

**MSc BIOINFORMATICS REVISED SCHEME & SYLLABUS
(w. e. f. 2015 ADMISSIONS)**

SCHEME

Sem. No:	Paper code	Title of the paper	Hrs per week	CA+ ESA
I	BI 211	Biomathematics and Statistics	4	40+60
	BI 212	Introduction to Bioinformatics and Databases	4	40+60
	BI 213	Biodiversity , Ecology and Evolution	4	40+60
	BI 214	Introduction to Information technology and C programming	4	40+60
	BI 215	Practical I	4	40+60
II	BI 221	Introduction to Molecular Biology, Cell Biology and Genomics	4	40+60
	BI 222	Introduction to Web Programming	4	40+60
	BI 223	Genetics and Genetic Engineering	4	40+60
	BI 224	Proteomics and CADD	4	40+60
	BI 225	Practical II	4	40+60
III	BI 231	Advanced Bioinformatics	4	40+60
	BI 232	Bioenergetics, Biochemistry and Applied Chemistry	4	40+60
	BI 233	Microbiology, Immunology and Enzymology	4	40+60
	BI 234	PERL Programming for Bioinformatics	4	40+60
	BI 235	Practical III	4	40+60
IV	BI 241	Research Methodology	4	40+60
	BI 242	Project, viva voce and Seminar	12	60+340*

* As per evaluation rubric in page 18

BI 211 BIOMATHEMATICS AND STATISTICS

Unit- I

Sets, relations & functions: Definition of sets and subsets: Combinations of sets – union intersection. Compliments, De Morgan's Laws, Relations-equivalence relations and partitions. Mappings- one-one, one-two, countable and uncountable sets. Introduction to Scilab

Unit- II

Vectors and Matrices: Scalars & Vectors, addition, subtraction, dot, cross products; Matrices: types, addition, subtraction, multiplication, transpose & inverse, determinants, Graph theory: Basic terminology, directed and undirected graphs, vertices and edges

Unit- III

Probability events, addition and multiplication theorems, Binomial, Poisson and normal probability distributions, Sampling theory and test of significance estimation, standard deviation and error, chi-square test, Statistical packages.

Unit- IV

Biostatistics: Collection, classification and diagrammatic representation of statistical data. Measures and central tendency, ANOVA, dispersion, correlation, regression, interpolation and extrapolation.

Unit –V (Flexi module - only for internal assessment, not to be included in University exam): Calculus: Limits & Derivatives: Limits, continuity, derivative as rate of change. Graphical treatment of derivative, Derivatives of simple functions, Integration, area under the graph, definite and indefinite integrals, Integrals of basic simple functions

References:

Core References

1. An Introduction to Biostatistics-SundarRao& Richard, PHI-3rdEdn.
2. Theory & Problem of Probability – Lipschutz-Shaum's Outline Series-Tata McGraw Hill.
3. A. K. Mukhopadhyay, "A Course in Vector and Matrix Analysis for Engineers and Physicists, I K International Publishing House Pvt. Ltd

Additional References

1. Maths-A Self Study Guide- Jenny Olive- Cambridge University Press
2. Calculus: Early transcendentals-James Stewart- Thonson Brooks/Cole
3. Theory & Problem of Probability – Lipschutz-Shaum's Outline Series-Tata McGraw Hill.
4. HemaRamachandran, Achuthsankar S Nair, "Scilab(A Free Software To Matlab)", S.Chand Publishers, 2012.
5. The pleasures of Probability-Richard Issac-Springer Verlag
6. Statistical Methods in Bioinformatics-W J Ewens, Gregory Grant- Oxford University Press

BI 212 INTRODUCTION TO BIOINFORMATICS AND DATABASES (60 Hrs)

Unit- I

Introduction to Bioinformatics:- Definition, concepts, History, Overview of molecular biology, the cell as basic unit of life-Prokaryotic cell and Eukaryotic cell - Central Dogma: DNA-RNA-Protein, Introduction to DNA and Protein sequencing, Human Genome Project, SNP, Future and scope of Bioinformatics

Unit- II

Bioinformatics databases - Nucleotide sequence databases, Primary nucleotide sequence databases-EMBL, GeneBank, DDBJ; Secondary nucleotide sequence databases; Protein databases- UniProt, Protein Data Bank

Unit- III

Sequence Analysis-Basic concepts, Alignment of pairs of sequence:- Homologous, Analogue, Orthologous, paralogous, Xenologous (Need for sequence alignment, Local and Global alignment, Scoring matrices- PAM and BLOSUM matrices

Unit-IV

Pairwise sequence alignments: BLAST, Multiple sequence alignments (MSA) BLAST:- Nucleotide BLAST, Protein BLAST, PSI-BLAST, Analysis of BLAST results, E Value, sensitivity and specificity of BLAST, FASTA Structure analysis tools and softwares

Unit- V (Flexi module - only for internal assessment, not to be included in University exam): Dynamic Programming, Needleman-Wunsch algorithm for global alignment, Smith-Waterman algorithm for local alignment, Introduction to RASMOL, SWISS-PDB Viewer, ARGUS LAB

References

Core References

1. P. Narayanan, Bioinformatics: A Primer, New Age International Publishers.
2. Harshawardhan P. Bal, Bioinformatics Principles and Applications, Tata McGraw-Hill Publishing Company Ltd.

Additional References

1. Marketa Zvelebil and Jeremy O. Baum, Understanding Bioinformatics, Garland Science
2. Rastogiet. al., Bioinformatics: Methods and Applications, Prentice Hall of India.
3. Dan E. Krane and Michael L. Raymer, Fundamental Concepts of Bioinformatics, Pearson Education.
4. Claverie & Notredame, Bioinformatics - A Beginners Guide, Wiley-Dreamtech India Pvt Ltd.

BI 213 BIODIVERSITY, ECOLOGY AND EVOLUTION

Unit-I

Biodiversity: Introduction, Types, biodiversity in India, species diversity & ecosystem stability, diversity indices- Alpha, Beta & Gamma diversity, Hot spots, causes for the loss of biodiversity, red data book, *in-situ* & *ex-situ* conservation, protected areas, Conservation strategies.

Unit-II

The Environment: Physical environment; biotic environment; biotic and abiotic interactions. Habitat and Niche: Significance of habitat, biodiversity, ecological niche, trophic level, Ecosystem structure; primary production and decomposition, primary and secondary productivity, food chains, food webs, ecological pyramids, energy flow and nutrient cycles and mineral cycling (C,N,P).

Unit-III

Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation, population dynamics & population genetics, Neutralism, Mutualism & Commensalism, survival of the fittest competitive exclusion principles Balance between intra and inter specific competition, Hardy-Weinberg principle.

Unit-IV

Molecular evolution, Gene evolution, Evolution of gene families, molecular drive, amino acid sequence, divergence in protein, nucleotide sequence divergence in proteins, DNA, Ancient DNA, The evolutionary history of proteins, concept of molecular clock, prokaryotic genomes, the "C-value paradox", Evolutionary history of neural integration- evolution of the endocrine system, hormones And evolution.

Unit-V (Flexi module - only for internal assessment, not to be included in University exam): Environmental pollution: Definition and classification, Global warming, Biological waste water treatment, BOD, COD, Primary, secondary and trickling biological filters, anaerobic digestion, composting, Biogas, super bug, air pollution, pollution control, biosensors, vermi-composting, bioleaching.

References

Core References

1. Fundamental of Ecology, Eugene P. Odum, Nataraj Publishers, DehraDum.
2. Animal Behaviour an evolutionary approach, John Alcock, Sinauer Associates, Inc. Publishers, Massachusetts

Additional References

1. Glimpses of Biodiversity, Hosetti B.B. , Daya Publishing house, New Delhi
2. The value of biodiversity, Ehrlich, P.R. and Ehrlich, Anna H 1992. *Ambio* 21: 219-226.
3. Action points for implementation of the convention on biological diversity. Chahan K.P.S. 1993, M.S. Swaminathan Research TFoundation, Madras.
4. International Treaties on Biological resources: Implications for the Asian region, Chauhan K.P.S. 1998, India PI Genet. Resources

BI 214 INTRODUCTION TO INFORMATION TECHNOLOGY & PROGRAMMING IN C

Unit I

Information technology; Functional introduction of computers, Hardware & Software; Von Neumann model. Hardware: CPU, Memory, I/P devices, O/P devices, memory unit, RAM, ROM. Auxiliary storage, Printers, Sound cards & speakers

Unit II

Software- System software, Application software; Application software, Computer viruses & protection. System Software, Introduction to Operating System, Different types of operating systems: Single user, Multitasking, time-sharing, multi user; Overview on Databases; Networking concepts: LAN, WAN, Server, Router

Unit III

Introduction to programming: Algorithm & Flow charts, definition. High level and low level languages, Programming languages, Language translators: Assemblers, compilers, Interpreter, editor, structure of the program, top down design, source code, object code, executable file extension of different files, program compilation, running of a program, Basic elements: Variables and constants, Rules for naming the variables/ identifiers

Unit IV

Basic data types of C: int, char, float, double,; storage capacity- range of data types; Operators and expressions, logical operator and conditional statements. Control structures, Arrays: one and two dimensional arrays, Strings: string handling functions; structures and unions; Pointers: The & and * Operators, pointer declaration, dynamic memory allocation, pointer to arrays, array of pointers; Functions: declaration, definition & scope, recursion

Unit V (Flexi module - only for internal assessment, not to be included in University exam): Applications of IT in various fields: office automation, education, entertainment, medicine, commerce, governance, resource management, law and order, communications, science and technology, defense; Historic evolution of IT; Debates in IT: Free software, Computer Creativity, digital divide, IT policy, IT in India and Kerala, Careers in IT, Threats in IT, Cyber Security

References:

Core References

1. Learning Computer Fundamentals- Ramesh Bangia, Khanna Book Publishers
2. Operating Systems & Systems Programming, P. Balakrishna Prasad, SciTech
3. Fundamentals of Information Technology, Alexis & Mathews Leon, LeoVikas
4. Let us C, Yashvant Kanetkar, BPB Publications, 3rd Edition

Additional References

1. Projects Using C, P.V.N Varalakshmi, Scitech Publications (India) Pvt. Ltd.
2. Information Technology: The Basics, Barbara Wilson, Thomson Learning
3. How computers work – Ron White, BPB New Delhi

BI 215: Practical -1

1. Make list of Biological databases for DNA and protein by browsing search engines.
2. Visit NCBI, EMBL, and DDBJ. Explore them, List out the salient features of these databases.
3. Retrieve the gene sequences by exploring and querying the nucleic acid databases.
4. Retrieve the protein sequences by exploring and querying the protein databases.
5. Find the chromosomal location of gene sequence and basic experiments in NCBI mapviewer.
6. Laboratory equipment handling and safety guidelines
7. Preparation of buffers, reagents and media
8. Staining- Simple and differential staining of bacteria. Simple staining – Bacillus and E coli.
9. Study of bacteria from contaminated water
10. An assortment of basic C programming
11. Write a C program to sort given set of numbers.

References

1. Bioinformatics: Concepts, Skills and applications-Rastogi, S.C., etal-CBS Publishers, NewDelhi
2. Bioinformatics: A Practical Approach- K.Mani& N. Vijayaraj-Aparna Publishers NewDelhi
3. How to program, Dietel&Dietel , Pearson edn.
4. Projects Using C, P.V.N Varalakshmi, SciTech Publications (India) Pvt. Ltd.
5. Elements of cytology , Cohn
6. Practical Biochemistry, Harold Varley

BI 221 INTRODUCTION TO MOLECULAR BIOLOGY AND GENOMICS

Unit I

The cell as basic unit of life- Prokaryotic cell and Eukaryotic cell. Cell membranes and overview of organelles. Molecular biology an overview, Experimental proof of DNA and RNA as genetic material, Watson and Crick model of DNA, Types DNA, RNAs and their structure & function, Chromosomes, Replication of DNA, Mutations and their consequences, Repair of DNA, Transcription, RNA processing and RNA splicing, Translation, Recombination, Transposons & retrotransposons, Gene regulation in Prokaryotes, Gene regulation in Eukaryotes, Cell cycle and its regulation; events during mitosis and meiosis.

Unit II

Genome-Genes, Gene Loci, Genetic Linkage Map, Physical Map, Markers, Genome sequencing-Human Genome sequencing, Composition of DNA-(Chargaff's Rule), Reading frames +1,+2, +3 & -1, -2, -3, sense/ antisense, coding/ noncoding, Complementary DNA, Enhancers, Silencers, Genetic code, Wobble hypothesis, Junk DNA, Codon bias.

Unit III

EST sequence Data Bases, Detailed study of Gen Bank of NCBI-typical Gen Bank (DDBJ + EMBL) entry and for DNA & RNA, BLAST & FASTA file formats. Tools for ORF, Gene finding, Promoters, Sequence Profiles, SNPs, RNA sequence data analysis.

Unit IV

Types of alignments: Pairwise and multiple sequence alignment - PAM & BLOSUM scoring matrices, e-value, Multiple sequence alignment, need, MSA-CLUSTAL X, Molecular Phylogenetic trees, Character based method-Maximum parsimony method, Validation phylogenetic trees. Tools for Phylogenetic Analysis - Phylip, NJPLOT, TREE VIEW.

Unit V (Flexi module - only for internal assessment, not to be included in University exam): Concepts of Genetic Engineering; recombinant DNA-steps involved in Steps involved in rDNA technology, PCR, primers, Applications of cloning and rDNA technology, cDNA, cDNA library, Genomic library. Nucleic Acid Hybridization: Principle and application - Preparation of nucleic probes, DNA finger printing- methodology and applications. Genome mapping methods: Physical, genetic and molecular markers in mapping (RFLP, RAPD, AFLP); Gene prediction and annotation; Comparative Genomics, Structural Genomics.

References:

Core References

1. James Watson, "DNA the Secret of Life", Arrow Books.
2. Dale & Scharz, "From genes to Genome", Wiley & Sons
3. R.C. Dubey, "A Text book of Biotechnology", S. Chand and Company.

Additional Reference

1. Peter J. Russel, "Cell and Molecular Biology", CENGAGE Learning.
2. Burton E. Tropp, "Molecular Biology: Genes to Proteins", Edition 4, 2012.
3. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, "Biochemistry".
4. Hyde David R., "Genetics and molecular biology" Special Indian edition, Tata McGraw Hill Education private limited, 2010.

BI 222 INTRODUCTION TO WEB PROGRAMMING

Unit I

General Introduction to Internet and WWW, Introduction to Html, The basic HTML text Formatting tags; bold, italics, size, color, line breaks, Linking and Embedding Graphics, Creating tables in HTML, Setting Background and Text Colors, Style Sheets, Brief introduction to Forms and Embedded Media,

Unit II

Introduction to CSS, Using external CSS files, Special Features of CSS3, Introduction to XML; Java Script: Basic concepts, data types, Control structures, operators, basic scripting; Introduction to MySQL, Create Database using MySQL, Creating Tables.

Unit III

PHP- Introduction, Versions, Scope of PHP, Basic PHP syntax, PHP data types, Control Structures- if() and else if condition and switch Statement, Embedding PHP with HTML, File upload and E-mail authentication with PHP, CGI programming with PHP, GET & POST methods, Install procedure of XAMPP/WAMP/LAMP, Application development using PHP (introduction only)

Unit IV

Object oriented programming concepts, Java Basic concepts, data types, Defining classes, methods, constructors, Arrays, Strings, Packages, JavaDoc comments, Expressions, Operators, and Control Structures, Classes, Packages and Interfaces, Exception Handling. Basic scripting and, Using Java applets in web pages

Unit V (Flexi module - only for internal assessment, not to be included in University exam): Familiarization of Ubuntu, New open-source mobile platform- Android and Firefox OS, Introduction to HTML5, The HTML5 New Elements, Canvas, Video and Audio, Introduction to JQUERY, basics and usage of AJAX and RSS feeds

References

Core References:

1. Wendy Willard, "HTML: A Beginner's Guide, 4th Edition", McGraw-Hill
2. Karl Barksdale, E. Shane Turner, "HTML, JavaScript, and Advanced Internet Technologies BASICS", Thomson/Course Technology

Additional reference

1. Christopher Murphy, "Beginning HTML5 and CSS3: The Web Evolved" APress
2. Robert Sheldon, "Beginning MySQL" Wiley Publishing
3. jQuery: <http://www.w3schools.com/jquery/>
4. HTML: <http://www.w3schools.com/html/>
5. CSS: <http://www.w3schools.com/css/>
6. PHP: <http://www.w3schools.com/php/>

BI 223 GENETICS AND GENETIC ENGINEERING

Unit I

Heredity and variation, classical Mendelian Genetics, Laws, Genetic Terminologies, Forked Methods and checker board method, Non Mendelian genetics, Multiple alleles, polygenic traits.

UnitII

Chromosomal basis of inheritance, Linkage and crossing over, types, chromosome mapping, sex determination mechanism, types, genetic variation, sex linked inheritance, cytoplasmic inheritance with example.

UnitIII

Scope of Recombinant DNA Technology, Milestones in Genetic Engineering, Gene cloning techniques: Vector, types, properties, enzymes in gene cloning (exonucleases, endonucleases, restriction endonucleases, ligases, reverse transcriptases, polymerase, terminal transferases) probes, molecular markers (RFLP, RAPD, AFLP) Homopolymer tailing, linkers and adaptors.

UnitIV: PCR, DNA finger printing, footprinting, DNA sequencing-MaxamGillbert method, Sanger-coulson method, Automated sequencing, NGS.Genomic library, Metagenomic library and CDNA libraries, site specific mutagenesis and gene targeting, Gene silencing at transcriptional level and post transcriptional level (RNA I) Antisense RNA

Unit V (Flexi module - only for internal assessment, not to be included in University exam): Methods of gene transfer, methods for gene knock out and knock in (BAC, YAC, (re &LoxP). rDNA in medicine and industry. Gene therapy, transgenic plants and transgenic animals, selection of recombinants (HRT & HART), social legal & ethical problems in genetic engineering

References

Core References:

1. Genetics- P.K. gupta- Rastogi publications
2. Principles of Genetics -Gardner, Simmons &Snustad John willey
3. Concept of Genetics By Klug and Cummings
4. Genetics: Principles and Analysis By Hartl and Jones

Additional reference

1. Gene Cloning –an introduction, T.R. Brown, Black well Scientific 1998
2. Modern biotechnology, S.B. Primose, Blackwel Scientific
3. Principles of Gene Manipulation, R.W. Old and S.B. Primose, Blackwel Scientific 1985
4. Genetic Engineering Vol-1-6. P.W. J. Rigby, Academic Press
5. Biotechnology and Genetic Engineering Review Vol.6, G.E. Russel, Intercept
6. Genetic Engineering-Principles and methods, Vol II, J.K. Setbow, Plenum press
7. Molecular Biology of Gene IV edn., J.D. Watson et.al. Benjamin Publishing Co.
8. Genetic Engineering 1-4, Williamson R, Academic press

BI 224 PROTEOMICS AND COMPUTER AIDED DRUG DESIGNING

Unit I

Proteome & Proteomics, Classification of proteins, Primary, secondary & tertiary structure of Proteins. Protein separation & analysis using 2D Gel electrophoresis, Chromatography. Protein structure Databases: PDB, PIR, Structural Classification- SCOP and CATH. Protein visualization tools Swiss PDB viewer, EXPASY proteomic tools, Amino acid: Structure and Properties of Amino acids- Hydrophobicity, EIIP, Molecular weight.

Unit II

Protein structure determination - X - ray crystallography & NMR spectroscopy. Secondary structure prediction: Chou – Fasman / GOR method and Neural network method. Tertiary structure prediction- Homology Modeling threading, Fold Recognition Methods – ab initio methods. Structure validation: Ramachandran Plot Introduction to software- Modeller, Procheck, 3DPSSM. Protein -Protein interactions, protein-ligand interactions, Interaction database – Intact, BIND

Unit III

Introduction to the concepts of molecular modeling. Molecular structure and internal energy. Application of molecular graphics. Bond Stretching, Angle Bending, Non bonded interactions, Electrostatic interactions and Vander Waals Interactions. Energy minimization: Local and Global minima, Steepest Descent, Conjugate Gradient method, Applications of Energy minimization Empirical representation of molecular energy.

Unit IV

Molecular dynamics: Setting and running a molecular dynamic simulation. Molecular dynamics using simple models, Trajectory analysis, CHARMM, Monte Carlo Simulation.

UnitV (Flexi module - only for internal assessment, not to be included in University exam): Drug Discovery pipeline - Target identification- Lead optimization. Serendipity, High throughput screening, Virtual screening, ADME test, QSAR method, Docking, design of ligands for known target sites, pharmacophore identification, Structure based drug design, Enzyme Inhibition. Pre clinical and clinical studies. Introduction to Softwares: Autodock, Gold etc. Drug receptor interactions, Classical SAR/QSAR studies implications in Bioinformatics. IP issues in Drug design, drug licensing in India.

References

Core References:

1. Povl Krosgaard Larsen, Tommy Liljefors and Ulf Madsen, "Textbook of Drug Design and Discovery", Dev Publishers & Distributors.
2. Rastogi et. al., "Bioinformatics: Methods and Applications", Prentice Hall of India.
3. Claverie & Notredame, "Bioinformatics - A Beginners Guide", Wiley-Dreamtech India Ltd.

Additional Reference

1. Thomas J. Perun and C. L. Propst, "Computer-Aided Drug Design: Methods and Applications", Marcel Dekker.
2. Pevnezer, "Bioinformatics and Functional Genomics", John Wiley.
3. Genomics, Proteomics and Bioinformatics. A. Malcolm Campbell & Laurie J. Heyer, CSHL Press and Benjamin Cummings.

BI-225 Practical-II

A. Genomics

1. Retrieve sequence from NCBI Genome, Genbank, GenPept
2. Practicals on ORFfinder, GenScan
3. Sequence alignment-pairwise- BLAST, FASTA, MSA-clustalW, Muscle

B. Proteomics

1. Practicals with MultiDent, AACompIdent, Protparam
2. Databases PDB, SCOP, CATH, Pfam
3. Secondary structure Prediction-GOR, SOPMA

C. Web programming

1. Create web page with image and menu items using html
2. Create web submission form consisting of fields- name, age and email id.
3. Write a PHP page to validate email address
4. Five Experiments in JavaScript
5. Creating a database using MySQL

BI 231 ADVANCED BIOINFORMATICS

Unit I

Introduction to Systems Biology, Introduction to interaction networks, Protein interaction network, Gene regulatory network, Metabolic and signaling networks, SBML, E-Cell, Introduction to CellDesigner and Cytoscape, Synthetic biology, Applications of Synthetic Biology.

Unit II

Metabolomics: Metabolism, metabolic pathways- Glycolysis, Krebs cycle, etc. metabolite, metabolome, metabolomic separation and analysis techniques, metabolic profiling, metabolic fingerprinting, Metabolome informatics. Resources/ databases of metabolomics, Applications, KEGG and BRENDA

Unit III

Mitochondriomics: - Genetic polymorphism, variations, alleles. Human Y-chromosome haplogroups. Mitochondrial haplogroups, rCRS, SNP, Mitochondrial eve, Human mitochondrial molecular clock, prevalence in mitochondrial haplogroups, Human genographic project, mitochondrial polymorphism, Dysfunction and disease studies.

Unit IV

Introduction to Pharmacogenomics, Pharmacogenomics vs Pharmacogenetics. drug metabolism, drug interactions, pharmacological actions of drugs, Pharmacokinetics and Pharmacodynamics, SNP's and drug response: Genetic variations, types of polymorphisms Personalized medicine; Inter-individual variability, Personalized sequencing, precision therapies.

Unit V (Flexi module - only for internal assessment, not to be included in University exam): Next Generation Sequencing Methods, NGS technologies/platforms, experiment types and applications, Workflows for various NGS experiments, Basics of Next Generation Sequence data analysis, Various file formats such as SAM, VCF, BED, ChIP-seq

References

Core References:

1. Uri Alon, "An Introduction to Systems Biology Design Principles of Biological Circuits", Chapman & Hall/CRC.
2. Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald, Hans Lehrach and Ralf Herwig, "Systems Biology", Wiley-Blackwell.

Additional reference

1. Paul S. Freemont & Richard I. Kitney, "Synthetic Biology : A Primer", Imperial College Press
2. William J. Griffiths "Metabolomics, Metabonomics and Metabolite Profiling", RSC publishing
3. Emily D. Aulicino, "Genetic Genealogy: The Basics and Beyond"
4. Joseph S. Bertino, "Pharmacogenomics An Introduction and Clinical Perspective", McGraw Hill
5. Stuart M. Brown "Next-Generation DNA Sequencing Informatics", Cold Spring Harbor Laboratory Press

BI 232 BIOENERGETICS, BIOCHEMISTRY & APPLIED CHEMISTRY

Unit I

Structure of atoms, molecules and chemical bonds, Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.), pH, buffer, reaction kinetics, thermodynamics- internal energy, enthalpy, entropy, isothermal process, adiabatic process, free energy, Redox potential, hydrolysis of ATP.

Unit II

Biomolecules; Composition, structure and function (carbohydrates, lipids, proteins, nucleic acids and vitamins), Carbohydrates (monosaccharides, disaccharides, polysaccharides, glycoproteins and peptidoglycans), Proteins (classification of amino acids with structure, Conformation of proteins and polypeptides, secondary, tertiary, quaternary , Domain and motif structure; Reverse turns and Ramachandran Plot), Nucleic acid (Nucleotides, Higher orders of DNA Structure: Chromatin Structure: Histones and Nucleosomes, Conformation of nucleic acids (helix (A, B, Z), t-RNA, m-RNA and r-RNA)), Plasma membrane (RBC membrane as an example) Membrane transport; cell-cell interaction, cytoskeletal structure and cell movements.

Unit III

Carbohydrate metabolism- Glycolysis, Gluconeogenesis, TCA, HMP pathway, Electron transport chain. Biochemistry of photosynthesis (light reaction, dark reaction).

Unit IV

Mole fraction, molarity, molality, Normality, osmolality, osmolality, ionic strength. Principle and applications of chromatography- Paper chromatography, Thin layer chromatography, Column Chromatography (Size exclusion, affinity, ion exchange), HPLC, Gas chromatography, Electrophoresis, Ultracentrifugation. NMR, colorimeter, spectrophotometer. Microscopy- Light microscopy, fluorescent, inverted and electron microscopy, Phase contrast microscopy.

Unit V(Flexi module - only for internal assessment, not to be included in University exam): Immunotechniques (Detection of molecules using ELISA, RIA, western blot) Spectroscopy, Mass spectrometry, Autoradiography, isoelectric focusing, FISH and GISH, Edmann degradation for protein sequencing, Nucleic acid sequencing methods

References:

Core reference

1. DNA structure and function- Richard R. Sinden- Academic Press
2. Plant Physiology-S.N. Pandey, V.K. Sinha-Vikas Publishing House Pvt. Ltd. -IV Edn.
3. Biochemistry- U.Sathyanarayana & U. Chakrapani-Books & Allied Pvt. Ltd 3rd Edn.

Additional reference

1. Essential Biology(Abrided), Campbell, Cambridge
2. Molecular Cell Biology- Lodish, H. Baltimore Scientific American Books,3rEdn.
3. Protein- Structure and molecular properties- Thomas E Creighton- W. H. Freeman.
4. Bioenergetics – Lehinger A.L., Benjamin-, 2nd Edn.

BI 233 MICROBIOLOGY, IMMUNOLOGY & ENZYMOLOGY

Unit I

Basic microbiology-discovery of penicillin: discovery of vaccination; contribution of scientists, Microscopy- Principles and applications, dark field, bright field, phase contrast microscopy, fluorescent microscopy, electron microscopy- TEM and SEM. Stains and staining- Principles of staining, simple staining, negative staining, differential staining, Gram and acid fast staining. Control of microbes- Sterilisation, disinfection, pasteurization

Unit II

Significance of microorganisms. Cell structure and sub cellular organelles of bacteria, fungi & viruses. Cultivation of bacteria- Types of growth media, pure culture methods (streak plate, spread plate, pour plate, stab culture, slant culture). Growth of bacteria- Definition, growth phases, kinetics of growth, direct and indirect measurement of growth, factors affecting growth (pH, temperature, oxygen)

Unit III

Fundamental concepts of the immune system; Components of innate and acquired immunity; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system; Antigens - immunogens, haptens; Major Histocompatibility Complex; Immunoglobulins- basic structure, classes & subclasses of immunoglobulins, antigenic determinants. Vaccinology: Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, reverse vaccinology.

Unit IV

Classification - IUB system, Characteristics of enzymes, enzyme substrate complex. Concept of active centre, binding sites and ES complex formation. Effect of temperature, pH and substrate concentration on reaction rate. Activation energy. Transition state theory. Enzyme activity, international units. Enzyme Kinetics: Michaelis - Menten Equation, steady state enzyme kinetics. V_{max} and K_m . Enzyme inhibition - types of inhibitors - competitive, noncompetitive and uncompetitive, mode of action, experimental determination.

Unit V (Flexi module - only for internal assessment, not to be included in University exam): Immunology: Hypersensitivity - Type I-IV; Autoimmunity; Types of autoimmune diseases; Treatment of autoimmune diseases- Cancer immunotherapy. Antibody engineering- chimeric and hybrid monoclonal antibodies. Immobilized enzymes & Biosensors.

References

Core References:

1. Dubey RC and Maheswari DK. A text of Microbiology, S. Chand and Company Ltd., New Delhi.
2. Pelczar TR M J Chan ECS and Kreig N R. Microbiology. Tata Mc Graw-Hill INC. New York.
3. Powar CB and Dagainawala H F. General Microbiology Himalaya publishing house, Mumbai .

Additional Reference

1. Madhavee Latha. A Text book Immunology. S.Chand & Company Ltd, New Delhi.
2. Kuby Immunology - W H Freeman and company. New York.
3. Fundamentals of Enzymology- Price and Stevens

BI 234 PERL PROGRAMMING

Unit I

Concepts of flowcharting, algorithm development, pseudo codes etc. Introduction to Perl: Basic Concepts, Data types in Perl: Scalar, Array, Hash. Scalar Data Numbers, Strings, Scalar Operators, Scalar Variables, Scalar Operators and Functions. Arrays and List Data, Literal Representation, Variables, Array Operators and Functions, Scalar and List Context Hashes: Hash Variables, Literal Representation of a Hash, Hash Functions, Hash Slices. Basic I/O, Control Structures

Unit II

Regular Expressions: Concepts About Regular Expressions, Simple Uses of Regular Expressions, Patterns, More on the Matching Operator, Substitutions, The split and join Functions, Subroutines Other Data Transformation: Finding a Substring, Extracting and Replacing a Substring

Unit III

Miscellaneous Control Structures: File handles and File Tests: What Is a File handle? Opening and Closing a File handle, Using Pathnames and Filenames, Using File handles.

Unit IV

Bioperl: Introduction, Installation procedures, Architecture, Uses of Bioperl, Basic programs using Bioperl- Transcription Translation reading frames, data retrieval from databases. CGI Programming: The CGI.pm Module, Perl scripting for CGI, Simplest CGI Program, Passing Parameters via CGI,

Unit V (Flexi module - only for internal assessment, not to be included in University exam): Object oriented perl: Introduction to modules, Creating Objects, Formatting Data: Sorting, Transliteration, System Information: Getting User and Machine Information, Getting Network Information, Perl and Graphics

References:

Core Reference

1. Bal, H.P. Perl programming for Bioinformatics. Publisher: Tata McGraw-Hill New Delhi.
2. Moorhouse Michael, Barry Paul. Bioinformatics, Biocomputing and Perl: an Introduction to bioinformatics computing skills and practice. Publisher: John Wiley and Sons, 2004

Additional reference

1. Tisdall James D. Mastering Perl for bioinformatics. Publisher: Shroff Publishers and distributors O'Reilly Media, Inc. 2003..
2. Curtis Jamison D. Perl programming for biologists. Publisher: John Wiley & sons, inc., 2003
3. Tisdall James D. Beginning Perl for bioinformatics. Publisher: Shroff Publishers and distributors O'Reilly Media, Inc. 2001
4. Gibas Cynthia, Jambeck Per. Developing Bioinformatics Computer Skills. Publisher: Shroff Publishers and distributors O'Reilly Media, Inc., 2001.

BI 235 PRACTICAL- III

- A. Molecular Visualization: Rasmol, SwissPDB viewer
- B. Homology Modeling: Swiss-model
- C. MSA using CLUSTAL-W, MULTALIN, BLOCK
- D. Phylogenetic analysis using Phylip / Mega
- E. Biochemistry
 - a) Identification of carbohydrates: glucose, fructose, sucrose, maltose, lactose, starch) Molisch's test, Fehling's, Benedicts
 - b) Amino acids and proteins: Ninhydrin reaction, xanthoproteic reaction, Millon's test, Glyoxalic acid reaction, Ehrlich's test, aldehyde test.
 - c) Ovalbumin & Casein- Solubility, Ninhydrin reaction, xanthoproteic reaction, Folin's reaction, Lowry's reaction, Heat denaturation
 - d) Quantitative Analysis:
Estimation of Glucose – Anthrone method or Nelson-Somogg method
Estimation of Protein – Folin-Ciocaltece method
Kinetics of amylose –Effect of pH, substrate conc, temperature, enzyme concentration)
- F. Immuno electrophoresis.
- G. ELISA techniques

References:

1. Molecular cloning, Sambrook
2. Practical Microbiology-R.C. Dubey and D.K. Maheshwari-S.Chand & Company
3. Experiments in Microbiology, Plant pathology & Biotechnology-K.R.Aneja-New Age International Publishers-4th Edn.
4. A Practical Guide to the Analysis of Genes and Proteins- Baxewins & Onellete-Wiley Publishers
5. Bioinformatics: Concepts, Skills and applications- Rastogi, S.C., *et al*-CBS Publishers, NewDelhi
6. Bioinformatics: A Practical Approach- K.Mani & N. Vijayaraj-Aparna Publishers NewDelhi
7. Biological Sequence Analysis-Durbin *et al*, CambridgeUniversity press
8. A Practical guide to the Analysis of Genes and Proteins, Baxewins & Onellette, Wiley Publishers
9. Conceptual data modeling for Bioinformatics. Bornberg- Bauer, E, and N. W. Paton
10. Bioinformatics: Concepts, skills and applications. Rastogi, S.C., *et al.*, CBS Publishers
11. Practical Applications of Computer Aided Drug Design, Paul S. -Marcel Dekker
12. Computer aided Drug Design: Methods and Application. Thomas J Perun, Marcel Dekker
13. Bioinformatics in support of Molecular Medicine.
14. Bioinformatics- A Practical Approach, K. Mani & N Vijayaraj. Aparna Publishers

BI 241 RESEARCH METHODOLOGY

Unit I

Creativity & Thinking Skills: Various views on creativity; stimulating creativity; obstructions to creativity; creativity & innovation, creativity & craft; critical thinking; problem solving strategies, logical thinking- common logical fallacies.

Unit II

Research and Research Reporting: Various outlooks on research; Types of research: pure versus applied, incremental versus innovative, qualitative versus quantitative; Philosophy of science; the scientific method, the research process -creative question - hypothesis - planning and designing of experiments - critical analysis - sources of errors and minimization - reporting; Format of a science research paper - the IMRAD format - objectives of each section - reference citing styles; Proof reading & editing; Publication process -Peer review - single/double blind and open; plagiarism Open Access Publications

Unit III

Knowledge Management Skills: Advanced internet search skills - specialized academic search; Google scholar and scopus; Bibliometrics and webometrics - impact factors -h, h-b and g indices - pitfalls in interpreting impact; Reference management tools:Current awareness: RSS feeds, TOC alerts, DB alerts.

Unit IV

IPR awareness:Copyrights, copyrights and patents; IPR of software and life forms; Brief overview of IPR laws in India - Protection of traditional knowledge; Patent amendment of 2005 and its impact; Economic benefits of IPR protection.

Unit V (Flexi module - only for internal assessment, not to be included in University exam): Allied Topics: Profile of key Bioinformatics/CB/ pharmaceutical institutions and industries in India& abroad. Job opportunities in Computational Biology/Bioinformatics & skill profiles; Ethics - its role in scientific research and academics, Gender and Research, Making effective multi-media and poster presentations.

References:

Core reference

1. AnithaRao and BhanejiRao, "Intellectual Property rights: A primer", Eastern Book Company.
2. Rowena Murray, "How to Write a Thesis", Tata McGraw Hill Education Pvt. Ltd.
3. C.R.Kothari, "Research Methodology, New Age Publishers

Additional Reference

1. Jeffrey A. Lee, "The scientific endeavor: a primer on scientific principles and practice", Benjamin Cummings.
2. Robert A. Day, "How to Write and Publish a Scientific Paper", Cambridge University Press.
3. Dr. Marlene Caroseli, "Quick Wits: 50 Activities for Developing Critical Thinking Skills", Ane Books.
4. Gregory Bassham, William Irwin, Henry Nardone and James Wallace, "Critical Thinking: A Student's Introduction", Tata McGraw Hill Education Pvt. Ltd.
5. Rhonda Abrams and Julie Vallone, "Winning Presentation in a Day", PHI Pvt Ltd.
6. Weisberg, R., "Creativity - Beyond the Myth of Genius", W.H. Freeman and Company, New York, 1993.

BI242: PROJECT, VIVA VOCE & SEMINAR

Students are required to carry out a three month individual project and submit a dissertation embodying the findings of the same. The project work is to be done preferably in an external organization of repute such as national R and D institutions or global IT companies. Only in exceptional cases will the student be permitted to work in the college itself. External Evaluation of the dissertation and conduct of viva-voce (Components 2 to 6 below) shall be done by an external examiner appointed by the University. The Viva shall, in addition to evaluation of project work, also attempt to gauge overall professional development of the student and also the generic subject awareness and knowledge of the student, mainly through an oral examination.

Evaluation components & sub components (Marks in brackets: Total 400)

1. Project Management (60) **To be awarded by internal guide of project**
 - Lab Note Book is regular & detailed (20)
 - Detailed & Precise Progress Reports (20)
 - Regular Peer Review/Supervisor review & Action (20)
2. Project Reporting (40)
 - Scientific Reporting Standards, Formatting (20)
 - Avoidance of Plagiarism, Citing Practice(20)
3. Technical Work (160)
 - Quantum of work (40)
 - Meetings Objectives (40)
 - Demonstration of Results (80)
4. Scholarship (60)
 - Critical Analysis in concluding chapter (20)
 - Contextualizing the work (20)
 - Knowledge as demonstrated in Viva (20)
5. Communication Skills (40)
 - Presentation Skills in Viva (20)
 - Use of language in Dissertation (20)
6. Overall Impression (40)

