edition,Hans-Dieter Höltje, Wolfgang Sippl, Didier Rognan, GerdFolkers

- Andrew R. Leach Molecular Modeling: Principles and Applications.

SEMESTER IV-CORE PAPER

RESEARCH METHODOLOGY

UNIT 1

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process

UNIT 2

Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.

UNIT 3

Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

UNIT 4

Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches.

UNIT 5

Interpretation of Data and Paper Writing – Layout of a Research Paper, Bioinformatics and Computational Biology Journals, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism.

Reference Books

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition

2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.

3. Research Methodology – C.R.Kothari

SEMESTER IV- CORE PRACTICAL I

MOLECULAR MODELING

1. Simple Genetic algorithm
2. Genetic algorithm and problem solving
3. Genetic algorithm in scientific models
4. Sequence alignment algorithm
5. Structure prediction - HM Model
6. Determination of Partition coefficient of established drugs by shake flask method to find out the distribution of drug.(2 to 3 experiments)
7. QSAR related experiments - calculation of molecular connectivity index values for Ibuprofen, Atropine, Propranalol, Epinephrine and methadone (Minimum of 3 experiments will be given for work out).
8. Molecular modeling experiments- Molecular Graphics (3D structure) - conformational analysis to correlate physicochemical parameters with biological activity using various molecular modeling software such as AMBER, CAMSEQ, FRODO and SYBL (minimum of 5 experiments will be given).
9. Study of Pharmacophore models by using software(2 experiments)
10. Designing a novel molecule and fitting with receptor for invitro activity evaluation - experiments related to this is given (minimum of 3 experiments)
11. Calculation of F and R substituent constants (2 experiments)

SEMESTER IV- CORE PRACTICAL II

PERL & PHYTON

1. Conversion of DNA to RNA sequence using Perl program.
2. Conversion of a DNA to RNA sequence using subroutine in Perl
3. Reverse complement of DNA sequence using Perl program.
4. Reading DNA sequence data from files using Perl program.
5. Finding motif in a protein sequence using Perl program.
6. Translation of given DNA sequence to protein sequence using Perl program.
7. Translation of DNA (taken from files) to protein sequence using Perl program.
8. Reading DNA sequence in all six reading frames using Perl program.
9. Counting Letters in DNA Strings using Phyton
10. Python Program to find sum of array
11. Python Program to find largest element in an array
12. Efficiency Assessment using Phyton
13. Verifying the Implementations using Phyton
14. Computing Frequencies using Phyton
15. Analyzing the Frequency Matrix using Phyton
16. Dot Plots from Pair of DNA Sequences using Phyton
17. Finding Base Frequencies using Phyton
18. Translating Genes into Proteins using Phyton
19. Random Mutations of Genes using Phyton

CORE ELECTIVE PAPER 4

BIOETHICS BIOSAFTEY AND IPR

Unit I Introduction to Intellectual Property: Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies

Unit II Agreements and Treaties: History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments

Unit III Basics of Patents and Concept of Prior Art: Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, esp@cenet(EPO), PATENTScope(WIPO), IPO, etc.)

Unit IV Patent filing procedures: National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting–disclosure/non-disclosure; Financial assistance for patenting-introduction to existing schemes, Patent licensing and agreement Patent infringement- meaning, scope, litigation, case studies

Unit V Biosafety: Introduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals.

Unit VI Biosafety guidelines: Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including; Cartegana Protocol. Module VII Bioethics: Ethical implications of biotechnological products and techniques. Social and ethical implications of biological weapons.

REFERENCES:

1. Beier F.K, Crespi R.S and Straus T. Biotechnology and Patent protection, Oxford and IBH Publishing Co. New Delhi.
2. Jeffrey M. Gimble, Academia to Biotechnology, Elsevier Academic Press.
3. Rajmohan Joshi (Ed.). 2006. Biosafety and Bioethics. Isha Books, Delhi.
4. Sasson A, Biotechnologies and Development, UNESCO Publications.
5. Senthil Kumar Sadasivam and Mohammed Jaabir M. S. (2008). IPR, Biosafety and Biotechnology Management, Jasen Publications, India.
6. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007.

7. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007.

CORE ELECTIVE PAPER IV

MEDICAL BIOTECHNOLOGY

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 2 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 3 Immune System: Structure, function and Cells of the immune system: The classification of human immune response: Humoral and cellular immunity, Innate and Adaptive immune response, Cellular components of the adaptive immune system, Phases of adaptive immune responses, Clonal expression, Toll like receptors, ABO blood Group. Lymphoid cells, clinical focus on the stem cells. Clinical uses and potential.B-lymphocytes and T-lymphocytes. Primary and Secondary lymphoid organs.

Unit 4 Molecular Basis of cancer: Types of Cancer – Stages of cancer development – Properties of cancer cells - Cell transformation – Tumor viruses – Genetic basis of cancer – Oncogenes – Tumor suppressor genes – Care taker genes.

Unit 5 Designing vaccines for active immunization: Live, attenuated vaccines. Subunit vaccines. Conjugate vaccines. DNA vaccines.Recombinant vector vaccines. Allergic responses in host defense Gell and Coombs Classification. IgE- Mediated (Type-I) hypersensitivity. Antibody-Mediated Cytotoxic (Type-II) hypersensitivity. Immune complex-Mediated (Type-III) Hypersensitivity.Type-IV or Delayed –type Hypersensitivity (DTH).Anaphylaxis. Pathogenesis and management of allergic asthma and rhinitis Clinical manifestations.

Texts / References:

1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.

2. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.

3. Janeway et al.,Medical Immunobiology, 4th Edition, Current Biology, publications., 1999.

4. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.

5. Goding, Monoclonal antibodies, Academic Press. 1985.

CORE ELECTIVE PAPER IV

BIG DATA ANALYTICS AND NGS

COURSE OBJECTIVES: To understand basics Big data and Next generation seqe3uncing and tools to analyze the huge biological data set.

Unit 1

Overview of Big Data, Evolution of Big data - Best Practices for Big data Analytics - Big data characteristics - Validating - The Promotion of the Value of Big Data - Big Data Use Cases.

Unit 2

Characteristics of Big Data - Four V's, Basic operations of in big data, Datasets, Data Analytics, different data types of big data, Awareness of Architecture- Big Data with Hadoop, Introduction to Hadoop,

Unit 3

Emergence of Next generation sequencing, Illumina Genome Analyzer, Applied Biosystems Sequencing, Ion Torrent Sequencing, Polonator Technology, Nanopore Sequencing, Single Molecule Real Time DNA sequencing, Comparison of Next generation sequencing techniques, NGS File formats, & applications.

Unit 4

De novo Genome sequence assembly, Reference sequence assembly, Challenges of Genome assembly, Use of paired – end reads in the assembly, Data Preprocessing methods and sequencing read correction methods, Assembly Errors, Evaluation of assembly methods.

Unit 5

Transcriptome (RNA) sequencing, Exome sequencing, Genome Annotation, Using NGS to detect sequence variants, ChIP-sequence, Biological theories on ChIPsequence analysis, Understanding the non – coding genome, Disease gene identification, DNA fragment evaluation, Peak identification, Two condition comparison, Saturation analysis, Motif finding and related theories.

Text Books

1. Big Data Fundamentals, Concepts, Drivers & Techniques Concepts, Drivers & Techniques by Thomas Erl, Wajid Khattak, and Paul Buhler, PRENTICE HALL, 2012.

2. Analytics in a Big Data World: The Essential Guide to Data Science and its Applications (WILEY Big Data Series) – Bart Baysen, 2014

3. Ali Masoudi-Nejad, Zahra Narimani, Nazanin Hosseinkhan; “Next Generation Sequencing and Sequence Assembly”, Methodologies and Algorithms, Springer; 2013.

4. Stuart M. Brown, “Next-Generation DNA Sequencing Informatics”, Cold Spring Harbor Laboratory Press, 2013.

Reference Books

1. Big Data Now, O’Reilly Radar, O’Reilly Media, 2012

2. Big Data for Dummies, Wiley, Judith Hurwitz, Alan Nugent, Fern Halper, Marcia Kaufman, 2012 COURSE OUTCOME: Able to analyze the data using R language. Able to work in NO SQL databases. Able to find hidden patterns in Big data

3. Mark I. Rees, “Challenges and Opportunities of Next-generation Sequencing for Biomedical Research”, Academic Press, 2012.

OPEN ELECTIVE PAPER 4

FUNDAMENTALS OF ALGORITHMS

UNIT 1

Notion of an Algorithm – Fundamentals of Algorithmic Problem Solving – Important Problem Types – Fundamentals of the Analysis of Algorithmic Efficiency –Asymptotic Notations and their properties. Analysis Framework – Empirical analysis – Mathematical analysis for Recursive and Non-recursive algorithms – Visualization

UNIT 2

Brute Force – Computing an– String Matching – Closest-Pair and Convex-Hull Problems - Exhaustive Search – Travelling Salesman Problem – Knapsack Problem – Assignment problem. Divide and Conquer Methodology – Binary Search – Merge sort – Quick sort – Heap Sort - Multiplication of Large Integers – Closest-Pair and Convex – Hull Problems.

UNIT 3

Dynamic programming – Principle of optimality – Coin changing problem, Computing a Binomial Coefficient – Floyd‘s algorithm – Multi stage graph – Optimal Binary Search Trees – Knapsack Problem and Memory functions. Greedy Technique – Container loading problem – Prim‘s algorithm and Kruskal’s Algorithm – 0/1 Knapsack problem, Optimal Merge pattern – Huffman Trees.

UNIT 4

The Simplex Method – The Maximum-Flow Problem – Maximum Matching in Bipartite Graphs, Stable marriage Problem.

UNIT 5

Lower – Bound Arguments – P, NP NP- Complete and NP Hard Problems. Backtracking – n-Queen problem – Hamiltonian Circuit Problem – Subset Sum Problem. Branch and Bound – LIFO Search and FIFO search – Assignment problem – Knapsack Problem – Travelling Salesman Problem – Approximation Algorithms for NP-Hard Problems – Travelling Salesman problem – Knapsack problem.

REFERENCE BOOKS

1. Introduction to Algorithms, 3rd Edition by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein

2. A Guide to Experimental Algorithmics, by McGeoch.