

THIRUVALLUVAR UNIVERSITY

MASTER OF SCIENCE

DEGREE COURSE

M.Sc. BIO INFORMATICS

UNDER CBCS

[with effect from 2008-2009]

The Course of Study and the Scheme of Examinations

Year / Semester	Subject	Paper	Title of the Paper	Ins. Hrs/ Week	Credit	Exam hrs	Max.Marks		
							IA	Uni. Exam.	Total
I Year I Semester	Core	Paper I	Introduction to Bioinformatics	4	4	3	25	75	100
	Core	Paper II	Biochemistry and Bio-Physics	4	4	3	25	75	100
	Core	Paper III	Computer Programming using C	4	4	3	25	75	100
	Core Practical		Biochemistry, Biophysics, Database and Computing	9	5	3	-	-	-
	Elective (a) or	Paper I	Cytogenetics	3	3	3	25	75	100
	Elective (b)		Cell Biology						
I Year II Semester	Core	Paper IV	Omes and Omics	4	4	3	25	75	100
	Core	Paper V	Molecular Biology and Biotechnology	4	4	3	25	75	100
	Core	Paper VI	Mathematical and Statistical Methods in Bioinformatics	4	4	3	25	75	100
	Core	Practical I	Biochemistry, Biophysics, Database and Computing	9	5	3	25	75	100
	Core	Practical II	Molecular Biology and Biotechnology and Computing Techniques	9	5	3	25	75	100
			Human Rights	2	2	3	25	75	100
	Elective (a) or	Paper II	Data Warehousing and Data Mining	3	3	3	25	75	100
	Elective (b)		Relational Database Management Systems						
II Year III Semester	Core	Paper VII	Genetic Algorithms	4	4	3	25	75	100
	Core	Paper VIII	Molecular Modeling and Drug Designing	4	4	3	25	75	100

M.Sc. Bio Informatics : Syllabus (CBCS)

Year / Semester	Subject	Paper	Title of the Paper	Ins. Hrs/ Week	Credit	Exam hrs	Max.Marks		
							IA	Uni. Exam.	Total
	Core	Paper IX	Advanced Programming in Bio-informatics (Java, Bio-Java, Perl, Bio-Perl, Xml, Web Designing, Python)	4	4	3	25	75	100
	Core Practical		Molecular Modeling and Programming	8	4	3	-	-	-
	Elective (a) or	Paper III	Genetic Engineering (Biosafety, Pharmacogenomics, Pharmacocheminformatics)	3	3	3	25	75	100
	Elective (b)		Digital Image Processing and Micro Array Analysis						
	Elective IV (Non-Major Subject)	Paper IV	Bio-Computing	3	3	3	25	75	100
II Year IV Semester	Core	Paper X	Research Methodology	4	4	3	25	75	100
	Core		Project /Dissertation with <i>viva voce</i>	12	6		50	150	200
	Core	Practical III	Molecular Modeling and Programming	8	4	3	25	75	100
	Core	Practical IV	Research Methodology	8	4	3	25	75	100
	Elective (a) or	Paper V	Bio-diversity Informatics	3	3	3	25	75	100
	Elective (b)		Nanotechnology						
Total				120	90				2200

THIRUVALLUVAR UNIVERSITY

M.Sc. BIOINFORMATICS

SYLLABUS

UNDER CBCS

[with effect from 2008-2009]

I SEMESTER

PAPER I

INTRODUCTION TO 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 - Phylogenetic 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 - Principles 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

BIOCHEMISTRY AND BIOPHYSICS

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.

PAPER III
COMPUTER PROGRAMMING USING C

Objectives

To equip students in programming using C and its application in bioinformatics exercises.

UNIT-I

Introduction to Computer - History of Computing - Computer characteristics - Components of Computer - Modes of operation - Types of Programming Languages - Parallel computing - Single user and Multi user system - Linux Clusters - Distributed Computing - Future of Computing - Role of computer in Biology (Biocomputing)

UNIT-II

Introduction to Operating Systems - MS windows commands, UNIX basic commands - General purpose, file handling, vi editor & environment - Linux - basic commands - Internet browsers - HTML, DHTML, XML - web page design tools - cgi-bin scripts - Linking - Text Formatting - Adding Images - Tables - Frames to web pages

UNIT-III

Introduction to C - History of C - Identifiers and Keywords - Data Types - Constants, Variables and arrays - Operators and expressions - Data Input and Output - Preparing and Running a complete C program - Control Structures - if and switch statements - while, do-while and for statements - goto statement - Arrays - Character strings - Simple programs.

UNIT - IV

User defined Functions in C - Defining and accessing functions - Passing arguments - Function prototypes - Recursion - Storage classes - Pointer Declarations - Passing pointers to functions - Pointers and arrays - Operations on pointers - Arrays of pointers - Dynamic memory allocation.

UNIT - V

Structures: User defined data types in C - Structures - Declaring structures and Accessing members - Array of structures - Structure within structure - Unions - File operations - open, close, reading and writing - Random access files - Linked list - Preprocessor directives - Macros - Command line arguments.

Text Books

1. Byron S. Gottfried, Schaum's outline of Theory and Problems of Programming with C, Tata McGraw-Hill, New Delhi, 1991.
2. Brain W. Kernighan and Dennis. M. Ritchie, The C Programming Language, Second Edition, Prentice-Hall of India, 1988.
3. Sumitabha Das, UNIX Concepts and Applications, 3rd Edition, Tata McGraw-Hill, New Delhi, 2003.
4. H.M.Deitel, P.J. Deitel and A.B. Goldberg, Internet and WWW - How to program, 3rd Edition, Prentice - Hall of India pvt ltd, New Delhi, 2005.
5. Ethan Cerami, XML for Bioinformatics, Springer International edition, 2005.

ELECTIVE

PAPER I

(to choose either A or B)

A) CYTOGENETICS

Objectives

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

UNIT-I

Prokaryotic and eukaryotic cells -. Structure and function of cell organelles [chloroplasts, mitochondria, ER, ribosomes, endosomes, lysosomes, peroxisomes, hydrogenosome]. - Nucleus, nucleolus, nuclear pore complex. Chromatin and nucleosome - Cell signaling and cell receptors. Signal transduction (G-1 proteins, etc.) - Mitosis and meiosis.

UNIT-II

Prokaryotic and Eukaryotic genome organizations - Molecular basis of life - DNA as the Genetic Material - Definitions of the Gene - Chemistry of the Gene - Gene as the unit of mutation and recombination - Mechanism of replication and transcription - Gene as the unit of expression Regulation of gene expression in Bacteria, yeast, Mitochondria & chloroplast.

UNIT-III

Structure and function of chromosomes. - chemical composition - types of chromosomes; lampbrush chromosomes, polytene chromosomes, B chromosomes - variations in chromosome structure: duplications, deletions, inversions, and translocations, isochromosomes, ring chromosomes, centric fusions and fissions.

UNIT-IV

Changes in chromosome number - aneuploidy and euploidy in both plants and animals, their origins, cytogenetic effects, use in crop breeding, and adaptive

significance - Variant chromosomal systems. - asexual reproduction, modified sexual reproduction (various forms of parthenogenesis), chromosome diminution and elimination.

UNIT-V

Cell aging and cell senescence, programmed cell death- molecular aspects, regulation of cell death, PCD in leaf senescence, in response to stress – Apoptosis - Role of different genes, cell organelles during apoptosis - genetic control of apoptosis.

Text 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. 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.
3. Hartl, D. L. and Jones, E. W. 2001. Genetics: Principle and Analysis (4th edition). Jones & Bartlett Pub., USA.
4. Snustad. D. P. and Simmons M. J. 2000. Principles of Genetics (2nd edition). John Wiley and Sons, Inc., USA.

References

1. Atherly, A. G., Girton, J. R. and McDonald, J. F. 1999. The Science of Genetics. Saunders College Pub. Fort Worth, USA.
2. Bumham, C. R. 1962. Discussions in Cytogenetics. Burgess Pub. Co., Minnesota.
3. Busch, H. and Rothblum, L. 1982. Volume X. The Cell Nucleus Rdna Part A, Academic Press.
4. Khush, G. S. 1973. Cytogenetics of Aneuploids. Academic Press New York, London.
5. Karp, G. 1999. Cell and Molecular Biology – Concepts and experiments. 2nd edn. Harris, D (ed.), John Wiley & sons, New york.
6. 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.
7. Lewin, B. 2000. GENE VII. Oxford University Press, New York, USA.

8. Lewis, R. 1997. Human Genetics: Concepts & Applications [2nd edition]. WCB McGraw Hill, USA.
9. Malacinski, G. M. And Freifelder, D. 1998. Essentials of Molecular Biology [3rd edition] Jones & Bartlet Publishers, Inc. London.
10. Russel, P. J. 1998. Genetics [5th edition]. The Benjamin/Cummings Pub. Co., Inc. USA.

B) CELL 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.

UNIT-III

Prokaryotic and Eukaryotic genome organizations - Molecular basis of life - DNA as the Genetic Material - Definitions of the Gene - Chemistry of the Gene - Gene as the unit of mutation and recombination - Mechanism of replication and transcription - Gene as the unit of expression Regulation of gene expression in Bacteria, yeast, Mitochondria & chloroplast.

UNIT-IV

Cell differentiation - Physiological aspects of cellular differentiation - Totipotency of plant cells, Organogenesis, Embryogenesis, and Cytodifferentiation - Differentiation of sieve tube elements and tracheids/vessels, specialized cell types like laticifers, transfer cells, secretory cells, and aleurone layer.

UNIT-V

Cell aging and cell senescence, programmed cell death- molecular aspects, regulation of cell death, PCD in leaf senescence, in response to stress - Apoptosis- Role of different genes, cell organelles during apoptosis - genetic control of apoptosis.

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.

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.

II SEMESTER
PAPER IV
OMES AND OMICS

Objective

To understand the genome and proteome details and to study their structural and functional organizations.

UNIT-I

Omes & omics - introduction - Omics revolution: genomics, transcriptomics, proteomics, metabolomics - Large scale genome sequencing strategies - Genome assembly and annotation - Gene networks/basic concepts - computational model such as Lambda receptor and Lac-operon.

UNIT-II

Functional genomics: application of sequence based and structure-based approaches to assignment of gene functions - e.g. sequence comparison, structure analysis (especially active sites, binding sites) and comparison, pattern identification, etc. - Use of various derived databases in function assignment - use of SNPs for identification of genetic traits.

UNIT-III

DNA microarray: understanding of microarray data and correlation of gene expression data to biological processes and computational analysis tools (especially clustering approaches) - Protein arrays: bioinformatics-based tools for analysis of proteomics data (Tools available at ExPASy Proteomics server); databases (such as InterPro) and analysis tools.

UNIT-IV

Gene finding in prokaryotes - identification of protein coding region - Open Reading Frame - Prediction of mRNA - Prediction intron/exon structure (using Exon finder) - Genscan - Genemark - Gene finding in Eukaryotes - Regulatory signals - Protein sequence - Human genome - mouse homology.

UNIT-V

Protein prediction - Secondary structure prediction - algorithms of Chou Fasman - GOR methods; Tertiary Structure prediction: Homology Modeling; Databases of models, neural network; Basic principles for fold recognition, ID profiles and threading approaches, *ab initio* structure prediction - Proteome analysis; electrophoresis - image analysis - high throughput analysis.

Text Books

1. Carl Branden and John Tooze, 1999. Introduction to protein structure. Garland Publishing, New York.
2. Kris Gevaert et al., 2000. Protein identification methods in proteomics. Electrophoresis, 21:145-54.

PAPER V

MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Objectives

To advance the students to acquire knowledge in molecular biology and biotechnology theories and skills.

UNIT-I

Cell structure - Prokaryotic and eukaryotic. Ultra structure of a plant cell, structure and function of cell wall and plasma membrane. Membrane properties, dynamic nature and movement of substances across cell membranes. Cell cycle - major molecular events.

UNIT-II

DNA as the genetic material - Griffith's experiment. DNA replication: semi - conservative mode, mechanics of DNA replication, enzymes and accessory proteins involved. Transcription - RNA polymerase, transcription factors, regulatory elements, transcriptional and post transcriptional modifications of mRNA. Gene regulation in Prokaryotes and Eukaryotes.

UNIT-III

Translation: Mechanism of initiation, elongation and termination of polypeptide, synthesis. Regulation of translation, post translational modifications of proteins. Protein targeting to different organelles (Chloroplasts, Mitochondria and Nucleus). Antisense RNA and ribozyme technology.

UNIT-IV

Gene and gene mapping. - rDNA technology - Molecular markers in genome analysis: RFLP, RAPD and AFLP. Application of molecular markers in germplasm accession, biodiversity and taxonomic studies, Marker-aided Breeding. Micro satellites, SCAR [sequence characterized amplified regions], SSCP [single strand conformational polymorphism], AFLP, QTL, map base cloning, molecular marker-assisted selection.

UNIT-V

Concept of genomics and its applications. Organelle genomes, Genomic Libraries (YAC, BAC) - recovery of clones. Analytical techniques. DNA sequencing, PCR, analysis of cloned genes. Microarray technology. Applications. Proteomics concept and applications. Comparative genomics.

Text Book

1. Celis, J. E. 1998. Cell Biology: A Laboratory Handbook, 2nd Edn. Vols. 1 to 4. Academic Press, San Diego.
2. Devlin, T. M. 2002. Text book of Biochemistry - with clinical correlations. 5th Edn. John Wiley & Sons Inc., New York, USA.
3. Punia, M.S. 1999. Plant Biotechnology and Molecular Biology - A Laboratory Manual. Scientific Publishers, Jodhpur, India.
4. Snustad, P., Michael, D. and Simmons, J. 2000. Principles of Genetics, 2nd Edn. John Wiley & Sons, Inc., New York.
5. Watson, J.D., Hopkins, N. H., Roberts, J. W. Steitz, J.A. and Weiner, A. M. 1987. Molecular Biology of the Gene, 5th Edn. Benjamin/Cummings Publication, California.

References

1. Becker, J.M., Caldwell, G.A. and Zachgo, E.A. 1996. Biotechnology: A Laboratory Course, 2nd Edn. Academic Press, Inc., San Diego, California.
2. Berger, S.L. and Kimmel, A.R. 1998. Methods in Enzymology Vol 152, Guide to Molecular Cloning Techniques. Academic Press, Inc., San Diego.
3. Campbell, W. Robinson, J. and Howell, A. 1985. Comprehensive Biotechnology, Vol.4, 1st Edn. Pergaman-Press, England.
4. Chirikjian, J.G.1995. Biotechnology: Theory and Techniques Vol.II.Genetic Engineering, Mutagenensis, Separation Technology. Jones and Bartlett Publishers, London, England.
5. Freifelder, D. and Malcinski, G.M. 1993. Essentials of Molecular Biology, 2nd Edn. Jones & Bartletl Publishers Inc., London.
6. Glover, D. M. and Hames, B. D. 1995. DNA Cloning: a Practical Approach. Glover, IRL Press, Oxford.
7. Goeddel, D.V. 1990. Methods in Enzymology Vol 185, Gene Expression Technology. Academic Press, Inc., San Diego.
8. Harvey, L.P., Berk, A.S., Lawrence, Z. Matsudaria, P., Baltimore, D. and Damell, J.E. 2000. Molecular Cell Biology, 4th Edn. Media Connected. W.H Freeman and Company, New York.

9. Meyers, R.A. 1995. *Molecular Biology & Biotechnology - A comprehensive desk reference*. VCH Publishers, New York.
10. Micklos, D.A., Freyerr, G. A. and Crotty, D. A. 2003. *DNA Science*, 2nd Edn. Cold Spring Harbor Laboratory Press, New York.
11. Sambrook, J. and Russel, D.W. 2001. *Molecular Cloning: A Laboratory Manual*, 3rd Edn. Cold Spring Harbor Press, Cold Spring Harbor, New York.

PAPER VI
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 PRACTICAL I
BIOCHEMISTRY, BIOPHYSICS AND DATABASE AND
COMPUTING

1. Preparation of buffers and use of pH meter
2. Estimation of carbohydrates
3. Determination of sugars, reducing and non-reducing sugars
4. Estimation of proteins
5. Isolation, purification and separation of proteins- Western Blotting.
6. Estimation and separation of lipids
7. Separation of lipids by TLC and paper chromatograms.
8. Quantification and separation of chlorophyll pigments
9. Determination of acid value of oil.
10. Estimation of free fatty acids
11. Isolation and separation of Enzymes
12. Absorption spectrum for chlorophyll
13. Measurement of redox potential
14. Biological databases (sequence, structure and specialized databases)
15. Data retrieval using ENTREZ
16. Database file formats
17. Gene finding (Genscan)
18. Protein prediction
19. Sequence search
20. Sequence alignment
21. Phylogenetic tree construction
22. Find the pH of a solution given the concentration of H^+ [or] OH^- ions
23. Compute the relative centrifugal force using r_{max} (in cm) and rpm value
24. Compute the rpm value using r_{max} (in cm) and RCF value
25. Find the molecular weight of a DNA with n base pairs in length

26. Find the molecular weight of a given dephosphorylated oligonucleotide sequence
27. Find the molecular weight of a given DNA sequence, after checking for phosphorylation
28. Computing amino acid composition of a given protein sequence. Read the sequence from a data file.
29. Computing base composition of a given nucleotide sequence. Read the sequence from a data file.

Note: Test all your programs on different platforms (windows, linux/unix)

CORE PRACTICAL II
MOLELCULAR BIOLOGY, BIOTECHNOLOGY AND COMPUTING
TECHNIQUES

1. Sequence comparison
2. Structure analysis
3. Pattern recognition
4. Proteome analysis using tools
5. Exon finding
6. Genome homology
7. Molecular visualization using Rasmol
8. Microscopy: Bright field, Phase contrast & Fluorescence microscopy
9. Instrumental methods for Cell Biology
10. Sub cellular fractionation and marker enzymes
11. Histochemical techniques for Plant cells and tissues
12. Mitosis - Onion root tip squash with heamatoxylin staining.
13. Meiosis - Tradescantia anther squash with Acetocarmine staining
14. Chromosome morphology observation and detection by Mutants.
15. Model building using space filling/ ball and stick models
16. Isolation of Mitochondria
17. Isolation of chloroplast
18. Isolation, purity determination and quantification of DNA from Coconut endosperm by SSC buffer method.
19. Isolation, purity determination and quantification of RNA
20. DNA amplification using Thermocycler.
21. Blotting Techniques - Southern, Northern & Western.
22. Hybridization - Autoradiography - Demonstration
23. Gel documentation system - Demonstration.

HUMAN RIGHTS COMPULSORY PAPER

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 Covenant 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 & K. Cheous (Ed) - International Encyclopedia of Peace, Security 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.

ELECTIVE

PAPER II

(to choose either A or B)

A) 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, Padhraí 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.

B) RELATIONAL DATABASE MANAGEMENT SYSTEM

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.

**III SEMESTER
PAPER VII
GENETIC ALGORITHMS**

Objectives

To know the application of genetic algorithms in science and engineering to solve practical problems and as computational models of natural evolutionary systems.

UNIT-I

Genetic Algorithms: An Overview - A Brief History of Evolutionary Computation - Elements of Genetic Algorithms - A Simple Genetic Algorithm - Genetic Algorithms and Traditional Search Methods.

UNIT-II

Genetic Algorithms in Problem Solving - Evolving Computer Programs - Data Analysis and Prediction - Search/Optimization method - Neural Network method.

UNIT-III

Genetic algorithms (GA) in machine learning (computer programs, data analysis and prediction, neural networks) - GA in scientific models (interactions among learning, evolution, and culture; sexual selection; ecosystems; evolutionary activity).

UNIT-IV

Applications of Genetic Algorithms - in sequence analysis: Global and Local alignment - Needleman and Wunsch algorithm - Smith and Waterman algorithm - in protein analysis - Folding - Docking - Molecular design - Side chain modeling.

UNIT-V

Neural network - Concepts and secondary structure prediction - probabilistic models - Hidden Markov model - Heuristic approach - Gene identification and other applications.

Text Books

1. Melanie Mitchell, 1998. An Introduction to Genetic Algorithms.
2. Terresa K. Attwood and David J. Parry - Smith. Introduction to Bioinformatics.

Reference

Richard Durbin, Sean Eddy, Anders Krogh and Graeme Mitchison, 1997. Biological sequence analysis: Probablistic models of proteins and nucleic acids. Cambridge University.

PAPER VIII

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, Tezoside, 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-trade marks as marketing tools, selection of trade marks, 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. Springer-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.

PAPER IX

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 Connectivity) - 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 pl 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.

ELECTIVE

PAPER III

(to choose either A or B)

A) GENETIC ENGINEERING

Objective

To train the candidates in genetics up to the level of genes and molecules

UNIT-I

Scope and principles of Genetic Engineering, Molecular Tools and Their Applications. rDNA technology - Nucleic acid Isolation, purification. Yield Analysis. Restriction enzymes - properties, types, functions and modification enzymes.

UNIT-II

Gene Cloning Vectors: Plasmid, bacteriophages, phagemids, cosmids, Artificial chromosomes, cDNA Synthesis and Cloning - mRNA enrichment, reverse transcription, DNA primers, linkers, adapters and their chemical synthesis, library construction and screening. T - DNA - binary vectors, co integrate vectors. PCR principles and its applications.

UNIT-III

Alternative Strategies of Gene Cloning: Cloning interacting genes - Two - and three hybrid systems, cloning differentially expressed genes. Nucleic acid microarrays. Site - directed Mutagenesis and Protein Engineering. Gene Regulation - NA transfection. Primer extension, SI mapping, Rnase protection assay, reporter assays.

UNIT-IV

Expression Strategies for Heterologous Genes: Vector engineering and codon optimization, host engineering, *In vitro* transcription and translation, expression in bacteria, expression in Yeasts and plants. Processing of Recombinant Proteins - Purification and refolding, characterization of

recombinant proteins, stabilization of proteins. Transposon Tagging. Role of gene tagging in gene analysis, T-DNA and transposon tagging. Identification and isolation of genes through T-DNA or transposon.

UNIT-V

Transgenic and Gene Knockout Technologies: Targeted gene replacement, Chromosome engineering. Chromosome walking, chromosome micro dissection. Gene Therapy - Vector engineering. Strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.

Text Books

1. Becker, J.M., Caldwell, G.A. and Zachgo, E.A. 1996. *Biotechnology: A Laboratory Course*, 2nd Edn. Academic Press, Inc., San Diego, California.
2. Kingsman, S. M. and Kingsman, A. J. 1998. *Genetic engineering: Introduction to gene analysis and exploitation in Eukaryotes*. Blackwell Scientific Publications, Oxford.
3. Lewin, B. 2004. *Genes VIII*. International Edition, Pearson Prentice Hall, Pearson Education, Inc., USA.
4. Sambrook, J. and Russel, D.W. 2001. *Molecular Cloning: A Laboratory Manual*, 3rd Edn. Cold Spring Harbor Press, Cold Spring Harbor, New York.
5. Snustad, P., Michael, D. and Simmons, J. 2000. *Principles of Genetics*, 2nd Edn. John Wiley & Sons, Inc., New York.
6. Watson, J.D., Hopkins, N. H., Roberts, J. W. Steitz, J.A. and Weiner, A. M. 1987. *Molecular Biology of the Gene*, 5th Edn. Benjamin/Cummings Publ., California.

References

1. Atherly, A.G., Girton, J.R. and McDonald, J.F. 1999. *The science of Genetics*. Saunders College Publishers, New Delhi.
2. Chirikjian, J.G.1995. *Biotechnology: Theory and Techniques Vol.II.Genetic Engineering, Mutagenesis, Separation Technology*. Jones and Bartlett Publishers, London, England.
3. Cooper, G.M. and Hausman, R. E. 2004. *The Cell: A Molecular Approach*, 3rd Edn. American Society of Microbiologists Press, Washington.

4. Cseke, L. J., Kaufman, P. B. Podila, G.K. and Tsai., C.J. 2004. Handbook of Molecular and Cellular Methods in Biology and Medicine, 2nd Edn. CRC Press. Florida, USA.
5. Glick, B.R. and Pastumak, J.J. 1998. Molecular Biotechnology- Principles and application of recombinant DNA, 2nd Edn. ASM Press, Washington.
6. Glover, D. M. and Hames, B. D. 1995. DNA Cloning: a Practical Approach. Glover, IRL Press, Oxford.
7. Primrose, S. B. 1994. Molecular Biotechnology, 2nd Edn. Blackwell Scientific Publishers, Oxford.
8. Scopes, R. K. 1994. Protein Purification: Principles and Practice, 3rd Edn. Springer-Verlag, New York.
9. Walker, M.R. and Rapley, R. 1997. Route Maps in Gene Technology. Blackwell Science Ltd., Oxford.

B) DIGITAL IMAGE PROCESSING AND MICROARRAY ANALYSIS

Objective

The Objective of this subject is to provide basic techniques for image and video processing. It also helps to augment the knowledge on image compressions and their standards.

UNIT-I

Digital Image Fundamentals - Image Model, Sampling Quantization, Relationship between Pixels, Image Transformations, DFT, FFT, Properties and Other Separable Transformation - Hotelling Transform

UNIT-II

Image Enhancement - Background, Enhancement by Point Processing - Spatial Filtering - Frequency Domain Enhancement - Color Image Processing - Image Segmentation Based on Textures & Edges - Edge Linking, Threshold - Region Oriented Segmentation.

UNIT-III

Image Compression - Fundamentals - Compression Model - Information theory - Lossless & Lossy Compression - Compression Standards.

Biomolecular visualization - RASMOL, MOLMOL

UNIT-IV

Introduction - Microarray databases - Tools for gene expression analysis - Types of microarrays - General and Commercial applications of Microarray - Challenges in using microarrays in gene expression studies - Research areas in Microarray - Methods for selecting differentially regulated genes - Experimental design - Computer design of Oligonucleotide probes - Image processing, normalization and data transformation - Functional analysis and biological interpretation of microarray data

UNIT-V

Important statistical elements for microarray data analysis - Analysis of gene expression data: gene expression matrices features and representations - clustering - classification algorithms and class prediction - Time series analysis - visualization - Downstream from expression profile analysis - Analysis of relationships between genes, tissues or treatments - Classification of tissues and samples - Data standards, storage and sharing

Text Books

1. Raffle C.Gonzalez & R.E Woods, "Digital Image Processing", Addison Wesley,1998.
2. Anil K.Jain, "Fundamentals of Image Processing", Prentice Hall of India,1998.
3. Helen C.Causton, John Quackenbush and Alvis Brazma, A beginner's guide Microarray Gene Expression Data Analysis, Blackwell Publishing, 2003.
4. Sorin Draghici, Data Analysis Tools for DNA Microarrays, Chapman & Hall/CRC, 2003.
5. Dov Stekel, Microarray Bioinformatics, Cambridge University press, 2003.

ELECTIVE
PAPER IV
(NON MAJOR SUBJECT)
BIO-COMPUTING

UNIT-I

Cell - Basic unit of life - Cell types, Gene, Protein, Central dogma of Molecular biology, post transcription & translation modifications - Chromosome - Structure and function.

UNIT-II: Computer Basics

Introduction to Computer - History of Computers - Types - Operating System, File handling - Internet browsers - HTML, XML, Scripting language - Introduction to C - Data types, Running & compiling a C programme - I/O statements - Control Statement - Structure - Data files - Life Science application program.

UNIT-III: Introduction to Bio-Computing

Role of Computer in Biology - Future in Bio-Computing, Applications of Bio-Computing, Finding Articles and Journals - Search for technical reports & Conference Papers - Intelligent agent - Use of Intelligent Agent - Characteristics of Intelligent agent.

UNIT-IV: Bio-Informatics and Bio-Computing

Introduction to Bioinformatics - Definition - History - Applications in various field - Software related to bioinformatics - Downloading - Installing - Running - Data Mining - Biological database - Types - Sequence and Structure - Data bases.

UNIT-V: Application of Bio-Computing

Sequence searching - BLAST & FASTA - Multiple sequence alignment - ClustalW, finding evolutionary relationship between organism - Phylogenetic analysis (basic concepts only) - Phylip - Motifs & Domain search - CADD - Molecular Modeling.

Books Recommended:

1. Bio-Computing by P.M.Pardalos, J.C.Principe, A.M.Lesla, Introduction to bioinformatics, 3rd Oxford University press,, New Delhi, 2007.
2. S.Parthasarathy, Essentials of Programming in C for Life Sciences, Anc Books India Pvt. Ltd., New Delhi, 2008
3. Bioinformatics Biocomputing and perl and Addison - wesly
4. Baxevanis: A practical guide of genes and proteins, Wiley - Interscience
5. Introduction to Bioinformatics, Teresa K.Atwood and David J.Parry-Smith
6. Andrew R Molecular modeling principles and applications Leach, Harlow

SEMESTER IV
PAPER X
RESEARCH METHODOLOGY

Objective

To impart training in analytical techniques to use and utilize the modern instruments and its technology for application-oriented one

UNIT-I

Centrifugation: Low speed, high speed, and Ultra and Refrigerated centrifuges. Principles and Operation methods of Weighing devices, pH, salinity and conductivity meters. Preparation of Buffers and stock solutions of media/reagents. Preparation of normality, ppm, molar and percentage solutions. Calibration of stage and ocular meter for micrometry and Haemocytometer.

UNIT-II

Spectrometry: UV, IR, NMR and A.A.Spectroscopy. Electrophoresis: Gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE & SDS PAGE) and Agarose gel electrophoresis, comet assay. Two dimensional electrophoresis, Vertical electrophoresis. Horizontal electrophoresis, Paper electrophoresis, Southern Blot, Northern Blot, Western Blot, DNA finger printing.

UNIT-III

Extraction methods: Crude extracts. Distillation, Separation procedures. Chromatography: Principles, working procedure, functions and application of CC, TLC, PC, GC, GLC, HPLC, HPTLC, Fourier Transform IR and MS.

UNIT-IV

Basics of computers and Biostatistics: Types of Computers - mini - macro system, Anatomy of computers, Operation Devices, DOS Files, Internal and External DOS commands, File management. Compilation and analysis of data, Standard deviation, ANOVA, T-Test, Chi-square analysis. Principles of Bioinformatics: Collection and storing of sequences, alignment of pairs of sequences, multiples sequences alignment, database searching for sequences. Gene, protein, classification, structure and prediction.

UNIT-V

Scientific Research - Principles and Methods of Scientific Research. Literature Collection, Conventional and Digital Publications. Differences in References and Bibliography. Preparation of Thesis, Research Papers and Reviews.

Text Books

1. Becker, J.M., Caldwell, G.A. and Zachgo, E.A. 1996. Biotechnology: A Laboratory Course, 2nd Edn. Academic Press, Inc., San Diego, California.
2. Brown, T.A 1991. Molecular Biology Labfax. Bios Scientific Publishers Limited, Oxford.
3. Harborne, J.B. 1998. Phytochemical Methods, 3rd Edn. Chapman & Hall, London.
4. Mount, D.W. 2003. Bioinformatics: Sequence and Genome Analysis. CBS Publishers and Distributors, New Delhi.
5. Punia, M.S. 1999. Plant Biotechnology and Molecular Biology - A Laboratory Manual. Scientific Publishers, Jodhpur, India.
6. Willard, H.H., Merritt, L., Dean, J.A., Settle, F.A. Instrumental Methods of Analysis, 1st Edn. CBS Publishers and Distributors, New Delhi.
7. Wilson, K. and Walker, J. 1997. Practical Biochemistry: Principles and Techniques. Cambridge University Press, Cambridge.

References

1. Bishop, M.J. and Rawlings, C.J. 1987. Nucleic acid and Protein sequence analysis: A Practical Approach. IRL Press, Oxford.
2. Cannel, J.P. 1998. Natural Products Isolation. Humana Press, New Jersey, USA.
3. Chirikjian, J.G. 1995. Biotechnology: Theory and Techniques Vol.II. Genetic Engineering, Mutagenesis, Separation Technology. Jones and Bartlett Publishers, London, England.
4. Darbre, P. D. 1988. Introduction to Practical Molecular Biology. John Wiley & Sons Ltd., New York.
5. Krawelz, S.A. and Womble, D.D. 2003. Introduction to Bioinformatics: a theoretical and Practical approach. Humana Press Inc., New Jersey, USA.
6. Sharma, B.K 1996. Instrumental Methods of Chemical Analysis, 15th Edn. Goel Publishing House, Meerut.

CORE PRACTICAL III
MOLECULAR MODELING AND PROGRAMMING

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, Propranolol, 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 IV
RESEARCH METHODOLOGY

1. Calibration of pH meter & preparation of Buffers 4, 7 & 9 pH.
2. Preparation of Normal (NaOH), PPM (Cr+) and Molar (Sucrose) & % solutions.
3. Absorption Frequency of any extract using UV Spectrophotometer.
4. Agarose Gel Electrophoresis - using DNA sample.
5. PAGE - any protein sample.
6. Southern Blotting.
7. Designing of Scientific Experiment.
8. Preparation of Research Article.
9. Column Chromatography.
10. Thin Layer Chromatography.
11. Paper Chromatography.
12. Standard Deviation and Analysis.
13. ANOVA.

**PROJECT WORK
DISSERTATION AND *VIVA VOCE***

ELECTIVE

PAPER V

(to choose either A or B)

A) 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, MicrolS, 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. Biodiversity: Measurement & Estimation - Hawksworth, 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. Uhler, 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/

B) NANOTECHNOLOGY

Objective

To utilize the nanotechnology in application field

UNIT-I

Overview and History of Nanotechnology - Generations of nanotechnology - Nanoparticles / Nanomaterials - Journals of Nanotechnology - Challenges of Nanotechnology - Applications of Nanotechnology - National and International Nanotechnology centers - Current and Future Research in Nanotechnology - Patent in Nanotechnology

UNIT-II

Molecular Manufacturing - Nano simulation; Is nanotechnology bad or good - Implications of nanotechnology: Health and safety implications from nanoparticles: Health issues - Environmental issues - Need for regulation - Societal implications: Possible military applications - Potential benefits and risks for developing countries - Intellectual property issues - Criticism of Nanotechnology - Studies on the implications of Nanotechnology

UNIT-III

Introduction to physics of the solid state: Structure - energy bands - Localized particles; Methods of measuring properties: Atomic structure - Particle size determination - Surface structure; Properties of Individual Nanoparticles: Metal Nanoclusters - Semiconducting nanoparticles - Rare Gas and Molecular Clusters; Carbon Nanostructures; Carbon Molecules - Carbon Clusters - Carbon Nanotubes - Applications of Carbon Nanotubes

UNIT-IV

Bulk Nanostructured materials: Solid disordered Nanostructures - Nanostructured crystals - Nanostructured Ferromagnetism; Optical and vibrational spectroscopy: Infrared Frequency Range - Luminescence - Nanostructures in Zeolite Cages; Quantum wells, Wires and Dots: Preparation of Quantum Nanostructures - Size and Dimensionality Effects - Excitons - Single Electron Tunneling - Applications - Superconductivity; Self Assembly and Catalysis

UNIT-V

Organic Compounds and polymers: Forming and Characterizing polymers - Nanocrystals - Polymers - Supramolecular structures; Biological Materials: Biological building blocks - Nucleic Acids - Biological Nanostructures; Nanomachines and Nanodevices: Microelectrochemical systems - Nanoelectromechanical systems - Molecular and Supramolecular switches

Text Books

1. Charles P. Poole Jr. and Frank J. Owens, A., 2003. Introduction to Nanotechnology, Wiley-Interscience Publications, India,
2. R.S. Greco, F.B.Prinz and R.L.Smith, 2005. Nanoscale Technology in Biological Systems, CRC Press, New York.
3. M. Wilson, G. Smith, K. Kannangara, M. Simmons and Burkhard Raguse, 2002., Nanotechnology: Basic Science and Emerging Technologies, CRC Press, New York.
4. Rebecca L. Johnson, 1999. Nanotechnology, Springer-Verlag, New York.
5. T.Pradeep - Nano Essentials - 2007, TMH, New Delhi.
