M. Sc. COMPUTATIONAL BIOLOGY

REGULATIONS AND SYLLABI

(Effective from 2010-2011)

Centre for Bioinformatics
SCHOOL OF LIFE SCIENCES
PONDICHERRY UNIVERSITY
PUDUCHERRY

Eligibility for M. Sc. Computational Biology

Students from any of the below listed Bachelor degrees with minimum 55% of marks are eligible.

1. B. Sc. Bioinformatics
   B. Sc. Physics
   B. Sc. Chemistry
   B. Sc. Mathematics

2. B. Sc. Biotechnology
   B. Sc. Biochemistry
   B. Sc. Microbiology
   B. Sc. Plant Biology and Biotechnology / Botany
   B. Sc. Animal Biology and Biotechnology / Zoology

   With Mathematics at +2 level Compulsory

3. B. Tech. Bioinformatics
   B. Tech. Biotechnology
   B. Tech. Industrial Biotechnology
   B. Tech. Pharmaceutical Technology
   B. Tech. Food Technology
   B. Tech. Chemical Engineering

4. B. E. Information Technology
   B. E. Computer Science and Engineering
   B. E. Electrical and Electronics Engineering
   B. E. Electronics and Instrumentation
   B. E. Electronics and Communication Engineering
   B. E. Mechanical Engineering
   B. E. Biomedical Engineering

PONDICHERRY UNIVERSITY
SCHOOL OF LIFE SCIENCES

Centre for Bioinformatics

SYLLABUS FOR M. Sc. Computational Biology

(Academic Year 2010-2011 onwards)

CBIO 401 - Cell and Molecular Biology

Total Credits: 3 **Total: 36 Hrs.**

Unit 1 **6 Lectures**

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

Unit 2 **7 Lectures**

Mitochondrial Structure and Function – Oxidative Metabolism in the Mitochondrion – The Role of Mitochondria in the formation of ATP – Translocation of Protons and the Establishment of a proton-motive force – The Machinery for ATP formation – Peroxisomes.

Unit 3 **7 Lectures**

Chloroplast structure and function – An overview of photosynthetic Metabolism – The absorption of light – Photosynthetic units and reaction centers – Photophosphorylation – Carbondioxide fixation and the synthesis of carbohydrates

Unit 4 **7 Lectures**

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 **9 Lectures**

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 (8^{th} Ed.) by Lewin, B, 2004, Pearson Education International.
2. Cell and Molecular Biology by De Robertes and De Robertis, 2002, Saunders College, Philadelphia, USA.

CBIO 402 – Biochemistry

Total Credits: 3 **Total: 36 Hrs.**

Unit 1 **8 lectures**

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 **7 lectures**

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 cycIe, breakdown of amino acids, amino acid biosynthesis, heme biosynthesis and degradation, chemical synthesis of peptides, oligonucleotides and oligosachharides.

Unit 3 **7 lectures**

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

Unit 4 **7 lectures**

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

Unit 5 **7 lectures**

Synthesis of purine ribonucleotides, synthesis of pyrimidiine 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.

CBIO 403 - Probability and Statistics

Total Credits: 3 **Total: 36 Hrs.**

Unit 1 **7 Lectures**

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 **7 Lectures**

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 **7 Lectures**

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 **7 Lectures**

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 **8 Lectures**

Test of Hypothesis of Small and Large Samples: Standard Normal distribution, Chi-square distribution, Student's t distribution, F distribution, Analysis of Variance

Text Books:

1. Biostatistics (9^{th} Ed.) by Wayne W. Daniel, 2004, Wiley ISBN: 978-0-471-45654-4
2. Schaum's Outlines - Introduction to Probability and Statistics by Seymour Lipschutz and John Schiller, 1998, TATA McGraw-Hill edition.

Reference Books:

1. Statistical Methods by N. G. Das, Vol: I and II, 2009, The McGraw-Hill Companies
2. Fundamentals of Biostatistics (6^{th} Ed.), Bernard Rosner, 2006, Thomson Brooks/Cole ISBN: 0-534- 41820-1

CBIO 404 - Communication Skills for Science and Technology

Total Credits: 3 **Total: 36 Hrs.**

Unit 1 **7 Lectures**

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 **5 Lectures**

Barriers to Communication: Definition of Noise, Classification of Barriers

Unit 3 **7 Lectures**

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

Unit 4 **9 Lectures**

Written Communication

Letter, Memos and E-mails/ discussion groups, Business Letters, Memos

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

Writing Journal Articles: Word choice and Syntax style, Number use, References, Plagiarism

Unit 5 **8 Lectures**

Technical Proposal and Thesis Writing Methodology

Reference Books:

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

CBIO 405 - Analytical Methods in Biotechnology

Total Credits: 3 **Total: 36 Hrs.**

Unit 1 **7 Lectures**

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 **8 Lectures**

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 **7 Lectures**

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

Unit 4 **7 Lectures**

Electroanalytical Techniques: Principles and applications of Potentiometry, Coulometry, Voltametry

Biochemical Techniques: Estimation of Carbohydrates, Lipids, Proteins, Nucleic Acids

Unit 5 **7 Lectures**

Sequencing methods: Basic DNA sequencing: Maxam-Gilbert method, Sanger method, Pyrosequencing, automated DNA sequencing, DNA sequencing by capillary array and electrophoresis. RNA sequencing, Protein sequencing: Edman degradation, Peptide mass fingerprinting, Mass spectrometry, Protease digests. Genome sequencing: High-throughput sequencing, shot-gun sequencing.

Reference Books:

1. Instrumental Analysis by Skoog, Holler, Crouch, 2007, Brooks/Cole, ISBN-13: 978-81-315- 0542-7.
2. Introduction to Instrumental Analysis by Robert D. Braun, 2006, Pharma Book Syndicate. ISBN 891- 88449-15-6
3. Genome (2nd Ed.) by, T.A Brown, 2002, BIOS Scientific Publishers Ltd.

CBIO 406 - Programming Language - Introduction to C and PERL

Total Credits: 3 **Total: 36 Hrs.**

Unit 1 **7 lectures**

Introduction to programming languages:

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

Unit 2 **9 lectures**

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 **7 lectures**

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 **6 lectures**

Object Oriented Programming:

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

Unit 5 **7 lectures**

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 – stat and lstat Functions – Perl Modules

Text Books:

1. Programming in ANSI C (4th Ed.) by E. Balagurusamy, 2007, Tata McGrawHill Publishing Company Limited.

Reference Books:

1. Object Oriented Programming using C++ (4th Ed.) by Lafore, R., 2002, Sams Publishers
2. Beginning PERL for Bioinformatics by James Tisdall, 2001, O'Reilly publications

CBIO 407 - General Biology

Total Credits: 2 **Total: 24 Hrs.**

Unit 1 **4 Lectures**

Diversity in Living World: Diversity of living organisms-Classification of the living organisms (five kingdom classification, major groups and principles of classification within each kingdom). Systematics and binomial System of nomenclature - Salient features of animal (non-chordates up to phylum level and chordates up to class level) and plant (major groups; Angiosperms up to class) classification, viruses, viroids, lichens Botanical gardens, herbaria, zoological parks and museums.

Unit 2 **4 Lectures**

Structural Organisation in Animals and Plants : Tissues in animals and plants. Morphology, anatomy and functions of different parts of flowering plants: Root, stem, leaf, inflorescence, flower, fruit and seed. Morphology, anatomy and functions of different systems of an annelid (earthworm), an insect (cockroach) and an amphibian (frog).

Unit 3 **5 Lectures**

Cell: Structure and Function: Cell: Discovery of the cells - Cell theory; Prokaryotic and eukaryotic cell, cell wall, cell membrane and cell organelles' (plastids, mitochondria, endoplasmic reticulum, Golgi bodies/dictyosomes, ribosomes, lysosomes, vacuoles, centrioles) and nuclear organization. Mitosis, meiosis, cell cycle.Basic chemical constituents of living bodies.Structure and functions of carbohydrates, proteins, lipids and nucleic acids.Enzymes: types, properties and function.

Unit 4 **6 Lectures**

Genetics and Evolution: 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 and RNA, search for genetic material, replication, transcription, genetic code, translation. Gene expression and regulation. Genome and Human Genome Project. DNA fingerprinting. Evolution: Origin of life, theories and evidences, adaptive radiation, mechanism of Evolution, origin and evolution of man.

Unit 5 **5 Lectures**

Methods in Biology: Light Microscope – Transmission Electron Microscopy – Scanning Electron and Atomic Force Microscopy – Fractionation of Cell contents by Differential Centrifugation – Purification of Nucleic Acids – Enzymatic amplification of DNA by PCR – DNA Sequencing.

Text Books:

1. Molecular Biology of the cell (4^{th} Ed.) by Bruce Alberts, 2002, Garland publishing Inc.

Reference Books:

1. Cell - A molecular approach (2^{nd} Ed.) by Cooper. G. M., 2000, Oxford University Press.
2. Cell and Molecular Biology by De Robertes and De Robertis, 2002, Saunders College, Philadelphia, USA.

CBIO 408 - General Mathematics

Total Credits: 2 **Total: 24 Hrs.**

Unit I **4 lectures**

Determinants and Matrices- Properties of Determinants, Minors and Cofactors, Multiplication of Determinants, Adjoint, Reciprocal, Symmetric Determinants, Cramer's rule, Different types of matrices, Matrix Operations, Transpose of a matrix, Adjoint of a square matrix, Inverse of a matrix, Eigen values and eigen vector

Unit II **4 lectures**

Vector Analysis: The concept of a Vector, Vector addition and subtraction, Products of two vectors-Dot product and Cross product, Products of three vectors- scalar triple product and vector triple product, Gradient, Divergence and Curl.

Unit III **5 lectures**

Trigonometry and Analytical Geometry: Trigonometric ratios, De Moivre's theorem, The general equation of a Straight line, slope of a line, intercepts of a line, Angle between two lines, Intersection of two lines, The general equation of a Circle.

Unit IV **6 lectures**

Calculus: Differential Calculus- Derivative of a function, Concept of limit, Continuity, Differentiation, Maxima and Minima of a function, Introduction to Partial Differentiation, Integral Calculus: The Idea of the Integral, The Definite Integrals, Indefinite Integrals.

Unit 5 **5 lectures**

Numerical Methods: Solution of algebraic and transcendental equations: Bisection method, Method of false position / Regula-falsi method, Newton-Raphson method, Approximate solution of equations - Horners' method

Text Books:

1. Algebra (3rd Ed.) by Serge A. Lang, 2003, Pearson education.
2. Introduction to Calculus & Analysis, Vol I and II by Richard Courant & Fritz John, 1999, Springer publisher.
3. Trignometry, Algebra and Calculus (3rd Ed.) by Veerarajan, T., 2003, Tata McGraw Hill Publishing Co. Ltd, New Delhi.

Reference Books:

1. Basic mathematics by Serge A. Lang, 1988, Springer publisher
2. A First Course in Calculus by Serge A. Lang, 1986, Springer publisher
3. Higher Engineering Mathematics (40th Ed.) by B.S. Grewal and J.S. Grewal, 2007, Khanna Publishers, New Delhi.

CBIO 451 - Lab Analytical Techniques in Biotechnology Laboratory

Total Credits : 1

1. Visible Spectroscopy – Verification of Beer Lambert's law for $KmnO_4$
2. UV spectra of nucleic acids
3. Fluorescence Spectroscopy for tetra phenyl Porphyrin
4. Optical Microscopy – Gram's Staining
5. Fluorescence Microscopy – Using Tetra phenyl sulphanato porphyrin
6. Atomic Force Microscopy - Demonstration
7. HPLC - Demonstration
8. Thin Layer Chromatography - Separation of Chlorophyll
9. Interpretation of NMR, Mass spec and FTIR data
10. Voltametry – Demonstration

CBIO 452 - Lab - Programming Language - Introduction to C and PERL

Total Credits : 1

LINUX Operating System: Overview of Linux Architecture, Installation, Booting and Shutdown Process, System Processes(an overview), User Management- Types of users, Creating Users, Granting Rights, File System management

C

1. Working with C tokens
2. Program that illustrate operator precedence
3. Sample program for Switch – case construct
4. Sample program for looping construct
5. Program for creating user defined function
6. Program for passing pointer in a function
7. Program for String Handling (Sequence alignment , Pattern match)
8. Sorting and Binary search
9. Read and write a sequence in a file

C++

1. Create a class which shows the various form of constructors
2. Implement any one form of Inheritance
3. Implement static and dynamic Polymorphism

PERL

1. Read and Print Matrix
2. Program to find the longest sequence
3. Implementing complex data structure
4. Procedure creation example
5. Reading / Writing Protein / DNA sequences in files.

CBIO 421 - Algorithms in Computational Biology

Total Credits: 3 **Total: 36 Hrs.**

Unit 1 **7 Lectures**

Introduction: Algorithm design paradigms, algorithm efficiency, run time analysis, asymptotic notations: big O, omega, theta. Greedy Method: Overview, examples & analysis of algorithms, optimization problems, minimum cost spanning tree, approximation problem, Knapsack, single source shortest path, prims algorithm, Kruskal's algorithm. Huffman tree. Greedy method in Computational Biology applications- genome rearrangement, sorting by reversal, motif finding.

Unit 2 **8 Lectures**

Decrease and Conquer: Overview and structure, examples- depth first search, breadth first search, insertion sort, generating permutations, topological sorting. Divide and Conquer- Overview and structure, examples- binary search, quick sort, Strassen matrix multiplication, recurrence relation. Computational Biology applications – space efficient sequence alignment, block alignment. Expectation and Maximation (EM) with forward and backward algorithms, discriminative learning, Knuth-Morris- Pratt and Boyer-Moore algorthim for exact match

Unit 3 **7 Lectures**

Transform and Conquer: Overview and structure, examples –pre-sorting, hashing- separate chaining, closed addressing- merge sort. **Dynamic Programming** - Overview and structure, examples, shortest path, Dynamic Programming in Computational Biology applications – longest common sub-sequence, local and global alignment, scoring alignment, gap penalty, gene prediction, and statistical approaches in gene prediction

Unit 4 **9 Lectures**

Hidden Markov Models: Markov processes and Markov Models, Hidden Markov Models, 3 basic HMM problems & corresponding algorithms – Application in bioinformatics

Artificial Neural Networks: Historic evolution – Perceptron, Features of NNs, Disadvantages; supervised and unsupervised networks, Back Propagation Algorithm (Derivation not required), Learning & Momentum Parameters, selecting Hidden modes, Training & Testing, ANN applications bioinformatics, overview of Support Vector Machines. **Bayesian network:** Definitions and concepts, Causal networks, Inference and learning: Inferring unobserved variables, Parameter learning, Structure learning

Unit 5 **5 Lectures**

Clustering and Trees: Hierarchical Clustering, k-Means Clustering, Evolutionary Trees and Hierarchical Clustering, Reconstructing Trees from Additive Matrices, Distance-Based Tree Reconstruction, Character-Based Tree Reconstruction, Small and large Parsimony Problem. **Genetic Algorithm:** Basic Concepts, Reproduction, Cross over, Mutation, Fitness Value, Optimization using GAs; Applications in bioinformatics

Text Books:

1. An introduction to bioinformatics algorithms by Neil C. Jones, Pavel Pevzner, 2004, MIT Press
2. Fundamentals of Computer Algorithms by Horowitz, S. Sahini, and Rajasekharan, 1984, Galgotia Publications

Reference Books:

1. Bioinformatics: the machine learning approach by Pierre Baldi, Søren Brunak, 2001, MIT Press
2. Probabilistic Methods for Bioinformatics: With an Introduction to Bayesian Networks by Richard E. Neapolitan, 2009, Morgan Kaufmann Publishers
3. Hand book for Hidden Markov model for Bioinformatics by Martin Gollery, 2008, CPC Press.

CBIO 422 - Sequence Analysis

Total Credits: 3 **Total: 36 Hrs.**

Unit 1 **7 Lectures**

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 **8 Lectures**

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 **6 Lectures**

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

Unit 4 **8 Lectures**

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 **7 Lectures**

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

Reference Books:

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

CBIO 423 - Database Management Systems

Total Credits: 3 **Total: 36 Hrs.**

Unit 1 **7 Lectures**

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 **7 Lectures**

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 **6 Lectures**

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 **8 Lectures**

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 **8 Lectures**

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

Text Books:

1. Database system Concepts (4th 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.

CBIO 424 - Molecular Evolution

Total Credits: 3 **Total: 36 Hrs.**

Unit 1 **6 Lectures**

History of evolution of life on earth: elements, molecules to species. Mendelian inhereitance. Hardy-Weinberg equilibrium: stability of gene (allele) frequencies under five conditions. Evolution of DNA, RNA and proteins, origin of the genetic code: chemical basis of evolution.

Unit 2 **10 Lectures**

Evolutionary change by mutation, gene flow, genetic drift, natural selection and non-random mating. Role of gene duplication, transitions and transversions- chromosomal deletions and insertions, in evolution. Role of repetitive DNA, transposable elements and junk DNA in evolution. Homology of proteins and DNA in evolution. Sequence clustering algorithms and software packages like UCLUST.

Unit 3 **10 Lectures**

Theoretical aspects: Darwin Wallace theory of evolution by natural selection, Neutral theory of molecular evolution (Kimura). Role of Mutation in evolution. Divergence rates as a function of heterozygosity and gene functionality. Computation of phyogenetic trees using distance matrix models: Fitch-Margoliash method, the Maximum Parsimony method, Maximum likelihood and Bayesian inference.

Unit 4 **6 Lectures**

The concept of the Molecular Clock. Calibration. Limitation of molecular clock models. Human molecular clock: deducing evolutionary histories through mitrochondrial DNA and Y chromosome.

Unit 5 **4 Lectures**

Evolution of the genome: Genomic sequencing and mapping: Genome databases Human Genome Project.

Reference Books:

1) Molecular Evolution by Wen Hsiung-Li, 1997, Sinauer Associates, Sunderland, MA. ISBN 0878934634.
2) Evolution (3rd Edition) by Ridley, M., 2004, Blackwell Science. ISBN 1-4051-0345-0

CBIO 425 - Structural Biology

Total Credits: 3 **Total: 36 Hrs.**

Unit 1 **7 Lectures**

Basic structural principles, building blocks of proteins, motifs of protein structures, alpha domain structures, alpha/beta structures, Macromolecular crystallography-concepts

Unit2 **7 Lectures**

DNA structures, DNA recognition in prokaryotes and eukaryotes, specific transcription factors, enzyme catalysis and structure. Membrane proteins, signal transduction, proteins of the immune system. Structure of Spherical viruses.

Unit 3 **7 Lectures**

Folding and flexibility, Prediction, engineering and design of protein structures. Methods to identify secondary structural elements

Unit 4 **8 Lectures**

Determination of protein structures by X-ray and NMR methods. Prediction of secondary structure- PHD and PSI-PRED methods. Tertiary Structure: homology modeling, fold recognition and ab-initio approaches. Structures of oligomeric proteins and study of interaction interfaces.

Unit 5 **7 Lectures**

In silico study of biological structures. Structural genomics- concepts and significance. Structural databases**.**

Reference Books:

1. Protein structure, stability and folding Ed KP.Murphy, 2001, Humana press.
2. Introduction to protein architexcture Arthur M.Lesk, 2001, Oxford University Press.
3. Introduction to Macromolecular Crystallography- A. McPherson, 2003, John Wiley Publications.
4. Introduction to Protein Structure, Branden, Carl and Tooze, 1991, John Garland, Publication Inc.

CBIO 426 - Biodiversity and IPR

Total Credits: 2 **Total: 24 Hrs.**

Unit 1 **6 Lectures**

Introduction to biological diversity- What is biodiversity: genetic, species and ecosystem diversity. Conservation of biodiversity. National legal frameworks for biodiversity conservation: Wildlife Protection Act (1972). Types of protected area, landed trusts, community forests. Biodiversity inventories and monitoring. Introduction to software such as Distance, Estimate S to assess densities and species diversity. DNA barcoding for rapid assessment of genetic diversity.

Unit 2 **5 Lectures**

Biodiversity and species extinction: impact of deforestation, hunting, wildlife trade, diseases and climate change on species extinction. Case studies on Amazonian deforestation, amphibian extinction through diseases, REDD, CITES. IUCN Red lists and other legal framework for biodiversity conservation.

Unit 3 **4 Lectures**

Convention on biological diversity (CBD), Rio Summit, Intergovernmental Committee for the Cartagena Protocol on Biosafety (ICCP). Case study: has the CDB achieved its 2010 target.

Unit 4 **5 Lectures**

Laws and agreements :IPR- patents, trade secrets, copyrights, trademarks, choice-Plant genetic resources-Agreement – GATT (General Agreement on Tariffs and Trade) and TRIPS (Agreement on Trade-Related Aspects of Intellectual Property Rights)- Cooperation and implications -Patents of Higher plants, Transgenic organisms, Isolated genes and DNA sequences

Unit 5 **4 Lectures**

SUI-GENESIS system and its uses- -Plant variety protection and UPOV-Terminator technology for seed protection-Traitor technologies uses and implications.

Text Books:

1. Biodiversity and Conservation (2nd Ed) by Jeffries, M. J., 2006, Routledge. ISBN 0-415-34299-6/3
2. Conservation of Genetic Resources by Virchow, Detlef, 1999 Springer. ISBN: 3-540-65343-0.
3. Biodiversity, conservation law and livelihoods by Jeffrey, M. J., Firestone, J., Bubna-Litic, K., 2008, Cambridge University Press. ISBN 978-0-521-88503-4.

CBIO 427 - Biomedical Informatics

Total Credits: 2 **Total: 24 Hrs.**

Unit 1 **4 Lectures**

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

Unit 2 **5 Lectures**

Electonic 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 **5 Lectures**

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

Unit 4 **5 Lectures**

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

Unit 5 **5 Lectures**

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, datamining, policy design and law. Translation research and its uses and implications Evidence based medicines.

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. Evaluation methods in medical Informatics by Friedman CP. Wyatt JC, New York Springer Verlag, 1996, ISBN 0-387-25899-2.

CBIO 453 - Lab - Sequence Analysis

Total Credits : 1

Introduction to sequence analysis software.

Installation of EMBOSS, Use of EMBOSS and GCG, BioEdit, Public Domain Software. internet access to software and databases.

1. **Accessing Biological databases:**
2. Retrieving protein and nucleic acid sequences, structures, ESTsequences, SNP data and Biomedical information from databases, using database browsers and genome browsers. converting sequences between different formats. Using sequence editors. sequence assembly.
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 penalities-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.
7. **Integrating information :**
8. Report generation. Making presentations of results. Placing analysis in biological context, Limits of analysis.

CBIO 454 - Lab-Database Management Systems

Total Credits : 1

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, Comparison
Operators, 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

CBIO 501 - Immunology & Pharmacology

Total Credits: 3 **Total: 36 Hrs.**

Unit 1 **7 Lectures**

Introduction and Antibodies: Innate and acquired immunity, active and passive immunity, natural and artificial immunity and humoral. 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 **7 Lectures**

Antibody generation: structure and function –clonal selection theory-different types of immunoglobulins, effectors, receptors and antibody diversity. complement system-activation,pathways and biological effects. Major Histochemical molecules/peptide complexes- Structure and 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 **7 Lectures**

Antigen and antibody reaction/interaction: Haemagglutination, direct and indirect immunofluroescence, hybridoma technology for mass production. Vaccine design, reverse vaccinologyand immunoinformatics, databases in immunology, prediction methods-B-cell and T-cell resources to study antibodies,

Unit 4 **9 Lectures**

Introduction and Receptors: Pharmacology: 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,

Review of Receptor theory. Signal transduction theory, drug examples. Outline of autonomic nervous system. Receptor systems, second messengers and location/specificity of action of alpha and beta receptor systems in the autonomic nervous system. mechanism of action glycosides ,antiarrhythmic and antihypertensive drugs. classification systems for receptors.

Unit 5 **6 Lectures**

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.I ntroduction to GLP and its principles. Development of vaccines.DNA, Plant and protein based-receombinant antigens as vaccines. Reverse vaccinology and Immunoinformatics-principles and its uses.

Reference books:

1. Text book of Immunology by Kuby, 2008
2. Text book of Immunology by Riott, 2006
3. Text book of Immunology by Lippinncott, 2008, Lippinncott
4. Rang and Dale’s Pharamcology ed Churchill Livingstone, 2007,
5. Lippincott’s Illustrative Reviews of Pharmacology, 2009, Lippinncott

CBIO 502 - Data Mining and Machine Learning

Total Credits: 3 **Total: 36 Hrs.**

Unit 1

Introduction **7 lectures**

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 **7 lectures**

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 **7 lectures**

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 **7 lectures**

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 **8 lectures**

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

Reference Books:

1. Data Mining Concepts and Techniques – Jiawei Hen, Micheline Kambler, 2006, Academic press Morgan kaufman Publishers. ISBN 1558609016
2. Data Mining: Practical machine learning tools Techniques with java implementation by Ian H.Witten, Eibe Frank, 2005, ISBN 1-55864-552-5
3. Machine Learning and data mining in pattern recognition in third International conference MLDM, by Petra Perner and Azriel Rosenfield, 2003, Springer ISBN 0302-9743

CBIO 503 - Advanced Programming Language

Total Credits: 3 **Total: 36 Hrs.**

Unit 1 **7 Lectures**

Perl & Bioperl : Uses of Regular expressions: Patterns, Single-character Patterns, Grouping Patterns (Sequence, Multipliers, Parantheses as Memory, Alternation) Anchoring patterns, Precedence, Matching operators, Ignoring case, Different Delimiter, Split and Join functions– Bioperl: Installation, architecture and uses.

Unit 2 **6 Lectures**

Object Oriented Languague II:

Java Basics - Importance and features of java, Modifiers, Access Controls, Data types, Expressions, Declarations, Statements & Control Structures, Program Structures, String handling, Packages, Interfaces, Working with java util Package, Garbage Collection

Unit 3 **8 Lectures**

Exception Handling,I/O & JDBC – Exception Handling: built in exception, creating your own exceptions, Input Stream & Output Stream: Streams, Byte and Character stream, Predefined streams, Reading and Writing from Console and Files, Buffered Reader & Writer, Serialization, Database: JDBC Basics

Unit 4 **8 Lectures**

Multithreading and Communication – Java Thread Model: Priorities, Synchronization, Messaging, Life Cycle of Thread, Thread class, Runnable interface, Interthread Communication, Suspending, Resuming and Stopping threads, Multithreading, Synchronization, Scheduling and Priority of Threads.

Unit 5 **7 Lectures**

HTML: Introduction – Formatting tags for creating a web page

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, Image Processing, Delegation Event Model, Event Classes, Event Listener Interfaces, Adapter and Inner Classes

Reference Books:

1. Advanced Perl Programming by Sriram Srinivasan, O-Reilly, 1997
2. Patrick Naughton and Herbertz Schildt, “Java2 The Complete Reference”, TMH, 1999.

CBIO 504 - Molecular Modeling and Molecular dynamics

Total Credits: 3 **Total: 36 Hrs.**

Unit 1 **7 Lectures**

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

Unit 2 **7 Lectures**

Molecular Mechanics: general features, bond stretching, angle bending, improper torsions, out of plane bending, cross terms, non-bonded interactions, 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 **7 Lectures**

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

Unit 4 **8 Lectures**

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 **7 Lectures**

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 quations.combinatorial libraries, design of "Drug like" libraries.

Text Books:

1. Molecular Modelling Principles and applications (2n Ed.). Andrew.R.Leach, 2001. Prentice Hall.
2. Molecular Modeling and Simulation – An interdisciplinary Guide by Tamar Schlick, 2000, Springer-verlag

Reference Books

1. Strategies for Organic Drug Discovery Synthesis and Design by Lednicer, D., 1998, Wiley International Publishers.
2. Combinatorial chemistry and molecular diversity in drug discovery by Gordon, E.M. and Kerwin, J.F., 1998, Wiley-Liss Publishers.

CBIO 505 - Genomics and Proteomics

Total Credits: 2 **Total: 24 Hrs.**

Unit 1 **5 Lectures**

Genomics and Metagenomics: Large scale genome sequencing strategies. Genome assembly and annotation. Genome databases of Plants, animals and pathogens. **Metagenomics:** Gene networks: basic concepts, computational model such as Lambda receptor and lac operon. Prediction of genes, promoters, splice sites, regulatory regions: basic principles, application of methods to prokaryotic and eukaryotic genomes and interpretation of results. Basic concepts on identification of disease genes, role of bioinformatics-OMIM database, reference genome sequence, integrated genomic maps, gene expression profiling; identification of SNPs, SNP database (DbSNP). Role of SNP in Pharmacogenomics, SNP arrays. Basic concepts in identification of Drought stress response genes, insect resistant genes, nutrition enhancing genes

Unit 2 **5 Lectures**

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 **5 Lectures**

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 **5 Lectures**

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 **4 Lectures**

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.
3. Bioinformatics and Functional Genomics by Pevsner, J., 2003, John Wiley and Sons, New Jersey, USA.

Reference Books:

1. Bioinformatics: Sequence and Genome Analysis by Mount, D., 2004, Cold Spring Harbor Laboratory Press, New York.

CBIO 506 - Systems Biology

Total Credits: 2 **Total: 24 Hrs.**

Unit 1 **5 lectures**

Introduction: Systems Biology Networks- basics of computer networks, Biological uses and Integration. Micro array – 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 **5 lectures**

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 **5 lectures**

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 adapation–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 metadata

Unit 4 **4 lectures**

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 **5 lectures**

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

CBIO 551 - Lab: Advanced Programming Language

Total Credits : 1

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

CBIO 552 - LAB: Molecular Modeling and Molecular Dynamics

Total Credits : 1

Exercises

1. Advanced Visualization Software and 3D representations with VMD and Rasmol
2. Coordinate generations and inter-conversions.
3. Secondary Structure Prediction
4. Fold Recognition, *ab initio method*
5. Homology based comparative protein modeling.
6. Energy minimizations and optimization
7. Validation of models.
    a. WHATIF
    b. PROSA
    c. PROCHECK
    d. VERIFY 3D
8. Protein Structure Alignment.
9. Modeller
10. Structure based Drug Design
    a. Molecular Docking
    b. De Novo Ligand Design
    c. Virtual Screening
11. Ligand based Drug Design
    a. Pharmacophore Identification
    b. QSAR
12. Molecular Dynamics with Gromacs
13. Binding Site Identification

CBIO 521 - Project

Total Credits : 12

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.