M. Sc. BIOINFORMATICS (2010-12)

Deficiency courses

MAS-312	Elementary Mathematics 4	3-1-0	
MBCE-302	Molecular Biology 2-0-1	3	
	Total	**07**	

Basic Supporting courses

MAS-814	Applied Biostatistics	3	2-0-1	
	Total	**03**		

Core Courses

MBCE-701	Molecular Cell Biology	3	2-0-1	
COMP-704	Object Oriented Language	3	2-0-1	
CBBI-701	Fundamental of Bioinformatics and Information Technology	3	2-0-1	
CBBI-710	Perl for Bioinformatics	3	2-0-1	
CBBI-711	Database Management System	3	2-0-1	
CBBI-712	Computational Biotechnology	3	2-0-1	CBBI-713 Biological Sequence Analysis 3 2-0-1
CBBI-780	Seminar I	1	0-0-1	
CBBI-880	Seminar II	1	0-0-1	
CBBI-800	Training	1	0-0-1	
CBBI-889	Research Project (Dissertation)	15	0-0-15	
-	***Total***	***39***		

Specialized Courses

CBBI-811	Molecular Structure Prediction and Visualization	3	2-0-1
CBBI-812	Rationale Drug Designing	3	2-0-1
CBBI-813	Evolutionary Systematics	3	2-0-1
CBBI-814	Microarray Data Analysis	3	2-0-1
	Total	**12**	
	Total	**61**	

COURSE STRUCTURE FOR M. Sc. BIOINFORMATICS

(ADMISSION YEAR 2010-12)
Semester I

S.No.	Paper Code	Subject Title	Credit	L.T.P.
1.	COMP-704	Object Oriented Programming	3	2-0-1
2.	CBBI-701	Fundamental of Bioinformatics & Information Technology	3	2-0-1
3.	MBGE-701	Molecular Cell Biology	3	2-0-1

Deficiency Course

S.No.	Paper Code	Subject Title	Credit	L.T.P.
1.	MAS-312	Elementary Mathematics	4	3-1-0
2.	MBCE-302	Molecular Biology	3	2-0-1

Semester II

S.No.	Paper Code	Subject Title	Credit	L.T.P.
1.	MAS-814	Applied Biostatistics	3	2-0-1
2.	CBBI-710	Perl for Bioinformatics	3	2-0-1
3.	CBBI-711	Database Management System	3	2-0-1
4.	CBBI-712	Computational Biotechnology	3	2-0-1
5.	CBBI-713	Biological Sequence Analysis	3	2-0-1
6.	CBBI-780	Seminar-I	1	0-0-1

1.	CBBI-800	Summer Training	1	0-0-1

Semester III

S.No.	Paper Code	Subject Title	Credit	L.T.P.
1.	CBBI-811	Molecular Structure Prediction and Visualization	3	2-0-1
2.	CBBI-812	Rationale Drug Designing	3	2-0-1
3.	CBBI-813	Evolutionary Systematics	3	2-0-1
4.	CBBI-814	Microarray Data Analysis	3	2-0-1
5.	CBBI-880	Seminar-II	1	0-0-1

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Semester IV

S.No.	Paper Code	Subject Title	Credit	Credit
1.	CBBI-899	Research Project (Dissertation)	15	0-0-15

SYLLABOUS FOR M. Sc. BIOINFORMATICS

Semester I

COMP-704 Object Oriented Programming 3 2-0-2

Unit 1

Programming concepts: Reduction of a given problem to a computer program; flow chart concepts, Conversion of the flow chart to code, Key concepts in programming: variables and constants; different kind or types of variables; storage needs.

Unit 2

Arrays; concept of address and value; keywords and reserved words; syntax, Programming tools: sequential execution; branching; conditional branching; different kinds of loops.

Unit 3

Machine dependent conditions: address; segment. Pointers, function calls, memory allocation, entry, exit codes, large programs (overlays).

Unit 4

Introduction to C: general features of a C program, Arrays and pointers in C: detailed discussion, Input and output: files: basic concepts of stream I/O, Strings and string operations, string handling.

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Unit 5

Classes and structures, Overloading operations, Objects, composition, inheritance and other properties, Template and iterators, Libraries, Compilers, options and optimizations, Loading, linking and debugging, Good programming practices.

CBBI-701 Fundamental of Bioinformatics & Information Technology 3 2-0-1

Unit 1

Introduction to Bioinformatics, philosophical, directional and application oriented background of Bioinformatics. Biological databanks: NCBI data model, GenBank sequence database, structural database, biodiversity information, virology information database, Chemoinformatics databases, practicals on data retrieval involving internet based Bioinformatics tools.

Unit 2
Introduction to database: Data abstraction, data models.

Unit 3
Information network - Internet, Web Browser and address (NCBI, EBI etc). Use of INTERNET & WWW; Ethernet and TCP/IP family of protocols

Unit 4
Computer Networking - LAN, WAN, MODEM; Network structure; Network architecture; Hierarchical networks, Optical Vs. Electronic Networking; Security of the network, Fire-walls; Network Goals; Applications Network.

MBGE-701 Molecular Cell Biology 3 2-0-2

Unit 1
Diversity of cell size and shape. General structure and constituents of prokaryotic and eukaryotic cells, Cell wall, cell membrane, cell surface related functions.

Unit 2
Endoplasmic reticulum, Golgi apparatus, nuclear membrane, tonoplast, vacuoles, their molecular structure and function.

Unit 3
Structure and function of major cell organelles-nucleus, chloroplast, mitochondria and ribosome in relation to cell growth and division Regulation of cell cycle and cell division.

Unit 4
Introduction and concepts in Molecular Biology, Macromolecules-major classes and understanding of macromolecules, Proteins- structural organization, conformation and biological function.

Unit 5
Enzymes- classification, active site, kinetics and regulation Nucleic acids- classification, structure, stereochemistry and secondary structure.

Unit 6
Organization of prokaryotes, eukaryotes and organelle genomes Gene structure in prokaryotes and in eukaryotes

Unit 7
Examination of cells- plant, animal and microbial cells, Examination of tissues- epidermis, parenchyma, chlorenchyma, collenchyma, sclerenchyma Preparation of microscopic slides and mounting of transverse and longitudinal sections of stem, root and leaf samples, Preparation of microscopic slides to study different stages of mitosis and meiosis.

Deficiency Course

MAS-312 Elementary Mathematics 4 3-1-0

Unit 1
Algebra: Theory of Quadratic equations, Partial fractions, Binomial theorem (for positive index), Exponential and Logarithmic series, Elementary concepts of Permutation and Combination.

Unit 2
Trigonometry: Elementary concepts of Complex numbers, De-Movier's theorem and its application.

Unit 3
Co-ordinate Geometry: Equation of standard curves and their identification.

Unit 4
-Differential Calculus: Function, Limit, Continuity and Differentiability, Differentiation of standard functions, Method of Differentiation, Trangent and Noraml, Maxima and Minima.

Unit 5
Integral Calculus: Indefinite integration of standard functions, Integration by substitution, by parts, by partial fraction.

Unit 6
Vector Analysis: Scalar and Vectors, sum and Difference of Vectors, Dot and Cross product. (Double, triple).

MBGE-302 MOLECULAR BIOLOGY 3(2-0-2)

Unit 1
Structure and properties of nucleic acid: Models of DNA structure, RNA structure, Physical, Chemical, Stereoscopic Nuclear & organelle genomes,

Unit 2
Genome Complexity: LC value paradox, cot analysis, Repetitive DNA, satellite DNA, pseudo genes, Synteny.

Unit 3
Chromosome Organization: Histones, Non-histones, Nuleosomes, chromatin, Chromosome structure in prokaryotes and eukaryotes,

Unit 4
Gene Organization: Split genes, Overlapping genes, Transposons, gene clustuers,

Unit 5
DNA-Protein interaction: DNA binding motifs, methods of studying DNA binding proteins

Unit 6
DNA Replication: Models of DNA replication, enzymology of DNA replication, the replication process, initiation, elongation and termination of replication; telomeres.

Unit 7
Transcription and mRNA processing: Components of transcriptional machinery in prokaryotes and eukaryotes; initiation, elongation and termination of transcription; capping, polyadenylation, spicing, mRNA stability

Unit 8
Translation: The genetic code; tRNA and aminoacyl sythetases, ribosomes, Translation process, initiation, elongation and termination of transcription; Capping, Polyadenylation, Splicing, mRNA stability.

Unit 9
Regulation of Gene Expression: General aspects of regulation in prokaryotes and eukaryotes; the operon model, lac and trp operons;DNA methylation;Tissue-sp. and developmental stage sp.Expression of genes.

Unit 10
Molecular Evolution: DNA based phylogenetic trees and their applications.

Unit 11
Gene mutation: Somatic vs germinal mutation, mutant types, selective systems, induction of mutations, chromosomal mutation, changes in chromosome structure, mutation and cancer, mutagens in genetic dissection, mutation readings, molecular basis of gene mutations, repair defects and human diseases, recombination, transposable genetic elements.

Semester II

MAS-814	**Applied Biostatistics**	**3**	**2-0-1**
CBBI-710	**Perl for Bioinformatics**	**3**	**2-0-1**

Unit 1

Perl Introduction: History of Perl, Availability, Support, Installation. Basic Concepts, Significance of Perl in Bioinformatics.

Unit 2

Perl Language Basics: Scalar Data: What is Scalar Data? Numbers, Strings, Scalar Operators, Scalar Variables, Scalar Operators and Functions. Arrays and List Data: What is a List or Array? Literal Representation, Variables, Array Operators and Functions, Scalar and List Context. Hashes: What is a Hash? Hash Variables, Literal Representation of a Hash, Hash Functions, Hash Slices. Control Structures: Statement blocks, loops and conditions. Basic Input / Output.

Unit 3

Perl Language Advanced: Regular Expressions: Concepts About Regular Expressions, Simple Uses of Regular Expressions, Patterns, Matching Operator, Substitutions, The split and join functions, Subroutines: System and User Functions, The local Operator, Variable-length,

Parameter Lists, Lexical Variables, File handles and File Tests: What Is a File handle? Opening and Closing a File handle, Using Pathnames and Filenames, die, Using File handles. Object oriented Perl: Introduction to modules, creating objects and references. CGI Programming: The CGI.pm Module, CGI Program in Context, Simple CGI Programs, Passing Parameters via CGI, Perl and the Web.

Unit 4

BioPerl: BioPerl overview and installation procedures. BioPerl modules, Creating BioPerl objects. Applications of BioPerl.

CBBI-711 Database Management System 3 2-0-1

Unit 1

Data Abstraction; Data Models; Instances & Schemes; E-R Model - Entity and entity sets; Relations and relationship sets; E-R diagrams; Reducing E-R Diagrams to tables.

Unit 2

Network Data Model: Basic concepts; Hierarchical Data Model: Basic Concepts; Multimedia Databases - Basic Concepts and Applications.

Unit 3

Indexing and Hashing; Basic concepts (ISAM, B+ Tree indexed files, B Tree indexed files, Static Hash functions, Dynamic Hash functions).

Unit 4

Introduction to Distributed Database Processing, Data Security.

Unit 5

SQL: Select Statements; Data Definition Statements; Data Manipulation Statements; Data Control Statements; Other Database Objects (Views, Sequences, Synonyms); Introduction to Application.

CBBI-712 Computational Biotechnology 3 2-0-1

Unit 1
Genome sequencing technology, genotyping, transcriptomics.

Unit 2
Whole genome analysis, Comparative genomics - Paralogs and orthologs, Phylogenetic profiling, Pathway analysis, Repeat analysis, Human genetic disorders, Candidate gene identification, Linkage analysis, Genotyping analysis, Concepts of Pharmacogenomics.

Unit 3
Introduction to basic Proteomics technology, Bio-informatics in Proteomics, Gene to Protein Function: a Roundtrip, Analysis of Proteomes, Analysis of 2-D gels, Protein to Disease and Vice Versa, Human Genome and science after Genome era.

Unit 4
Introduction to Metabolomics, synthetic and system biology.

CBBI-713 Biological Sequence Analysis 3 2-0-1

Unit 1
Analysis of protein and nucleic acid sequences e.g. Genome analysis, Microarray-data analysis etc.

Unit 2
Pairwise sequence alignment: Basics and techniques, Local alignment and Global alignment, NEEDLEMAN and Wunsch algorithm, Smith and Waterman algorithm.

Unit 3
The Dot Plot, Dynamic Programming Algorithm.

Unit 4
Multiple Sequence Alignment: The goal of MSA, Definition, Consensus Sequence, Computational Complexity.

Unit 5
Methods for MSA: Heuristic approaches, Combined approaches (Dynamic programming and Heuristic), Dynamic programming approaches or Progressive approaches.

Unit 6
Sequence analysis, Database similarity searches: FASTA & BLAST, Amino-acid substitution matrices, and Statistical significance of database-searches.

Semester III

CBBI-811	**Molecular Structure Prediction and Visualization**	**3**	**2-0-1**

Unit 1
Concepts of Molecular Modeling, Simulation of molecular mechanics and dynamics, Empirical representation of molecular energies, Simulations of Free Energy changes, Force fields, Use of Force Fields. A Energy minimization of small molecules, Local and global energy minima. Molecular Mechanics methods, Techniques in Molecular Dynamics, Monte Carlo Simulation for conformational analysis and semi-empirical methods, Application of molecular graphics.

Unit 2
Methods for Prediction of Secondary and Tertiary structures of Proteins - Knowledge-based structure prediction, Principles of Protein Folding, Fold recognition, Methods for comparison of 3D structures of proteins; Methods to predict three dimensional structures of nucleic acids.

Unit 3
Analysis of structures and correctness of structures, Submission of data to PDB: atomic coordinates and electron density maps; Anatomy of Proteins - Ramachandran plot. Evaluation of stereo-chemical properties of protein structures.

Unit 4
Internal and external co-ordinate system; Generation of co-ordinates of biopolymers in Cartesian and cylindrical polar co-ordinate system; Methods of single crystal X-ray diffraction of macromolecules: molecular replacement method and direct method - Fiber diffraction. Structural data banks - Protein Data Bank, Cambridge small molecular crystal structure data bank.

CBBI-812 Rationale Drug Designing 3 2-0-1

Unit-1

What are drugs? Various routes of Drug Administration, Pharmacokinetics - Absorption, Distribution, Metabolism, Elimination and Toxicity, Pharmacodynamics - Receptor Types, Theories of Receptor, Molecular mechanism of drug action through Enzymes, Ion channels and Carrier Proteins.

Unit-2

Drug discovery and development, Devising a Research Strategy, Challenges in Drug Discovery. Rational drug design, Structure based drug design- de novo drug design and Virtual screening of drugs.

Unit-3

Ligand based drug design- Quantitative Structure Activity Relationship, Molecular descriptors, 2D and 3D-QSAR analysis, Methods to derive 3D Pharmacophores, Pharmacophore mapping and its applications.

Unit-4

Docking- protein-ligand, protein-protein and protein-DNA docking, Algorithms, Scoring functions used in docking.

CBBI-813 Evolutionary Systematics 3 2-0-1

Unit 1

Molecular-Phylogenetics, Phylogenetic-trees, Terminology of tree-reconstruction, rooted and unrooted trees, gene vs species trees, character and distance data.

Unit 2

Phylogenetic analysis algorithms/methods: (a) Distance based methods: UPGMA, Transformed distance method, Neighbor's relation method, Neighbor-Joining Method, Multiple sequence alignment. (b) Character based methods: Parsimony, Weighted & unweighted parsimony, Branch & Bound method and Heuristic searches.

Unit 3

Probabilistic models and associated algorithms; Probabilistic models of evolution, Maximum likelihood algorithm

Unit 4

Approaches for tree reconstruction; Character optimization; delayed and accelerated transformation. Reliability of trees: Bootstrapping, parametric tests jackknife, decay and randomization tests.

Unit 5

Comparisons of Trees, Consensus (Strict, semi strict, Adam's majority rule, Nelson),Data partitioning and combination. Tree to tree distances and similarity.

Unit 6

Applications of Phylogenetic analyses Comparison of Phylogenetic Trees obtained using DNA sequences vs. Protein. Sequences vs. Full genomes. Need for addition of other properties towards total Phylogenetic analysis, Comparative methods for detection of species / organism relationships Gene duplication, Horizontal transfer, Domain evolution, Study of co-evolution: Plant-insect interactions. Host-parasite interactions, viral evolution.

CBBI-814 Microarray Data Analysis 3 2-0-1

Unit 1
Introduction to basic micrroarray technology, Bioinformatics in micrroarrays, Getting started – target selection, Customized microarray design, Image processing and quantification.

Unit 2
Preprocessing of data, Normalization and Filtering.

Unit 3
Normalization, Normalization Technology, Mathematical calculations etc.

Unit 4
Finding Differentially Expressed genes, Identifying under and over expressed genes.

Unit 5
Cluster analysis of microarray information, basic concepts of clustering, Types of clustering, Pros and cons of clustering.

Unit 6
Data mining, gene regulatory networks, promoter sequences, biological sequence annotations.

Unit 7
Introduction to R and Bioconductor.