Madurai Kamaraj University

M.Sc., Computational Biology- Regulations and Syllabi 2010 - 2011

Course Code Semester I	Course Title	C/E (Core/Elective)	Credits	Page No
CBI011C	Cell and Molecular Biology	C	4	
CBI012C	Biochemistry	C	4	
CBI013C	Probability and Statistics	C	4	
CBI014C	Communication Skills in Science and Technology	C	4	
CBI0 15C	Analytical Methods in Biotechnology	C	4	
CBI016E	General Biology (OR)	E	5	
CBI017E	General Mathematics	E	5	
Lab				
CBI018C	Analytical Methods in Biotechnology	C	1	
CBI019C	Programming Language	C	1	
Semester II				
CBI021C	Algorithms in Computational Biology	C	4	
CBI022C	Sequence Analysis	C	4	
CBI023C	Database Management Systems	C	4	
CBI024C	Molecular Evolution	C	4	
CBI025C	Structural Biology	C	4	
CBI026E	Biodiversity and IPR (OR)	E	5	
CBI027E	Biomedical Informatics	E	5	
Lab				
CBI028C	Sequence Analysis	E	2	
CBI029C	Database Management Systems	E	2	
Semester III				
CBI031C	Immunology and Pharmacology	C	4	
CBI032C	Data Mining and machine Learning	C	4	
CBI033C	Advanced Programming Language	C	4	
CBI034C	Molecular Modeling and Molecular Dynamics	C	4	
CBI035E	Genomics and Proteomics (OR)	E	5	
CBI036E	Systems Biology	E	5	
Lab				
CBI037C	Advanced Programming Language	C	2	
CBI038C	Molecular Modeling and Molecular Dynamics	C	2	
Semester IV				
CBI041C	Project Work	C	4	
	Total credits.		90	

Semester I

Core – CBI011C - Cell and Molecular Biology

Unit 1: **Cell organisation and the Cell Cycle** Cell Architecture - Organisation of the cellular structure – Organelles in the eukaryotic cell – The nucleus: Packing DNA in eukaryotes - Packing of DNA in prokaryotic cells – Eukaryotic Cell cycle: Mitosis and meiosis and their regulation. Extrachromosomal Inheritance.

Unit 2: **Transport across membrane and the cytoskeleton** Strategies for transport of small ions and molecules – Transport of proteins – Transport of lipids- Endocytosis – The cytoskeletal structure: microfilaments, intermediate filaments and microtubules – Actin and myosin in muscle contraction

Unit 3: Signal Transduction Different mechanisms of Signal transduction, Concepts in Signal Network-Seconday messenger. Neuro Transmission – Transmission of signal by motor neuron - Signalling at cell surface – Signalling molecules and their receptors – Signal Transduction pathways – G protein coupled receptors- TGF β - Cytokine signalling -Receptor tyrosine Kinases -MAP kinase – NF-kB . Calcium binding proteins. Notch delta.

Unit 4: Molecular biology of cloning vectors Restriction endonucleases – Cloning vectors – Plasmids – Phage DNA as vectors – Cosmids – Phasmids – Genomic and cDNA library construction

Unit 5: Application of recombinant DNA technology Site Directed mutagenesis – Gene silencing - Expression of recombinant proteins in microbes – Somatic cell nuclear transfer – Expression in plants – Molecular Diagnostics - Neonatal Screening – Gene therapy

References:

1. Lodish et al, Molecular Cell Biology (2008) 6e – W H Freeman & Co. ISBN: 978-0-716-77601-7

2. Primrose and Twyman, Principle of Gene Maniuplation (2006) 7e – Wiley-Blackwell ISBN: 978-1-4051-3544-3

3. Gerald Karp Cell and Molecular Biology-Study Guide: Concepts and Experiments (2008) John Wiley and Sons. ISBN 13.978-0-470-04214-4

4. Geoffrey M.Cooper, Robert E.hausman The Cell : a molecular approach (2009) Ed 5 ASM Press ISBN 087893300X

Semester I

Core – CBI012C – 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.

Unit2: 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: 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: 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 pyrimidiine ribonucleotides, formation of deoxyribonucleotides. nucleotide degradation integration and regulation of mammalian fuel metabolism.

References:

1. Voet and Voet, Biochemistry 3e Wiley (2004*)* ISBN: 978-0-471-19350-0

2. Nelson and Cox, Lehninger Principles of Biochemistry 5e W H Freeman & Co *(2009)*

ISBN: 978-0-716-77108-1

3. Berg, Tymoczko & Stryer (2007) Biochemistry 6th ed W.H.Freeman and Co New York. ISBN 0716787245

4. Horto, Moran, Scimgeor, Perry and Rawn Principles of Biochemistry 4th Ed (2006) Pearson Education Institutional. ISBN -10 0131453068

Semester I

Core – CBI013C - Probability and Statistics

Unit 1: Probability Theory Sample Space and Events, Axioms of Probability, Conditional Probability, Independent Events, Baye's Formula.

Unit 2: Numerical Description of Data Discrete and Continuous variables, Mean,Median,Mode, Quartiles, Standard Deviation, Variance, Coefficient of Variation.

Unit 3: Discrete and Continuous Distributions Bernoulli, binomial, Geometric, Poisson's, Exponential, Gaussian, Chi-Square test, Student's t-Test, F-test, Z-test

Unit 4: Estimation Theory and Limit Theorems Unbiased Estimator, Confidence Intervals-population mean, population variances, Limits theorems-Central Limit Theorem, Hypothesis testing

Unit 5: Regression and Analysis of Variance Spearman Ranking Coefficient, Regression Analysis, One-way ANOVA, Two-way ANOVA, Three-way ANOVA

References:

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

2. Bernard Rosner, Fundamentals of Biostatistics 6e (2006) Thomson Brooks/Cole ISBN: 0-534-41820-1

Semester I

Core – CBI014C - 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

References:

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 – CBI015C- 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.

Unit 4: Electroanalytical Techniques Potentiometry, Coulometry, Voltametry

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

References:

1. Skoog, Holler, Crouch, Instrumental Analysis Brooks/Cole (*2007)* ISBN-13: 978-81-315- 0542-7.

2. Robert D. Braun, Introduction to Instrumental Analysis Pharma Book Syndicate. (1987) ISBN 891-88449-15-6

Semester 1 – Elective- CBI016E – General Biology

Unit 1: Cells The Cell- structure and function, introduction to metabolism, cellular respiration, biochemical cycles, cell communication, cell cycle. Vesicular transport and protein traffic in cells.

Unit 2: Genetics and Molecular Biology Genetics- Mendelian genetics, chromosomal, DNA replication, molecular basis of inheritance, from gene to protein- transcription, Initiaiton, elongation and termination. template and enzyme properties, promoter and regulatory sequences. translation, Regulation of translation . protein metabolism; post translation modifications and protein sequencing methods.X-linked and autosomal diseases. Mitochondrial related methods and QTL method and diagonisitics.

Genetics of viruses and bacteria, Genetic Information transfer, Horizontal gene transfer. Operons, positive and negative regulation. Processing of RNA and Proteins. Transport and Stability.

Eukaryotic genomics- organization, regulation, evolution. Methods for studying variation and polymorphism at genome level, PCR, Northern, southern, Western Blotting, RFLP and Fingerprinting. RAPD's, sequencing methods. Molecular genetics and genetic disorders.

DNA technology and genomics.Methods for studying gene expression and regulatory. Sequencing large scale expression analysis, Use of Microarrays.

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, Plant reproduction- Angiosperm reproduction and Biotechnology.

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 Ecology: Biodiversity, Population ecology, community ecology, Behavioural ecology; Ecosystems, Conservation Biology and restoration Ecology.

References:

1. Neil A. Campbell, Jane B. Reece. Biology 8e Benjamin Cummings (2008) ISBN: 9780805371468

Semester 1 Elective - CBI017E - 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.

References:

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

Semester 1 Lab

CBI018C – Analytical Techniques in biotechnology Laboratory

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

Semester I

CBI019C – Lab - Programming languages - Introduction to C and PERL

UNIT 1: Introduction to programming languages: Introduction – Flowcharts – Algorithms - Pseudocodes – Programming languages: data types, variables, constants, operators, input output, expressions, control flow constructs (conditional and loop statements) - functions, arrays, structures and unions - Pointers - Data structures - File handling. Programming languages for Bioinformatics.

UNIT 2: Procedural languages: Programming in C Procedural languages - C language introduction: Variables, Data Types – Arrays (one and two dimensional arrays)- Functions: Types, Parameters, Recursion, Function prototype, Standard C library - Structures. Pointers: Introduction, Pointer with variables, Arrays and Strings, Pointers and structures, Pointers and linked list – Unions - File handling: File I/O, File opening modes – C Preprocessor - Graphical Interfaces: Dialog Boxes, Dynamic Memory Allocation.

UNIT 3: PERL & PYTHON Perl doc - Data types: scalar data (numbers and strings), lists, arrays, variables, operators, expressions, operators, control flow constructs (conditional and loop statements), miscellaneous control flow built in functions, associative arrays hashes, functions, Basic I/O, file handling.

UNIT 4: Web Programming –I Introduction to Web Technology, Developing web pages with Rasmol, Kinemage, etc.

HTML: Tags, Links, Tables, Forms, Frames - ASP: Basic of active server pages, introduction of ASP Objects - XML: Introduction, anatomy of XML document, XSL, DTD, XHTML - PHP: variables and data types, language syntax, controls, structures, functions, strategies and tools for handling input and generating output, error handling

Unit 5 : Web Programming – II CGI: forms, environment variables, parsing, POST and GET, functions, Perl modules - Java Script and Dynamic Web Pages: Introduction to client and server side scripting, data types, operators, controls, objects and elements in Java script.

Lab : Programming Language

Lab exercises based on the above topics 1

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

References:

1. B.W. Kernighan and D. Ritchie The C Programming Language (1988) Ed 2 Prentice Hall of India. ISBN: 0131103628.

2. E. Balagurusamy Programming in ANSI C (2008) Ed 2 Tata McGrawHill Publishing Company Limited.

3. James Tisdall Beginning PERL for Bioinformatics – an introduction to perl biologist 2001 O'Reilly publications. ISBN**:**978-0-596-00080-6

4. Robert W. Sebesta, Concepts of Programming Languages, (2003) 5th or 6th ed., Addison-Wesley,

5. S. G. Kochan, Programming in C, (2005) 3rd Edition, Sam's Publishing, ISBN-10: 0672326663

6. Gottfried, B.S., Schaum's Outline of Theory and Problems of Programming with C, McGraw-Hill.1996. ISBN 10 0070240353

7. Lincoln Stein Official Guide to Programming with CGI.pm. (1998) John Wiley & Sons, Inc.(1998). ISBN-10: 0471247448

8. Tim Bunce , Alligator Descartes Programming the Perl DBI (2000) O-Reilly publications. ISBN 978-1-56592-699-8

Semester II

Core – CBI021C - Algorithms in Computational Biology

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

Unit 2: **algorithms Issues and Problems** Algorthims-Complexity of algorithms –NP complete problem-polynomial-Reducibilty-Travelling sales man problem-sorting problem and fibonaci 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 algorthim for exact match and graph and maximum likelihood algorithm etc.,

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

Unit 5: Methods: Methods : Algorthims for partial digest- double digest problem-Graph Algorithm for DNA sequence assembly (CASP3, Phrap, Phred) – Consecutive one problem (CIP) – Protein structure prediction- Chou-Fasman algorithm.

References:

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

2) 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

3) Michael.S.Waterman Introduction to Computational Biology : Maps, Sequences and Genomes . Waterman. (1995) Chapman and Hall/ CRC Press ISBN-10: 0412993910

4) Dan Gusfield Algorthims on Strings, Trees and Sequences : Computer Science and Computational Biology (1997) Cambridge University Press. ISBN-10: 0521585198

Semester II Core – CBI022C - 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

References:

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

Semester II - Core – CBI023C - Database Management Systems

Unit 1: Introduction – concepts and overview – Types DBMS- Relational and transactional Database-

Unit 2: **Database planning and Design concepts** General Database Planning and Design – Document or forms – preparation and architexture Entity-Relational ship Model- entities, Attributes, keys, tables design, relationships, roles and dependencies. Advanced E-R model. - concepts.Relational Algebra and relational calculus- introduction-principles and uses for design. Mapping ER model to Relational DB. Normalization.

Unit 3: Relational DB Introduction to relational DB and transactions.SQL-statements-Data Definition-Manipulation-control-Objects, - Views, sequences and Synonyms. Working with code and forms- Front end development-query sublanguage-modifying relations in SQL.

Unit 4: Internals of RDBMS Physical data structures, query optimization. Join algorthim statisca and cost base optimization. Transaction processing.concurrency control and recovery management. Transaction model properities, state serizability, lock base protocols, two phase locking.

Unit 5: Database technologies: JDBC, ODBC standard and CORBA –extended entity relationship model, object data model UML diagram. File organizations and data structures. Distributed database environment and its overview. Different databases and internet. Use of XML.

References:

1)Abraham Silberschatz, Henry F.Korth and S.Sudhashan (2005) Database system concepts. 5 Ed McGraw Hill Publications.
2) Elmasri Ramez and Novathe Shamkant, " Fundamentals of Database systems" (2007) Benjamin cummings Publishing Company. ISBN-10: 0321369572.
3) P. Ramakrishnan Rao: Database Management system, (2003) 3EdMcGraw Hill Publications. 9780071230575
4) Jim Gray and A.Reuter " Transaction processing : Concepts and Techniques" Morgan Kaufmann Press.(1997) ISBN-10: 1558601902
5) V.K .Jain. Database Management system (2002) Dreamtech Press ISBN 8177222279

6) Date C.J. " Introduction to database management" (2009) Vol1, Vol2, Vol3 addison Wesley.
7) Ullman, JD " Principles of Database systems" (1992) Galgottia publication
8) James Martin Principles of Database Management systems" (1985) PHI.

Semester II Core – CBI024C - Molecular Evolution

Unit 1: Introduction. Evolutional biology and History of Molecular Evolution - BIG-BANG and formation of the elements- Life process. logistics. Biogenesis 1 – primitive earth, Biogenesis 2- self assembly, energetic and Bioinformational Molecules, Biogenesis 3 – Protein or nucleic acid RNA or DNA first evolution. Comparison of DNA sequences to calculate gene distance

Unit 2: Life Processes RNA world- origin of Genetic Code-genomes overviews, content and architexcture- mutation-nucleotide substitutions and amino acid replacements. Convergent and divergent evolution: concepts. Molecular Evoultion-data, polymorphism and mutation. Mutation Vs. Substitution-Rate of Molecular Evolution. Jukes Cantor Correction-Mutation. Types and chemical basis of mutation. Transitions and Transversions- Deletions and Insertions. Gene duplications.

Unit 3: Process of evolution The process of evolution-population genetics-allele(gene) and genotype frequencies.Hardy-weinberg equilibrium-Heterozygosity. gene frequency and heterozygosity. Loss of heterozygosity-mutant alleles-theta as the measure

Unit 4: Theory and Clock Molecular clock- Concepts and significance-molecular mechanisms of molecular clock- Neutral theory -gene family organization.

Unit 5: **Evolution of genome and databases** Paralogy and Orthology- coordination expression in evolution-genome : content, structure and evolution. Molecular evolution of recently diverged species - Databases of Molecular evolution.

References :

1) Dan Graur Wen Hisiung Li Fundamentals of Molecular Evolution (2000) Sinauer Assoc ISBN 0878932666.

2) John H.Gillespie Population genetics A concise guide (2004) John Hopkins Univ.Press ISBN 080188092 2nd ed.

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

4) D.C.Reanney Hicks and Smith Molecular Evolution. Frontiers of Biology (1973) ISBN 0454018606

Semester II Core - CBI025C - 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, Macromolecular crystallography-concepts

Unit2 : 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: Folding and flexibility, Prediction, engineering and design of protein structures. Methods to identify secondary structural elements

Unit 4: 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: *In silico* study of biological structures. Structural genomics- concepts and significance. Structural databases**.**

References :

1) K.P.Murphy Protein structure, stability and folding (2001) Humana press.

2) Arthur M.Lesk Introduction to protein architechcture (2001) Oxford University Press.

3) A.McPherson Introduction to Macromolecular Crystallography (2003) John wiley Publications.

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

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

6)Vasantha Pattabhai and N.Gautham Biophysics (2002) Narosa Publishers ISBN 1-4020-0218-1.

Semester II Elective – CBI026E - 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.

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.

References:

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 CBI027E - Biomedical Informatics

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

Unit 2: 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 : 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: 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: 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.

References :

1) 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.

2) Charles P.Friedman, Jeremy C.Wyatt Evaluation methods in Biomedical informatics (Health Informatics) (2005) Springer ISBN 0387258892

3) C. William Hanson Healthcare informatics (2005) McGraw-Hill Professional ISBN 0071440666

4) Vadim Astakhov Biomedical informatics (2009) Vol 569 Methods in Molecular biology Springer protocols Humana Press.

Semester II

Lab

CBI028C Sequence Analysis

Introduction to sequence analysis software.

1)Installation of EMBOSS, Use of EMBOSS , BioEdit, Public Domain Software. internet access to software nd databases.

2)Accessing Biological databases: 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. Integrating information :
7) Report generation. Making presentations of results. Placing analysis in biological context, Limits of analysis.

CBI029C Database Management Systems

1. DDL & DML: Creating and working with databases, creating tables, dropping tables, primary and secondary keys, data validation, simple queries using MySQL, cursors, stored procedures.
2. Working with DBA: Different drivers, API for ODBC, JDBC.
3. Database architecture - preparation of forms – three tier architecture.
4. DTD and XML schema- simple DTD and creation of data in XML.
5. Design of database architecture - Design, planning, databases, UML Schema, Data models to physical tables.
6. Design of entity-relationship model using features from laboratory information systems.Normalization of data.
7. Database management: Authorization, Control, Security
8. Accessing molecular biology databases: Entrez, SRS, PIR
9. Databases: Retrieving, parsing and analysing sequences, structures etc.

Semester III - Core – CBI031C - Immunology & Pharmacology

Unit 1: 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 : 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 : 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: Introduction and Receptors: Pharmacology : Unit 1: 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: 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.

Introduction 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.

References

1) Thomas J.Kindt Richard A. Barabara A Janis . Kuby Immunology (2006) W.H.Freeman &Co ISBN - 10 0716767643
2) Roitt Immunology (2001) Mosby Publishers ISBN 0723431892, 9780723431893
3) Mary Julia Mycek, Richard A.Harvey, Richard A.Harvey Pamela C.Champe Pharamacology Lippincott's illustrative reviews, (1997) Lippincott-Raven ISBN 9780397515677

Semester III

Core – CBI032C - Data Mining and Machine Learning

Unit 1: **Introduction**- Data Mining and Machine Learning – Data Types-functionalities. Data Processing, classification-Patterns-Data Integration-Issues and Transformation and Reduction. rule based classification- Text Mining goals and its applications

Unit 2 : Methods: Concepts. Itemset Mining methods-Association rules-correlation analysis. Interaction between Association rules and Correlation analysis- Classification : Types-Decision Tree-Baynesian Rule based-Back Propagation, SVM and other methods.

Unit 3:Data Mining Technologies and OLAP technologies-Data visualization- Datawarehouse-concepts, application and uses.

Unit 4: **Machine Learning** –Techniques and Tools: Introduction-defintion-goals and specification, aspects of *learning system*. Ensemble Learning - Supervised and Unsupervised learning-Reinforcement Learning- Concepts, significance and uses. Inductive *Classfication*-concepts and Learning aspects. Techniques of machine learning –Hidden Markov Models- Neural Nets and genetic algorthim. Gene finding and DNA computing- Learning –Decision tree learning-concepts-searching of simple tress and computational complexity-Occam's razo-noisy data and pruning.

Unit 5: Models and Methods : mathematical methods and research methods involved in Machine Learning. Graphical models. Evolutionary systems-Probabilistic methods. Markov chain Monte Carlo (MCMC) for machine learning –Intelligent systems in Bioinformatics.

References :

1) Jiawei Han, Micheline Kambler Data Mining Concepts and Techniques. (1998) Morgan kaufman Publishers. ISBN 1558609016.

2) Ian H.Witten Eibe Frank Data Mining : Practical machine learning tools and Techniques with java implementation (2005) ISBN 1-55864-552-5

3) Petra Perner Azriel Rosenfield Machine Learning and data mining in pattern recognition in third International conference MLDM (2003) Springer ISBN 0302-9743

Semester III

Core – CBI033C - Advanced Programming Language

UNIT 1: Advanced programming :Syntactic specification - abstraction : data types - packages – classes - sequences control: iteration, branching, exceptions - Data control: global data, shared data, passing parameters - Functional programming - Programming styles and layouts.

UNIT 2: Perl & Bioperl Regular expressions: Pattern matching, Substitution, Split & Joint functions – Subroutines. String manipulation - Directory access and manipulation – Formats - Object Oriented Perl, Built-In functions, Modules, LWP Get/LWP UserAgent, Process management, Algorithms and sequence alignment. Database manipulation (DBM): DBM databases, DBM hashes – Bioperl: Installation, architecture and uses.

UNIT 3: Python programming for Bioinformatics Introduction to Python - Working data: tuples, lists, dictionaries, and sets. Program Organization and Functions - Modules and Libraries - Classes and Objects – Biopython: API for Biopython. **Python for bioinformatics** Working data: String handling, regular expressions

UNIT 4: Object Oriented Languague I: C++, OOPS – Variables, Methods – Data abstraction- Inheritance - Polymorphism implementing data structures – Classes – Operator overloading – Pointers to Objects – I/O, Exception - Storage management.

UNIT 5: Object Oriented Languague II: Core JAVA Introduction to Java: Keywords, Constants, Variables, Arrays, Operators, Expressions, Decision Making, Branching and Looping - Constructors – Methods – Classes - Objects – Packages – Interfaces - Exception handling – Event handling – Multithreading - Graphics – Animation - AWT – Java Applets - JAVA Beans - Swing – Servlet .

References:

1. Sriram Srinivasan Advanced Perl Programming (1997) O-Reilly Publications.

2. E. Balagurusamy, Object Oriented Programming with C++ (2005) Tata McGraw Hill

3. B. Stroustrup Object oriented programming in C++ (2001) Addision Wessely,2001.

3. R.Decker, S. Hirshfield, “Programming Java: A introduction to programming using JAVA” (2000) Vikas Publication .

4. David M. Beazley, Python: Essential reference.(2001) New Riders.

5. Patrick Naughton and Herbertz Schildt, “Java2 The Complete Reference”, (1999) Tata McGraw Hill.

Semester III

Core – CBI034C - 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-emperical methods. Macro-molecular force fields, salvation , 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.

References :

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

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 – CBI035E - Genomics and Proteomics

Unit 1 : Overview of Genomes : Genomes of Bacteria, archae and eukaryote.

Unit 2: Maps: all types of Maps, Cytogenetic maps and different types of maps.. Physical mapping .Sequence Assembly. Methods involved in all maps. Genomics & Proteomics research – methods for whole genome sequencing-whole genome sequence data-mass Spectrometry; tools for genome and proteome analysis. Ionization methods : MALDI, SELDI, ES,FAB, LSI, PDMS PB CI, Electron capture Ionization. Spectral analysis- MALDI-TOF MS, Quadrupole mass filter instruments- Trapping Instruments- Tandem Mass Spectrometers. E-PCR- methods and mapping and sequencing of genomes – from genome sequences to function.

Unit 3: Functional genomics : Functional genomics of microbes, plants and animals; transcriptome analysis methods, microarrays and serial analysis of gene expression. Basic concepts of identification of disease genes, role of bioinformatics-OMIM database, reference genome sequence, integrated genomic maps, gene expression of profiling , identification of SNPs, Role of SNP in pharmacogenomics, SAGE; TOGA.

Unit 4: Proteomics Techniques: Protein level estimation. Edman protein microsequencing. Protein cleavage. 2D gel electrophoresis.detection of proteins on SDS gels. Pattern analysis. Peptide mass fingerprinting. Interaction proteomics.Computational methods for identification of polypeptides from Mass spectrometry.

Unit 5: Databases: Minimal genome concept. Metagenomics. Genome databases of plants, animals and pathogens.- array databases and basic tools, Gene Expression Omnibus (GEO), ArrayExpress, SAGE databases. Databases of expressed sequence tags.SNP database 9DbSNP)Expasy, InterPro and analysis tools. Server and databases .DIP, PPI and tools for protein –protein and Domain-Domain Interaction. protemics research and its significance.

References:

1) C.Stan Tsai An Introduction to computational biochemistry (2003) Wiley Liss ISBN 9812-53-101-7
2) Ion Mandoiu, Alexander Zelikovsky Bioinformatics Algorthims- Techniques and applications. wiley Interscience (2008) ISBN 978-0-470-09773-1-90000
3) C.Cantor and C.L.Smith Genomics : the science and technology behind the Human genome Project (2000). Wiley Interscience New York.
4) J.M.Davies Genome analysis : a practical approach (1995) Oxford University Press.
5) D.H.Dear Genome mapping : a practical approach (1997) Oxford University Press.
6) K.E.Davies Genome analysis : a practical approach (1990) IRL press.
7) M.R.wilkins K.L.Williams P.Appel Hochstrasser Protein Research : New frontiers in Functional genomics (1997) springer-Verlag New York.
8) McClelland and A.Parke Expression genetics : Accelerated High throughput methods (1999) . Eaton publishers M.A.

Semester III

Elective – CBI036E - Systems Biology

Unit I Introduction – Systems Biology- Networks.- basics of computer networks and Biological –uses and Integration. Micro array – definition, types of array, Micro array analysis: Hierarchical clustering, Applications of Micro Arrays in systems biology- Self-organizing maps- Connectivity maps- definition and its uses- Networks and Pathways – Types and methods. Metabolic networks, or network of metabolites and enzymes.

Unit 2 : **Simulation and pathways**: - Whole cell **:** Principle and levels of simulation – Virtual Erythrocytes, Pathological analysis. Flux Balance Analysis – metabolomics- and enzymes - Digestion of proteins and protein metabolism, Transport metabolism, Carbohydrate metabolism – metabolism of glucose – glycolysis, TCA cycle, glycogenesis, Pentose phosphate shunt, Electron transport, Interconnection of pathways, metabolic regulation. Translating biochemical networks into linear algebra. Cellular models, ECELL Networks and Motifs – Gene Networks: basic concepts, computational model such transcription networks basic concepts . as Lambda receptor and *lac* operon as an example. – all types of networks.-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 adapation –any model.

Unit 4 : **Robustness and optimality in Biology** :– model and integral feedback-signaling/bifunctional enzymes. Perfect robustness- Role and its measurement-the biochemical paradigm-the genetic paradigm-the systems paradigm. Linking models and measurement-concepts- calibration and identification –data Vs metadata

Unit 5: Design of Circuits and Databases : Introduction- databases KEGG and EMP etc . Introduction- databases MetaCyc and 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.

References :

1) Uri Alon An Introduction to Systems Biology-Design principles of Biological circuits (2007) Chapman and Hall/CRC Taylor francis group. ISBN 1-58488-642-0

2) L. Alberghina H.V.westerhoff. Systems Biology : Definitions and perspectives.(2007) Springer ISBN 978 3-540-74269-2

3) A.Kriete, R.Eils Computational systems biology (2005) Academic press. ISBN 0-12-088786-X

4) E.Klipp , R.Herwig, A.Kowlad, C.Wierling and H.Lehrach Systems Biology in practice: Concepts, Implementation and applications.(2005) ISBN 10-3-527-31078-9

Semester III

Lab: CBI037C - Advanced Programming Language

2. Reading/Writing Protein/DNA sequences in files.
3. Mutation and randomization in Bioperl/Biopython.
4. DNA manipulation: Transcription DNA to RNA, Reverse complementing.
5. Passing Data to Subroutines
6. Parsing and retrieving information from SWISS-PROT, GenBank, PDB, BLAST output files.
7. Calculate Ka/Ks ratio of selective pressure.
8. Implement a dynamic programming algorithm for both global alignment and local alignment.
9. Creating simple JAVA graphical user interface.

Semester III

Lab - CBI038C - Molecular Modeling and Molecular Dynamics

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

Semester IV **Project – CBI041C – Project Work**

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

The process includes

a) The conceptulation of the independent research that will comprise the dissertation
b) The preparation of 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 of the semester.

Madurai Kamaraj University

Center of Excellence in Bioinformatics

School of Biotechnology

M.Sc., Computational Biology – Choice Based Credit System (CBCS)

Revised Course Structure and Scheme of Examination August 2010 (…… Credit based)

I Semester

Sl.No	Code	Subject	Credits	Scheme of Exam		
				Ext	Int	Total
01	CBI011C	Cell and Molecular Biology	4	75	25	100
02	CBI012C	Biochemistry	4	75	25	100
03	CBI013C	Probability and Statistics	4	75	25	100
04	CBI014C	Communication Skills in Science and Technology	4	75	25	100
05	CBI015C	Analytical Methods in Biotechnology	4	75	25	100
06	CBI016E	General Biology (Elective) (OR)	5	75	25	100
07	CBI017E	General Mathematics (Elective)	5	75	25	100
Lab						
	CBI018C	Analytical Methods in Biotechnology	1	60	40	100
	CBI019C	Programming Language	1	60	40	100
		Total Credits	27			900

II Semester

Sl.No	Code	Subject	Credits	Scheme of Exam		
				Ext	Int	Total
01	CBI021C	Algorithms in Computational Biology	4	75	25	100
02	CBI022C	Sequence Analysis	4	75	25	100
03	CBI023C	Database Management Systems	4	75	25	100
04	CBI024C	Molecular Evolution	4	75	25	100
05	CBI025C	Structural Biology	4	75	25	100
06	CBI026E	Biodiversity and IPR (OR)	5	75	25	100
07	CBI027E	Biomedical Informatics (Elective)	5	75	25	100
Lab						
	CBI028C	Sequence Analysis	2	60	40	100
	CBI029C	Programming Language	2	60	40	100
		Total Credits	29			900

III Semester

Sl.No	Code	Subject	Credits	Scheme of Exam		
				Ext	Int	Total
01	CBI0 31C	Immunology and Pharmacology	4	75	25	100
02	CBI032C	Data Mining and Machine Learning	4	75	25	100
03	CBI033C	Advanced Programming Language	4	75	25	100
04	CBI034C	Molecular Modeling and Molecular dynamics	4	75	25	100
05	CBI035E	Genomics and Proteomics	5	75	25	100
06	CBI036E	Systems Biology (Elective)	5	75	25	100
Lab						
	CBI037C	Advanced Programming Language	2	60	40	100
	CBI038C	Molecular Modeling and Molecular Dynamics	2	60	40	100
		Total Credits	30			800

IV Semester

Sl.No	Code	Subject	Credits	Scheme of Exam		
				Ext	Int	Total
01	CBI041C	Project Work	04	75	25	100
		Total Credits	04			100

Core Courses : 14 X 4 =56 credits + LAB 2X1 =2+ (4X2=8)=56+10=66+ Project 4 credit = 70 credits

Electives (4X5=20) (20) Total credits = 70+20 = 90 Total Credits = 90

Madurai Kamaraj University

Center of Excellence in Bioinformatics

School of Biotechnology

Choice Based Credit System (CBCS) from ……. 2010

Question Paper patterns and Schemes of Evaluation :

Theory : For (Core or Elective …….. or 2 credit Courses)

Total 100 Marks

Internal 25 Marks

5 Marks for assignment

20 Marks for two internals

Total 25 Marks

External 75 Marks (for 3 credit course – Core) External 75 Marks (2 credit courses core or ***Elective***)

Part – A Answer 10 out of 12------- 10 X 2 = 20 Marks Part A Answer 6 Out of 8 6 X 5 = 30marks

Part – B Answer 5 out of 6 ------- 5 X 5 = 25Marks Part B Answer 3 Out of 4 3X15 = 45 marks

Part – C Answer 2 Out of 3 ------3 X 10 = 30 Marks **Total** **75 marks**

Total **75 Marks**

Practicals

Total Marks 100

Internal 40 marks -- (*Assignment 10 marks*) **External 60 marks**

(*Record 10 marks*) *Part A Answer 5 out of 6 5X4 = 20 marks*

Internal Test 20 marks) *Part B Answer 5 Out of 6 5X 8 = 40 marks*

Total marks **40 marks Total marks** **60 marks**