M.Sc. Computational Biology

CBCS Course Structure & Syllabus

(2014-2015)

School of Biotechnology

Madurai Kamaraj University

Madurai - 625 021, India

MADURAI KAMARAJ UNIVERSITY

(University with Potential for Excellence)

CBCS syllabus for M.Sc. Computational Biology

School of Biotechnology (with effect from 2018-19)

1. Introduction

M.Sc., Computational Biology is an interdisciplinary program involving various areas in Biology, Biotechnology, Computational Methods, Mathematical Methods and Chemistry. With the true spirit of interdisciplinary program, this course is offered with the involvement and collective efforts from multiple Schools of Madurai Kamaraj University with the very experienced faculty heavily engaged in cutting edge research investigations in various aspects of computational biology. The duration of the M.Sc. Computational Biology programme is two years and the syllabus is divided into four semesters.

2. Eligibility for admission

Bachelor's degree in any relevant area of Life Sciences/ Zoology / Botany / Microbiology / Biochemistry / Biotechnology / Mathematics / Physical Science / Chemical Science / Computer Science / BE / B.Tech / M.B.B.S. with evidence of Maths at +2 level.

- Candidates should have secured at least 55% marks in the above degree.
- A relaxation is permitted for the admission for SC/ST/Physically Challenged candidates as per the norms of the CBCS guidelines of University and Tamil Nadu Government.

Duration of the course

- The students will undergo the prescribed course of study for a period of two academic years under semester pattern (Four semesters)
- Medium of Instruction: English

3. Objectives of the programme

This course is designed as lab training and research oriented course and students will get extensive hands on training in various aspects of Computational Biology including Structural Biology, Molecular Biology, Biotechnology, Functional Genomics and Proteomics. The objectives of M.Sc. Biotechnology programme are to empower the students from the basics of multidisciplinary biosciences with computational skills for the benefit and welfare of the human society.

4. Outcome of the Programme

The outcome of this course would be:

- To provide the requisite knowledge on basic skills of mathematical analysis and computations for various applications in biological systems

- To instruct theoretical and practical skills for the development and implementation of powerful computational algorithms, for representing, analyzing and simulating life at sub-cellular or molecular level.
- To impart knowledge for the identification of new drug targets for developing rational therapeutic strategies in drug discovery.
- To accomplish needs of the industry for the trained manpower with the specialized skills on computational tools.

5. Core subject Papers

I Semester

S.No	Code	Subject	Credits	Scheme of Exam		
				Ext	Int	Total
01	CBIO11C	Cell and Molecular Biology	**3**	**75**	**25**	**100**
02	CBIO12C	Biochemistry	**3**	**75**	**25**	**100**
03	CBIO13C	Probability and Statistics	**3**	**75**	**25**	**100**
04	CBIO14C	Communication Skills in Science and Technology	**3**	**75**	**25**	**100**
05	CBIO15C	Analytical Methods in Biotechnology	**3**	**75**	**25**	**100**
06	CBIO16E CBIO17E	**Major Elective 1** General Biology General Mathematics	**4**	**75**	**25**	**100**
Lab						
07	CBIO18C	Analytical Methods in Biotechnology	**2**	**60**	**40**	**100**
08	CBIO19C	Programming Language	**2**	**60**	**40**	**100**
		Total Credits	**23**			**800**

II Semester

S.No	Code	Subject	Credits	Scheme of Exam		
				Ext	Int	Total
01	CBIO21C	Algorithms in Computational Biology	**3**	**75**	**25**	**100**
02	CBIO22C	Sequence Analysis	**3**	**75**	**25**	**100**
03	CBIO23C	Database Management Systems	**3**	**75**	**25**	**100**
04	CBIO24C	Molecular Evolution	**3**	**75**	**25**	**100**
05	CBIO25C	Structural Biology	**3**	**75**	**25**	**100**
06	CBIO26E CBIO27E	**Major Elective 2** Biodiversity and IPR Biomedical Informatics	**4**	**75**	**25**	**100**
Lab						

07	CBIO28C	Sequence Analysis	**2**	**60**	**40**	**100**
08	CBIO29C	Programming Language	**2**	**60**	**40**	**100**
		Total Credits	**23**			**800**

III Semester

S.No	**Code**	**Subject**	**Credits**	**Scheme of Exam**		
				Ext	**Int**	**Total**
01	CBIO31C	Immunology and Pharmacology	**3**	**75**	**25**	**100**
02	CBIO32C	Data Mining and Machine Learning	**3**	**75**	**25**	**100**
03	CBIO33C	Advanced Programming Language	**3**	**75**	**25**	**100**
04	CBIO34C	Molecular Modeling and Molecular dynamics	**3**	**75**	**25**	**100**
05	CBIO35E CBIO36E	**Major Elective 3** Genomics and Proteomics Molecular Transport Physiology	**4**	**75**	**25**	**100**
Lab						
06	CBIO37C	Advanced Programming Language	**2**	**60**	**40**	**100**
07	CBIO38C	Molecular Modeling and Molecular dynamics	**2**	**60**	**40**	**100**
		Total Credits	**20**			**700**

IV Semester

S.No	**Code**	**Subject**	**Credits**	**Scheme of Exam**		
				Ext	**Int**	**Total**
01	CBIO41C	Project work	**10**	**75**	**25**	**100**
02	CBIO42E CBIO43E	**Major Elective 4** Systems Biology Immunotechnology	**4**	**75**	**25**	**100**
		Total credits	**14**			**200**

Total Core Credits	**64**
Total Elective Credits	**16**
Sub Total	**80**

Soft Course Credit	**10**
Overall Total	**90**

6. Subject Elective Papers

1. General Biology
2. General Mathematics
3. Biodiversity and IPR
4. Biomedical Informatics
5. Genomics and Proteomics
6. Molecular Transport Physiology
7. Systems Biology
8. Immunotechnology

7. Non-Subject Elective Papers

8. Unitization

Each subject paper is divided into five units. Each unit should be given equal importance in terms of teaching and examination.

9. Pattern of semester exam

The theory examination would be for three hours duration for each paper at the end the semester. The candidate failing in any subject (s) will be permitted to appear in the subsequent semester examinations. The practical examinations for PG course should be conducted at the end of the every semester

Course Structure:

The course is organized on semester basis with a total of four semesters. A candidate has to study 90 credits to qualify for the degree.

Transitory provision:

Transitory provision for the existing syllabus is up to May 2021.

10. Scheme of internal assessment

For the PG courses, the internal assessment marks will be as follows.

Test	: 10 Marks (Average of the best two tests)
Assignment	: 5 Marks
Seminar / Group Discussion	: 5 Marks
Peer-team Teaching	: 5 Marks
Total	: 25 Marks

11. External Exam

Guidelines for the Pass minimum:

To get a pass, a student should fulfill the following conditions:

a) Theory:

i) 50% of the aggregated (Internal +External)

ii) No separate pass minimum for Internal

iii) 34 marks out of 75 is the pass minimum for the External

b) Practical

i) 50% of the aggregated (Internal +External)

ii) No separate pass minimum for Internal

iii) 27 marks out of 60 is the pass minimum for the External

Candidates who have secured 60% and above in aggregates of the Part III will be given **First class**; Candidates who have secured 60% and above but not less than 50% will be given **Second class**; Candidates who have secured 40% and above but below 50% will be given a **Third class**. Ranking will be made for the candidates who have necessarily completed the course without any arrears in each semester and scored the maximum total in the Part III be given the **First Rank.**

12. Question Paper Pattern

Time : 3 Hours **Section A:** (10 x 1 = 10 marks) **Max. Marks : 75**

Question No. **1 to 10** (Multiple choice or Objective type)

1. Two questions from each unit

2. Four Choices in each question. One mark objective questions are also acceptable.

3. No 'none of the above' choice

Section B: (5 x 7 = 35 marks)

Answer all questions choosing either (a) or (b)

Answers not exceeding one page

(One question from each unit)

11 (a)	or	11 (b)
12 (a)	or	12 (b)
13 (a)	or	13 (b)
14 (a)	or	14 (b)
15 (a)	or	15 (b)

Section C: (3 x 10 = 30 marks)

Questions 16 – 20, Answers not exceeding four pages
Answer any three out of five (one question from each unit)

Course of study (Table)

13. Scheme of evaluation

1. The pattern for internal valuation may be : two tests – 15 marks each: average 15 marks (Average of the two)
2. Group discussions/Seminar/Quiz – 5 marks
3. 2 Assignments: 5 marks each: average 5 marks
4. 3rd test may be allowed for absentees of any one of the two tests.
5. If quiz is opted, 2 Quiz should be conducted.

14. Passing minimum

PG: Passing minimum – 50% (aggregate).
No pass minimum for internal 34/75 is the minimum in External.

Semester I

Core- CBIO11C - Cell and Molecular Biology

Unit 1

Cell organization and composition - Structural organization of prokaryotic and eukaryotic cells- Concept of a composite cell and Molecular composition of cells. Biomembranes- Structure Models of a plasma membrane, Membrane permeability- Transport across cell membranes- Transmembrane signals- Artificial membranes- liposome.

Unit 2

Mitochondrial Structure and Function – Ultrastructure of Mitochondria, Oxidative Metabolism in the Mitochondrion –The Role of Mitochondria in the formation of ATP – The Machinery for ATP formation – Peroxisomes.

Unit 3

Chloroplast structure and function – An overview of photosynthetic metabolism – The absorption of light – Photosynthetic units and reaction centers – Photophosphorylation – Carbon dioxide fixation and the synthesis of carbohydrates.

Unit 4

Cellular Components – Cytoskeleton – components of Cytoskeleton, Microtubules, Intermediate filaments – Microfilaments, Cell cycle, Endoplasmic reticulum, Golgi complex, Types of vesicles - transport and their functions, Lysosomes. Nucleus – Internal organization, Nuclear pore complex, Nucleosomes, Chromatin.

Unit 5

DNA and Protein Synthesis - Structure of DNA - evidence for DNA as genetic material. Gene transfer in microorganisms – conjugation, transformation, transduction – protoplasmic fusion. The genomes of bacteria, viruses, plasmids. DNA Structural organization – DNA replication, Transcription – mRNA processing, Translation. Protein synthesis – Ribosomes, enzymes, Protein processing, Introduction to the methods of DNA sequencing

Text Book:

1. Cell and Molecular Biology – Concepts and Experiments by Gerald Karp, 2008, Wiley International Student Version.

Reference Books:

1. Genes VIII (8th Ed.) by Lewin, B, 2004, Pearson Education International.

2. Cell and Molecular Biology by De Robertes and De Robertis, 2002, Saunders College, Philadelphia, USA.

Semester I

Core-CBIO12C – Biochemistry

Unit 1

Overview of metabolism, high energy compounds, oxidation-reduction reactions, experimental approaches to the study of metabolism, the reactions of glycolysis, fermentation, the anaerobic fate of pyruvate, control of glycolysis, metabolism of hexoses other than glucose. The pentose phosphate pathway, glycogen breakdown and synthesis, control of glycogen metabolism, gluconeogenesis and other carbohydrate biosynthetic pathways.

Unit 2

Overview of citric acid cycle, Synthesis of acetyl coenzyme A, enzymes of the citric acid cycle, regulation of the citric acid cycle, reactions related to the citric acid cycle, protein degradation, amino acid deamination, the urea cycle, breakdown of amino acids, amino acid biosynthesis, heme biosynthesis and degradation, chemical synthesis of peptides, oligonucleotides and oligosaccharides.

Unit 3

Lipid digestion, adsorption and transport, fatty acid oxidation, ketone bodies, fatty acid biosynthesis, regulation of fatty acid metabolism. Lipid bilayers and membranes.

Unit 4

The mitochondrion, electron transport, oxidative phosphorylation, control of oxidative metabolism, chloroplast, the light reactions, the dark reactions, photorespiration.

Unit 5

Synthesis of purine ribonucleotides, synthesis of pyrimidine ribonucleotides, formation of Deoxyribonucleotides, nucleotide degradation integration and regulation of mammalian fuel metabolism.

Reference Books:

1. Biochemistry (3rd Ed.) by Voet and Voet, 2004, Wiley ISBN: 978-0-471-19350-0.
2. Principles of Biochemistry (5th Ed) by Nelson and Cox, Lehninger, 2009, W H Freeman & Co ISBN: 978-0-716-77108-1
3. Biochemistry (6th Ed.) by Berg, tymoczko & Stryer, 2007, W.H.Freeman and Co New York.
4. Principles of Biochemistry (4th Ed.) by Horto, Moran, Scimgeor, Perry and Rawn, 2006, Perason Education Institutional.

Semester I

Core- CBIO13C - Probability and Statistics

Unit 1: **Numerical descriptive techniques: Measures of central tendency**: mean, median, mode, relation between mean, median and mode. **Partition values**: quartiles, deciles, percentiles; **Measures of dispersion**: Absolute and Relative Measures, Moments, skewness and kurtosis

Unit 2: Correlation and Regression: Principles of least squares, scatter diagram, correlation, covariance, correlation coefficient, properties of correlation coefficient, regression, properties of linear regression, rank correlation, multiple correlation

Unit 3: Probability Theory: Concept of probability: sample space and events, independent events, mutually exclusive events. axioms of probability, conditional probability, additional and multiplication theorem of probability, Baye's theorem, Bernoulli trials, binomial distribution, normal distributions, Poisson distribution

Unit 4 : Sampling Theory: Meaning and objective of sampling, Sampling Error, Types of Sampling, Sampling Distribution, Sampling Distribution of Sample Mean and Sample Proportion, Standard Error

Unit 5: Test of Hypothesis of Small and Large Samples: Unbiased Estimator, Confidence Intervals, Standard Normal distribution, Chi-square distribution, Student's t distribution, F distribution, Analysis of Variance

Text Books:

1. Biostatistics (9th Ed.) by Wayne W. Daniel, 2004, Wiley ISBN: 978-0-471-45654-4

Reference Books:

1. Schaum's Outline series - Introduction to Probability and Statistics by Seymour Lipschutz and John Schiller, 1998, TATA McGraw-Hill edition.
2. Statistical Methods by N. G. Das, Vol: I and II, 2009, The McGraw-Hill Companies
3. Fundamentals of Biostatistics (6th Ed.), Bernard Rosner, 2006, Thomson Brooks/Cole ISBN:0-534- 41820-1

Semester I

Core–CBIO14C-Communication Skills for Science and Technology

Unit 1: Basics of Technical Communication: Introduction and Structure of Communication, The Process of Communication, Language as a Tool of Communication, Levels of Communication, The Flow of Communication, Communication Networks, The Importance of Technical Communication.

Unit 2: Barriers to Communication: Definition of Noise, Classification of Barriers

Unit 3: Oral Communication: Active Listening, Speech Structure, The Art of Delivery, Effective Presentation Strategies, Use of Visual Aids, Handling the Audience, Body Language, Conducting Meetings, Interviews, Group Discussion, Negotiation, Small Talk

Unit 4: Written Communication:

a. Letter, Memos and E-mails - Business Letters, Memos, E-mails.

b. Reports-Informal and Formal - Characteristics of a Report, Types of Reports, The Importance of Reports, Formats, Prewriting, Structure of Reports, Writing the Report, Revising, Editing and Proofreading

Unit 5: Technical Proposal and Thesis

Reference Books:

1. Meenakshi Raman, Sangeetha Sharma Technical Communication,(2004) Principles and Practice. Oxford University Press, ISBN 0-19-566804-9.
2. Robert Hays Principles of Technical Writing. (1965) Addison-Wesley. ASIN: B0000CMXHJ
3. Joan Van Emden Palgrave Writing for Engineers. (2005)Macmillan. III Edition. 2005 ISBN-13: 978-1-4039-4600-3, ISBN-10: 1-4039-4600-3.
4. Arthur Asa Berger Improving Writing Skills.(1993).Sage Publications. ISBN 0803948239
5. K.C.Verma The Art of Communication. (2001). Associated Publishing Company. ISBN : 81-85211-49-3.
6. Vilanilam J.V More Effective Communication: A Manual for Professionals.(2000) 2000 Saga Publications. ISBN 0761993636

Semester I

Core – CBIO15C- Analytical Methods in Biotechnology

Unit 1: Microscopy Identification of microorganisms using Light and Compound microscopy, Phase Contrast Microscopy, Fluorescence Microscopy, Confocal Microscopy, Microscopy with Light and Electrons, Electrons and Their Interactions with the Specimen, Electron Diffraction, The Transmission Electron Microscope, The Scanning Electron Microscope, Atomic Force Microscopy.

Unit 2: Spectroscopy Introduction to Spectroscopic Methods, Ultraviolet-Visible Molecular Absorption Spectrometry, Fluorescence Spectrometry, Infrared Spectrometry, Raman Spectroscopy, Nuclear Magnetic Resonance Spectroscopy, Molecular Mass Spectroscopy.

Unit 3: Separation Methods Introduction to Chromatographic Separation, Column Chromatography, Thin Layer Chromatography, Gas Chromatography, Liquid Chromatography, High Performance Liquid Chromatography, Electrochemistry.

Unit 4: Electroanalytical Techniques Potentiometry, Coulometry, Voltametry.

Unit 5: Biochemical Techniques - Estimation of Carbohydrates, Lipids, Proteins, Nucleic Acids.

Text Book:

1. Terrance G. Cooper, The Tools of Biochemistry (1997), Reprint 2011, Wiley India Pvt. Ltd, ISBN:978-81-265-3016-8

Reference Book:

1. Skoog, Holler, Crouch, Instrumental Analysis Brooks/Cole (*2007).* ISBN-13:978-81-315-0542-7.
2. Analytical Biochemistry by David J. Holme & Hazel Peck, 3rd ed. Prentice Hall. 1998.
3. Robert D. Braun, Introduction to Instrumental Analysis Pharma Book Syndicate. (1987) ISBN 891- 88449-15-6

Semester I

Elective-CBIO16E–General Biology

Unit 1: Chemical Basis of Life: Cell Structure and Function, Molecules of Life, Metabolism & Cellular respiration

Unit 2: Genetics: Mendelian inheritance. Chromosome theory of inheritance, deviations from Mendelian ratio (gene interaction- incomplete dominance, co-dominance, multiple alleles). Sex determination in human beings: XX, XY. Linkage and crossing over. Inheritance pattern: Mendelian disorders and chromosomal disorders in humans. DNA fingerprinting.

Epigenetic mechanisms of inheritance and regulatory RNA Molecules (RNA,MiRNA,SiRNA) and sense RNA and their applications.

Unit 3: Plant Biology Plant structure, growth and development, plant nutrition, transport in vascular plants & reproduction in plants

Unit 4: Animal Biology Basic Principles of Animal Form and Function; Animal Nutrition. Various organ systems in animals- immune system, reproductive system, circulatory, nervous system, respiratory system.

Unit 5: Ecology & Evolution: Ecological niche, population growth curves, Ecosystems stability, competition, conservation methods (both in situ and ex situ) Origin of life, theories and evidences, adaptive radiation, mechanism of Evolution, origin and evolution of man.

Text Books:

1. Neil A. Campbell, Jane B. Reece. Biology 6th edition Benjamin Cummings (2008) ISBN: 9780805371468

Reference Books:

1. Michael Roberts, Michael Reiss and Grace Monger. Advanced Biology (2000) ISBN 0-17-438732-6

Semester I

Elective - CBIO17E - General Mathematics

Unit 1: Basic Overview and Geometry: 2D geometry, 3D geometry, Area under curves, Areas of Polygons, Trigonometry, Complex numbers, Number integration. Coordinate system, Cartesian coordinates, Polar coordinates, Vectors, addition, subtraction, dot, cross, scalar triple product, divergence and Curl. Vector Geometry, Logarithms and Exponentials. Principles of component analysis. Linear algebra and its applications in bioinformatics.

Unit 2: Matrices and Determinants: Set theory, Matrix inverse and multiplication, linear equations, linear transformations, square matrices, determinant, Eigen values and eigenvector, Matrix decomposition methods, Graph Theory

Unit 3: Differential Calculus: Derivative, Newton's and Leibniz's notation for differentiation, Derivative of a constant, Sum rule in differentiation, Constant factor rule in differentiation, Linearity of differentiation, Calculus with polynomials, Chain rule, Product rule, Quotient rule, Differential equation, Newton's method, Taylor's theorem, L'Hospital's rule, Leibniz's rule, Mean value theorem.

Unit 4: Integral Calculus: Sum rule in integration, Constant factor rule in integration, Linearity of integration, Integral by parts, Inverse chain rule method, Substitution rule, Trapezium rule, Arclength, Partial integrals, Curves and Interpolation.

Unit 5: Numerical Methods: Solution of equations by iteration, Interpolation by polynomials and approximate methods, Piecewise linear and cubic splines, Numeric integration and differentiation, Linear systems: Gauss elimination, Gauss-Siedel, Euler and Runge-Kutta methods, Newton Rahpson method, Predictor-Corrector methods, Exposure to software packages like Matlab or Scilab. Mathematic modeling and Simulation.

Text Books:

1. Mathematics for Science, S.M. Uppal & H.M.Humphreys, (1996) New Age International Publishers. ISBN: 8122409946.

Reference Book:

1. Philip Schmidt, Frank Ayres Schaum's Outline of College Mathematics (2003) McGraw Hill ISBN –13 9780071402279

Semester I

Lab- CBIO18C – Analytical Techniques in biotechnology Laboratory

1. Visible Spectroscopy - Proteins and Nucleic acids
2. UV Spectroscopy – Proteins, nucleic acids
3. Fluorescence Spectroscopy - Proteins
4. Fluorescence Spectroscopy – Nucleic acids
5. Gel electrophoresis – Proteins
6. Gel electrophoresis – Nucleic acids
7. Gel Filtration – Proteins
8. Ion Exchange Chromatography - Proteins
9. Fluorescence Microscopy- Demonstration
10. NMR spectra - small molecules : Demonstration

Semester I

Lab-CBIO19C - Programming Language - Introduction to C and PERL

Unit 1: Introduction to programming languages: Introduction –Programming languages – Problem solving Technique: Algorithm, Flowchart, Compiling, Testing and Debugging, Documentation – Data structures – Array, Stack, Queue, Search, Linked List concepts.

Unit 2:Programming in C: C language Introduction – Tokens – Keywords, Identifier , Variables, Constants, Operators – Expression – Data types –Operator precedence - Statement: Input statement, Output statement, Conditional and Unconditional Control Statement – Looping Statement: while, do-while, for – nested loop – Arrays.

Unit 3: Procedural Concept: Structured Programming – Built-in library function – User defined functions – Pointer introduction – Passing pointer in a function – Structure – Union – File handle: Read and Write character from a file.

Unit 4: Web Programming: Introduction to Web Technology, HTML: Tags, Links, Tables, Forms, Frames – Java Script and Dynamic Web Pages: Introduction to client and server side scripting, data types, operators, controls, objects and elements in Java Script.

Unit 5: PERL : Basic Perl Data Types, References, Matrices, Complex/Nested Data Structures, Scope: my, local, our – Function/Subroutines, System and User Function, File handle and File Tests – Perl Modules – Regular expressions: Patterns, Single-character Patterns, Grouping Patterns, Anchoring patterns, Precedence, Matching operators, Ignoring case, Different Delimiter, Split and Join functions.

Lab exercises based on the above topics:

1. File input/output, using open(), read(), write() and close().
2. Codon Usage analysis, back translation of DNA, local alignments of sequences.
3. composition and motif analysis in protein and DNA sequences
4. hydropathy analysis
5. Sequence conversions
6. Analysis of protein structural data
7. Analysis of DNA structural data

Text Books:

1. Programming in ANSI C (4th Ed.) by E. Balagurusamy, 2007, Tata McGrawHill Publishing Company Limited.
2. Programming Perl (3rd Ed) by Larry Wall

Reference Books:

1. Beginning PERL for Bioinformatics by James Tisdall, 2001, O'Reilly publications

Semester II

Core – CBIO21C - Algorithms in Computational Biology

Unit 1: **Introduction** Algorithm: History, principles, types, development and its complexity.

Unit 2: **Algorithms Issues and Problems** Algorithms, asymptotic analysis of algorithms, NP complete problem, polynomial reducibility, traveling sales man problem, consecutive integer problem (CIP), sorting problem and Fibonacci Problem.

Unit 3: **Use of different algorithms** Linear, exhaustive search, branch and bound, divide and conquer. Expectation and Maximation (EM) with forward and backward algorithms, discriminative learning, Knuth-Morris-Pratt and Boyer-Moore algorithm for string matching, graph and maximum likelihood algorithm etc.

Unit 4: Dynamic Programming Dynamic programming, principles and its uses. Heuristics second generation alignment tool (Blast, FASTA, ClustalW). Probabilistic and statistical method- concepts and its significance. Models of evolution and its algorithm.

Unit 5: Methods: Algorithms for partial digest, double digest problem. Graph algorithm for DNA sequence assembly (CASP3, Phrap, Phred). Protein structure prediction- Chou-Fasman algorithm.

Text Books:

1. Neil C.Jones and Pavel.A Pevzner An introduction to Bioinformatics Algorithms. (Computational Molecular Biology) (2004) MIT press. ISBN-10: 0262101068

Reference Books:

1. R. Durbin, S.Eddy, A.Krogh, G.Mitchison Biological sequence analysis : Probabilistic models of Proteins and Nucleic acids (1998) Cambridge University Press 0-521-62971-3
2. Michael.S.Waterman Introduction to Computational Biology : Maps, Sequences and Genomes . Waterman. (1995) Chapman and Hall/ CRC Press ISBN-10: 0412993910
3. Dan Gusfield Algorthims on Strings, Trees and Sequences : Computer Science and Computational Biology (1997) Cambridge University Press. ISBN-10: 0521585198.
4. T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein. Introduction to Algorithms 3rd Ed. MIT Press 978-81-203-4007-7.

Semester II

Core–CBIO22C-Sequence Analysis

Unit 1 Overview : Biological Literature Information access, storage and retrieval; Genomics; Proteomics; Structural Genomics; Pharmainformatics; Pharmacogenomics: Population genomics; Biodiversity; Systems Biology; Hardware and Software approaches.

Unit 2 : Data alignment and applications: Collecting and Storing Sequence Data: Genomic Sequencing; Sequence assembly; Submission of Sequences; Sequence accuracy; Sequence databases; Sequence formats; Conversion between formats; Database browsers; EST databases; SNP databases; Annotation and Archival .Sequence alignment and applications: Uses: Choice to be made for alignment; Scoring matrices; Homology and related concepts; Dot Matrix methods; Dynamic programming methods for global and local alignments- Database Searching- FASTA, BLAST, statistical and Biological significance.

Unit 3 : Nucleic acid sequence analysis: Reading frames; Codon Usage analysis; Translational and transcriptional signals; Splice site identification; Gene prediction methods; RNA fold analysis

Unit 4 : Multiple Sequence alignment and applications: Uses; Methods available- Iterative alignment, Progressive alignment – ClustalW, T-Coffee; Profile Methods – Gribskov profile, PSI-BLAST, HMM ; Clustering and Phylogeny; Methods for Phylogeny analysis: Distance and Character based methods; Motif detection ; Protein family databases; Use of Structure based sequence alignment

Unit 5 : Protein sequence analysis: Compositional analysis ; Hydrophobicity profiles; Amphiphilicity detection; Moment analysis; Transmembrane prediction methods; Secondary structure prediction methods

Text Books:

1. N.Gautham, Bioinformatics, Narosa publications. (2006) ISBN-13: 9781842653005

Reference Books:

1. A.D.Baxevanis et al., Current Protocols in Bioinformatics, (2005) Wiley Publishers.
2. David W.Mount Bioinformatics (2001) Cold Spring Harbor Laboratory Press, ISBN 0-87969-608-7
3. Computational Molecular Biology by P. A. Pevzner, Prentice Hall of India Ltd, (2004) ISBN 81-203-2550-8
4. D.E.Krane and M.L.Raymer Fundamental concepts of Bioinformatics (2003) Pearson Education ISBN 81-297-0044-1

Semester II

Core-CBIO23C - Database Management Systems

Unit 1: Introduction – Database System Versus File Systems, Characteristics of Database, Database Concepts, Schemas & Instances, DBMS architecture and Data Independence, Data Models, Database Languages & Interfaces, View of Data, Database users and Administrators, Database System Structure, Database System Applications.

Unit 2: Data models – ER Model: Keys, Constraints, Design Issues, Extended ER features, Reductions of ER Schema to Tables. Relational Model: Structure, Relational Algebra; Hierarchical Model, Network Model, Object Oriented Model.

Unit 3: Structured Query Language – Basic Structure, Set Operations, Aggregate Functions, Null Values, Nested Sub queries, Views, Integrity: Domain constraints, Joined Relations, Data-Definition Language.

Unit 4: Relational Database and Storage – Pitfalls in Relational Design Database, Functional dependencies, Decomposition Normal Forms – 1NF, 2NF, 3NF & Boyce-Codd NF, Data Storage – Ordered indices, Hashing concepts - Security and Authorization.

Unit 5: Concurrency control techniques & Information retrieval – Transactions: Properties of transactions: Concurrency problems, Serialisability and Locking techniques – Database System Architecture and Information retrieval: Centralized and Client-Server Architecture.

Text Books:

1. Database system Concepts (5th Ed.) by Silberschatz, A., Korth, H.F. and Sudarshan, S., 2002, McGraw Hill Publishers.

Reference Books:

1. An introduction to Database systems (7th Ed.) by Date, C.J., 2000, Addison Wesley Publishers.
2. Fundamentals of Database systems (4th Ed.) by Elmasri and Navathe, 2004, Addison Wesley Publishers.
3. Principles of Database systems (2nd Ed.) by Ullman, J. D., 2001, Galgotia Publications.

Semester II

Core – CBIO24C - Molecular Evolution

Unit 1: The Big Bang theory and the Steady State alternative, Proofs for the Big Bang theory, Formation of elements and molecules, Chemical evolution of biomolecules, RNA as the precursor of first genes and catalysts, Major events in life's history, Dating of ancient events, Changes in earth's continents and climates, Evolutionary rates among groups of organisms.

Unit 2: The process of evolution, Population genetics, Allele and genotype frequencies, Hardy-Weinberg equilibrium, Mechanisms of evolutionary change, Mechanisms that result in adaptation, Maintenance of genetic variation within populations, Constraints on evolution, Influence of humans on evolution.

Unit 3: Nucleic acids, proteins and amino acids, Genetic code, mutations, Types and chemical basis of mutation, Transitions, Transversions, Deletions and Insertions, Gene duplications, Physico-chemical properties of amino acids and their importance in protein folding, Visualization of amino acid properties using principal component analysis, Clustering amino acids according to their properties

Unit 4: Sequence variation within and between species, Paralogy and Orthology, Genealogical trees and coalescence, Phylogenetic methods, phylogenetic trees, UPGMA and NJ clustering methods, bootstrapping, tree search and optimization methods, Molecular clock: Concepts and significance

Unit 5: Models of sequence evolution, Models of nucleic acid sequence evolution, Solution of the Jukes–Cantor model, The PAM model of protein sequence evolution, PAM distances, scoring matrices for amino acids, Molecular evolution of recently diverged species, Databases of Molecular evolution.

Text Books:

1. P.Higgs and T.Atwood (2005): Bioinformatics and Molecular Evolution , John wiley and sons ISBN 1405130857.

Reference Books:

1. Sadava, Heller, Orians, Purves and Hillis (2008): Life, the science of biology, 8th edition, W.H.Freeman company.
2. Dan Graur Wen Hisiung Li Fundamentals of Molecular Evolution (2000) Sinauer Assoc ISBN 0878932666.
3. John H.Gillespie Population genetics A concise guide (2004) John Hopkins Univ.Press ISBN 080188092 2nd ed.
4. D.C.Reanney Hicks and Smith Molecular Evolution. Frontiers of Biology (1973) ISBN 0454018606

Semester II

Core -CBIO25C-Structural Biology

Unit 1: Basic structural principles, conformational principles, Ramachandran diagram, forces involved in macromolecular interaction, building blocks of proteins, motifs of protein structures, alpha domain structures, alpha/beta structures, Fibrous Proteins, Protein interface

Unit2 : DNA structures, DNA recognition in prokaryotes and eukaryotes, specific transcription factors, enzyme catalysis and structure.

Unit 3: Membrane proteins, signal transduction, proteins of the immune system, Structure of spherical viruses.

Unit 4: Folding and flexibility, engineering and design of protein structures.

Unit 5: Determination of protein structures by X-ray and NMR methods.

Text books:

1. Carl Branden and John Tooze. Introduction to Protein Structure, (1991, 1999) Garland, Publication Inc.

Reference Books:

1. Biomolecular Crystallography: Principles Practice, and Application to Structural Biology - Bernhard Rupp (2010). Garland Science; ISBN 978-0-8153-4081-2
2. K.P.Murphy Protein structure, stability and folding (2001) Humana press.
3. Arthur M.Lesk Introduction to protein architechcture (2001) Oxford University Press.
4. A.McPherson Introduction to Macromolecular Crystallography (2003) John wiley Publications.
5. Vasantha Pattabhai and N.Gautham Biophysics (2002) Narosa Publishers ISBN 1-4020-0218-1.

Semester II

Elective–CBIO26E-Biodiversity and IPR

Unit 1:Introduction to biological diversity: biodiversity and global biodiversity- principles and applications-Biodiversity and land conservation – methods, laws and regulation- Biodiversity and ecosystem approach- Emerging issues in global biodiversity, Bioethics.

Unit 2: Biodiversity and climate change: Biodiversity and politics- bill passed by Indian government-Biodiversity and climate change- Biodiversity inventory and monitoring- Biodiversity and its conservation – Levels, alpha (α) and beta (β) – Extinction and Endangered species-Reasons – *In situ* and *ex situ* conservation

Unit 3: Convention on biological diversity (CBD): Global plan of action, Species conservation.CBD : thematical areas (marine biodiversity, Inland waters, agricultural biodiversity, Drylands Biodiversity, Forest Biodiversity, Mountain Biodiversity, protected areas etc)-Biodiversity inventory and monitoring-Genetic Biodiversity-Biodiversity Informatics-Biodiversity and its conservation – Levels, alpha (α) and beta (β) – Extinction and Endangered species-Reasons – *In situ* and *ex situ* conservation

Unit 4: Laws and agreements: IPR- patents, trade secrets, copyrights, trademarks, choice-Plant genetic resources-Agreement – GATT (General agreement of Tariffs) and TRIP (Trade related IPR)-Cooperation and implications -Patents of Higher plants, Transgenic organisms, Isolated genes and DNA sequences

Unit 5: Methods: SUI-GENERIS system and its uses- DNA barcoding and its uses -Plant variety protection and UPOV-Terminator technology for seed protection-Traitor technologies uses and implications.

Reference Books:

1. Graham Dutfield Intellectural property rights, trade and biodiversity : seeds and plant varieties. IUCN World conservation union (2000) ISBN 1853836923.
2. Proceedings of the Indian National Science Academy. Physical Sciences, vol. 68, Indian national Science Academy (2002).
3. T.M.Swansom Global action for biodiversity an international framework for implementing the convention of an biological diversity (1997) Earth scan publishers. ISBN 185833533.

Semester II

Elective-CBIO27E-Biomedical Informatics

Unit 1: Introduction : Biomedical data-Clinical and life sciences -standards and databases. Principles and its uses.

Unit 2: Electronic health records (EMR) and health Information exchanges—including information retrieval, medical decision making, evaluation and evidence. Patient monitoring systems-ethics in informatics - bayesian networks-learning and decision-data structure in algorithm design and analysis.

Unit 3 : Networking : TCP/IP Sockets and DNS clinical database concepts-design of the clinical information systems/Clinical Decision support systems- anyone-Synchronization, concurrency, deadlock, full-text databases, distributed database services and architecture on one of the database-any clinical database structure as one example.

Unit 4: Methods and Evaluation : Sampling, appropriate use of controls, data collection including human-testing of statistical significance, sensitivity and specificity.ROC plots. Methods and issues specific to healthcare.

Unit 5: Healthcare informatics: Understanding and interaction Health organization especially academic heath centers, understanding the health care environment, understanding the organization informatics- Interaction between these three units-machine learning approaches to make decision making and discovery. Human factors in clinical systems – use of machine learning to make modeling, data mining, policy design and law. Translation research and its uses and implications Evidence based medicines.

Text Books:

1. Biomedical Informatics Jules J. Berman, (2007) Jones and Barlett, Publishers Inc.

Reference Books :

1. Biomedical Informatics: computer applications in Health care and Biomedicine (3rd ed), by Shortliffe EH, Ciminio JJ., 2000, New York Springer-Verlag, ISBN 0-387-28986-0.
2. Shortliffe EH, Ciminio JJ. Biomedical Informatics : Computer applications in Health care and Biomedicine (2000) 3rd ed. New York Springer-Verlag ISBN 0-387-28986-0.
3. Charles P.Friedman, Jeremy C.Wyatt Evaluation methods in Biomedical informatics (Health Informatics) (2005) Springer ISBN 0387258892
4. C.William Hanson Healthcare informatics (2005), McGraw-Hill Professional ISBN 0071440666
5. Vadim Astakhov Biomedical informatics (2009), Vol. 569 Methods in Molecular biology Springer protocols Humana Press.

Semester II

Lab - CBIO28C- Sequence Analysis

Introduction to sequence analysis software.

1. **Access to software tools**: Download and installation of EMBOSS, Blast, Jalview and etc. Internet access to software and databases.

2. **Accessing Biological databases**: Retrieving protein and nucleic acid sequences, structures, EST sequences and SNP data. Accessing biomedical information from databases, using database browsers and genome browsers. Convert sequences between different formats.

3. **Nucleic acid sequence analysis**: Detecting ORF's, identification of translational and transcriptional signals, gene predictions, codon usage, RNA fold analysis.

4. **Sequence alignment and applications**: Pairwise alignment-dot matrix comparisons, global and local alignment, Database searching-different pairwise methods. Use of scoring matrices and gap penalties - Statiscal Vs Biological significance: Handling large datasets. Genome comparisons.

5. **Multiple sequence alignment and applications**. Use of multiple sequence editors. Progressive alignment and iterative alignment approaches. Use of profile methods > motif detection. Clustering and Phylogeny approaches. Protein family classification.

6. **Protein Sequence analysis**: Composition, Hydrophobicity and amphilicity. *Predictions :* transmembrane and secondary structures. Annotation of protein sequence features.

7. **Report generation:** Making presentations of results. Placing analysis in biological context, Limits of analysis.

Semester II

CBIO29C - Lab-Database Management Systems

Exercise in DBMS (MYSQL)

Data Definition Language (DDL) statements:

Creating database, Selecting database, Deleting database, Creating table, Modifying Table, Deleting table

Data Manipulation statements:

Inserting, updating and deleting records

Retrieving Records

Retrieving specific rows and columns

Use of MySQL operators – Arithmetic operators, ComparisonOperators, Logical operators

Math functions, Aggregate functions

String operations

Limiting, Sorting and grouping query results

Handling null values

Renaming or aliasing table and column names

Using subqueries

Using Joins – joining a table to itself, joining multiple tables

Use of Indexes

Security Management

Granting and Revoking rights on tables

Semester III

Core – CBI031C - Immunology & Pharmacology

Unit 1: Introduction and Antibodies: Innate and acquired immunity, active and passive immunity, natural and artificial immunity. Lymphoid system- primary or secondary organ .Cells- Lymphocytes, mononuclear, phagocytes, antigen presenting, polymorphs, mast cells, cluster designation (CD) and antigen specific receptors – Principles and its uses.

Unit 2: Antibody generation – structure and function – clonal selection theory-different types of immunoglobulins, effectors, receptors and antibody diversity. Major Histochemical molecules/peptide complexes – Structure, Function and production of MHC Locus in Mice and Human. T-lymphocytes and cytokine network, receptors, production from TH1 and TH2 CD4+ T- cells.

Unit 3: Antigen and antibody reaction/interaction- Haemagglutination, direct and indirect immunofluroescence, hybridoma technology for mass production. Vaccine design, reverse vaccinology and immunoinformatics, databases in immunology, prediction methods-B-cell and T-cell resources to study antibodies. Introduction to GLP and its principles. Development of vaccines.DNA, Plant and protein based-receombinant antigens as vaccines.

Unit 4: Pharmacology - Introduction and Receptors: Introduction – principles-Pharmacokinetics and pharmacodynamics and Drug Metabolism, Adsorption, distribution and fate of drugs. General pathways of metabolism of drugs. Drug interactions, properties of metabolizing reactions with specific examples. how drugs work, characterization of receptors including dose-response relationships, agonists and antagonists.

Unit 5: Chemotherapy: Antibiotics- antibacterial – antiviral and anticancer-types and mechanism of action with one example-Detoxification and poisoning and Drug discovery and approval. Role of bioinformatics in drug design. Target identification and validation, lead optimization and drug design. Structure based drug design and ligand based design. Modeling of target small molecular interactions.

Text Books:

1. Thomas J.Kindt Richard A. Barabara A Janis . Kuby Immunology (2006) W.H.Freeman &Co ISBN -10 0716767643
2. H. P. Rang, M. Maureen Dale. Pharmacology (2007). Publisher: Churchill Livingstone, ISBN 0443069115, 9780443069116

Reference Books:

1. Roitt Immunology (2001) Mosby Publishers ISBN 0723431892, 9780723431893
2. Mary Julia Mycek, Richard A.Harvey, Richard A.Harvey Pamela C.Champe Pharamacology Lippincott's illustrative reviews, (1997) Lippincott-Raven ISBN 978039751567

Semester III

Core – CBIO32C - Data Mining and Machine Learning

Unit 1: Introduction: Introduction, Importance of Data Mining, Relational Databases, Data Warehouses, Transactional Databases, Advance Database Systems and Applications, Data Mining Functionalities, Classification of Data Mining Systems, Major issues in Data Mining.

Unit 2 : Primitives and System Architectures: Data Mining Primitives, Data Mining Query Language, Designing Graphical User, Interfaces Based on a Data Mining Query Language, Architectures of Data Mining Systems.

Unit 3: Concept Description and Association Rules: Concept Description, Characterization and comparison, Data Generalization and Summarization-Based Characterization, Analytical Characterization, Mining Class Comparisons, Mining Association Rules in Large Databases, Association Rule Mining, Mining Single-Dimensional Boolean Association Rules from Transactional Databases.

Unit 4: Classification and Prediction: Classification and Prediction, Issues: Data preparation for classification and Prediction, Comparing classification Methods, Classification by Decision Tree Induction: Decision Trees and Decision Tress induction

Unit 5: Clustering Methods: Clustering Analysis, Types data in clustering analysis: Scaled variable, Binary variables, Variables of Mixed Types, Partitioning Methods: K-means and K-Medoids, Model-Based Methods, Data Mining Applications: Data mining for Biomedical and DNA Data Analysis.

Text Books:

1. Data Mining Concepts and Techniques – Jiawei Hen, Micheline Kambler, 2006, Academic press Morgan kaufman Publishers. ISBN 1558609016.

Reference Books:

1. Data Mining: Practical machine learning tools Techniques with java implementation by Ian H.Witten, Eibe Frank, 2005, ISBN 1-55864-552-5
2. Machine Learning and data mining in pattern recognition in third International conference MLDM, by Petra Perner and Azriel Rosenfield, 2003, Springer ISBN 0302-9743

Semester III

Core – CBIO33C - Advanced Programming Language

Unit 1: **Programming in C++:** Object Oriented Concept: Encapsulation, Inheritance, Polymorphism – Different forms of Constructor – Destructor – Abstract class – Virtual function

Unit 2: **Core Java:** Introduction to Java: Data types, Variables, Expressions, Declarations, Statements, Control Structures – Arrays – String handling – Constructors – Methods – Classes – Objects – Packages – Interfaces – Exception handling – Event handling.

Unit 3: Multithreaded Programming – Java Thread Model: Priorities, Synchronization, Messaging, Creating Thread – Creating Multiple Threads, Inter thread Communication, Suspending, Resuming and Stopping threads, Multithreading, Synchronization and Priority of Threads.

Unit 4: AWT & Event Handling in java – Creating user interface with AWT – Applets, Applet Life Cycle, Simple Graphics, Fonts and Colors, Events, Listeners, Components, Containers, Working with Layouts and Images.

Unit 5: **Bioperl and Python:** Bioperl: Installation, architecture and uses. Python: Introduction –Data Types, Variables – Conditional and Looping statements – String handling – Functions – Tuples and Sequences – Sets – Dictionaries – Modules – Packages – Errors and Exceptions – Classes –Regular Expression.

Text Books:

1. Object Oriented Programming using C++ (4th Ed.) by Lafore, R., 2002, Sams Publishers.
2. Herbertz Schildt, "Java2 The Complete Reference 5th Edition", TMH, 2002.
3. Learning Python (4th Ed, 2010) by Mark Lutz

Reference Books:

1. Bioinformatics Programming using Python (1st Ed, 2009) by Mitchell L Model
2. www.bioperl.org/wiki/BioPerl_Tutorial

Semester III

Core – CBIO34C - Molecular Modeling and Molecular dynamics

Unit 1: Computational Chemistry-concepts of computational chemistry-Born-Oppenheimer approximations, Application of Hartree-Fock equations to molecular systems, approximate molecular orbital theories, semi-empirical methods. Macro-molecular force fields, solvation, long range forces.

Unit 2: Molecular Mechanics: general features, bond stretching, angle bending, improper torsions, out of plane bending, cross terms, non-bonded interactions, Ramachandran diagram point charges, calculation of atomic charges, polarization, van der waals interactions, hydrogen bond interactions, Water models, Force field, all atoms force field and united atom force field.

Unit 3: Energy minimization: Steepest descent, conjugate gradient – Derivatives, First order steepest decent and conjugate gradients. Second order derivatives Newton-Raphson, Minima, maxima saddle points and convergence criteria.-non derivatives minimization methods, the simplex, sequential univariative.

Unit 4 : **Simulation methods :** Newton's equation of motion, equilibrium point, radial distribution function, pair correlation functions, MD methodology, periodic box, Solvent access, Equilibration, cutoffs, algorithm for time dependence; leapfrog algorithm, Verlet algorithm, Boltzmann velocity, time steps, duration of the MD run, Starting structure, analysis of MD job, uses in drug designing, ligand protein interactions. Various methods of MD, Monte Carlo, systematic and random search methods. Differences between MD and MC, Energy, Pressure, Temperature, Temperature dynamics, simulation softwares. Various methods of MD, Monte Carlo, systematic and random search methods.

Unit 5:Docking and Drug design : Discovery and design of new drugs, computer representation of molecules, 3d database searching, conformation searches, derving and using the 3d Pharmacophore,- keys constrained systematic search, clique detection techniques, maximum likelihood method, molecular docking, scoring functions, structure based *de novo* Ligand design, quantitiative structure activity relationship QSAR, QSPRs methodology, various descriptors quantum chemical. use of genetic algorthims, Neural Network and Principle components analysis in QSAR equations. combinatorial libraries, design of "Drug like" libraries.

Text Books:

1. Andrew R.Leach, Molecular Modelling Principles and applications. (2001) II edition, Prentice Hall.

Reference Books :

1. Molecular Modeling and Simulation – An interdisciplinary Guide by Tamar Schlick, 2000, Springer-verlag
2. Fenniri, H. "Combinatorial Chemistry – A practical approach",(2000) Oxford University Press, UK.
3. Lednicer, D. "Strategies for Organic Drug Discovery Synthesis and Design"; (1998) Wiley International Publishers.
4. Gordon, E.M. and Kerwin, J.F "Combinatorial chemistry and molecular diversity in drug discovery" (1998) Wiley-Liss Publishers.

Semester III

Elective – CBIO35E-Genomics and Proteomics

Unit 1: **Genomics and Metagenomics:** Genome data bases of Plants, animals and Pathogens; Gene networks: basic concepts on identification of disease genes, drought stress response genes, insect resistant genes and nutrition enhancing genes.

Unit 2: **Epigenetics:** DNA microarray: database and basic tools, Gene Expression Omnibus (GEO), ArrayExpress, SAGE databases DNA microarray: understanding of microarray data, normalizing microarray data, detecting differential gene expression, correlation of gene expression data to biological process and computational analysis tools (especially clustering approaches)

Unit 3: **Comparative genomics:** Basic concepts and applications, whole genome alignments: understanding the significance; Artemis, BLAST2, MegaBlast algorithms, PipMaker, AVID, Vista, MUMmer, applications of suffix tree in comparative genomics, synteny and gene order comparisons Comparative genomics databases: COG, VOG

Unit 4: 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. Gene/Protein function prediction using Machine learning tools viz. Neural network, SVM etc

Unit 5: Proteomics: Protein arrays: basic principles. Computational methods for identification of polypeptides from mass spectrometry. Protein arrays: bioinformatics-based tools for analysis of proteomics data (Tools available at ExPASy Proteomics server); databases (such as InterPro) and analysis tools. Protein-protein interactions: databases such as DIP, PPI server and tools for analysis of protein-protein interactions

Text Books:

1. Principles of Genome Analysis and Genomics (3rd Ed.) by Primrose, S.B. and Twyman, R.M., 2003, Blackwell Publishing Company, Oxford, UK.
2. Introduction to proteomics – Tools for the new biology (1st Ed.) by Liebler, D.C., 2002, Human Press Inc., New Jersey, USA.

Reference Books:

1. Bioinformatics: Sequence and Genome Analysis by Mount, D., 2004, Cold Spring Harbor Laboratory Press, New York.
2. Bioinformatics and Functional Genomics by Pevsner, J., 2003, John Wiley and Sons, New Jersey, USA.

Semester III

Elective-CBIO36E – Molecular Transport Physiology

Unit I:
Membrane components and structures; membrane transport – diffusion, osmosis, passive & active transport. Endocytosis & Exocytosis.

Unit II:
Transport across biological membranes – active transport, career proteins, Na+ Ka+ pump, ATPase, ABC transporters, Ion channels.

Unit III:
Interaction and regulation of cell signaling pathways: Protein Kinases: cAMP-dependent Protein Kinase; Serine/Threonine Phosphatases; Protein Kinase C; Calcium/Calmodulin-dependent Protein Kinase.

Unit IV:
Computational analysis of transport proteins; Structure and dynamics of motor proteins; Vesicular trafficking.

Unit V:
Molecular transport physiology of nutrients under pathological processes.

Reference Books

1. Cell biology and membrane transport processes by Michael Caplan. Current topics in membranes V41, 1994. Academic Press, Inc. California, USA.
2. Molecular Biology of the Cell, 4th edition. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. New York, 2002.
3. Molecular biology of membrane transport disorders By Stanley G Schultz, Thomas E. Andreoli, Arthur M. Brown, Douglas M. Fambrough, Joseph F. Hoffman and Michael J. Welsh, 1980.
4. Biochemistry of Signal Transduction and regulation. 4th edition. Gerhard Krauss. Wiley-VCH Verlag GmbH & Co, 2008.

Semester III

Lab - CBIO37C - Advanced Programming Language

1. Reading/Writing Protein/DNA sequences in files.
2. Mutation and randomization in *Bioperl*.
3. DNA manipulation: Transcription DNA to RNA, Reverse complementing.
4. Passing Data to Subroutines
5. Local and Global alignment of sequences
6. Java Applets Basics, Graphics, Fonts and Color.
7. Simple Animation and Threads.
8. Creating simple JAVA graphical user interface

Semester III

Lab-CBIO38C-Molecular Modeling and Molecular Dynamics

Exercises

1. Advanced Visualization Softwares.
2. Secondary Structure Prediction and validation.
3. Homology modeling.
4. Molecular mechanics - Geometry optimization.
5. Protein Structure Alignment.
6. Structure based Drug Design.
7. Ligand based Drug Design.
8. Molecular Dynamics.
9. Binding Site Identification.

Semester – IV

CBIO 41C - Project

The course is designed to result in the satisfactory completion and defense of the Masters dissertation.

This process includes
a) the conceptualization of the independent research that will comprise the dissertation,
b) the preparation of and satisfactory defense of the dissertation proposal,
c) the collection, analysis, and interpretation of data,
d) presentation of findings in the dissertation format, and
e) oral defense of the dissertation.

Dissertation activity must be completed within prescribed time frame for the semester.

Semester IV

Elective-CBIO42E - Systems Biology

Unit 1

Introduction: Systems Biology Networks- basics of computer networks, Biological uses and Integration. Microarray – definition, Applications of Micro Arrays in systems biology. Self-organizing maps and Connectivity maps - definition and its uses. Networks and Pathways – Types and methods. Metabolic networks.

Unit 2

Simulation of pathways: Whole cell: Principle and levels of simulation – Virtual Erythrocytes. Pathological analysis. Flux Balance Analysis. Biochemical metabolic pathways, Metabolomics and enzymes. Interconnection of pathways, metabolic regulation. Translating biochemical networks into linear algebra. Cellular models.

Networks and Motifs: Gene Networks: basic concepts, computational models. Lambda receptor and lac operon as an example - all types of networks and its uses.

Unit 3

Signalling & Experimental methods in systems biology: slow and auto–regulation The coherent FFL-temporal order, FIFO, DOR, Global, Development, memory and irreversibility- signaling networks and neuron circuits-robust adaptation–any model.

Robustness and optimality in Biology: model and integral feedback-signaling/bifunctional enzymes. Perfect robustness- Role and its measurement. Linking models and measurement, concepts, calibration and identification, data Vs meta data.

Unit 4

Design of Circuits and Databases: Introduction- databases KEGG, EMP, MetaCyc, AraCyc etc., Expression databases and various databases related to systems biology. Optional design of gene circuits I-cost and benefit: gene circuits II- selection of regulation. Stochasticity in gene expression.

Unit 5

Synthetic Biology:

Introduction, definition and Basics, Synthetic Oligonucleotide/DNA-based, RNA-based, Peptide-based and polyketide Technologies and Applications, Technologies and Applications of Directed Evolution and Microbial Engineering, Potential Hazards of Synthetic Biology.

Text Books:

1. Systems Biology: Definitions and perspectives by L.Alberghina H.V.westerhoff, 2005, Springer.
2. Synthetic Biology, A New Paradigm for Biological Discovery, a report by Beachhead Consulting, 2006.

Reference Books:

1. Computational systems biology by A.Kriete, R.Eils, 2005, Academic press.
2. Systems Biology in practice: Concepts, Implementation and applications by E.Klipp R.Herwig, A.Kowlad, C.Wierling and H.Lehrach, 2005, Wiley InterScience.
3. Systems Biology and Synthetic Biology by Pengcheng Fu, Sven Panke, 2009, Wiley InterScience

Semester IV

Elective-CBIO43E – Immunotechnology

Unit -I

Antigen recognition by B and T cell development. Innate immunity and hunoral and cell mediated immunity. Immune response to infection. Th1 and Th2 paradigm. Cytokines in immunity.

Unit -II

Genetic control of immune response. HLA typing. MHC associated predisposition to disease.

Unit -III

Principles and strategies for developing vaccines. Newer methods if vaccine development. T-cell vaccines. Immunodiagnostics of diseases.

Unit -IV

Hybridoma technology and monoclonal antibody production. Application of monoclonal antibodies and their uses.

Unit -V

Immune system in health and disease. Tumor immunology. Transplantation.

References:

1. Antibody Engineering, B.K.C. Lo, Humana Press.
2. Immunobiology, Janeway et al. Current biology publications.
3. Fundamental Immunology, Paul. Lippincott Raven
4. Monoclonal Antibodies. Goding, Academic Press.
5. Immunology. Kuby 6th Edison.