ANNA UNIVERSITY, CHENNAI – 600 025.

UNIVERSITY DEPARTMENTS

REGULATIONS 2013

I TO IV SEMESTERS CURRICULUM AND SYLLABUS

M.SC. COMPUTATIONAL BIOLOGY (2 YEARS)

SEMESTER I

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	CB8101	Analytical Methods in Biotechnology	3	0	0	3
2	CB8102	Biochemistry	3	0	0	3
3	CB8103	Cell and Molecular Biology	3	0	0	3
4	CB8104	Communication Skills in Science and Technology	3	0	0	3
5	CB8105	Probability and Statistics	3	0	0	3
6		Elective I	3	0	0	3
PRACTICAL						
7	CB8111	Analytical Methods in Biotechnology Laboratory	0	0	4	2
8	CB8112	Programming Language Laboratory	0	0	4	2
		TOTAL	**18**	**0**	**8**	**22**

SEMESTER II

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	CB8201	Algorithms in Computational Biology	3	0	0	3
2	CB8202	Database Management Systems	3	0	0	3
3	CB8203	Molecular Evolution	3	0	0	3
4	CB8204	Sequence Analysis	3	0	0	3
5	CB8205	Structural Biology	3	0	0	3
6		Elective II	3	0	0	3
PRACTICAL						
7	CB8211	Database Management Systems Laboratory	0	0	4	2
8	CB8212	Sequence Analysis Laboratory	0	0	4	2
		TOTAL	**18**	**0**	**8**	**22**

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1	CB8301	Advanced Programming Language	3	0	0	3
2	CB8302	Data Mining and Machine Learning	3	0	0	3
3	CB8303	Immunology and Pharmacology	3	0	0	3
4	CB8304	Molecular Modeling and Molecular Dynamics	3	0	0	3
5		Elective III	3	0	0	3
PRACTICAL						
6	CB8311	Advanced Programming Language Laboratory	0	0	4	2
7	CB8312	Molecular Modeling and Molecular Dynamics Laboratory	0	0	4	2
		TOTAL	**15**	**0**	**8**	**19**

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1	CB8411	Project Work	0	0	24	12
		TOTAL	**0**	**0**	**24**	**12**

TOTAL CREDITS: 75

LIST OF ELECTIVES

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	CB8001	General Biology	3	0	0	3
2	CB8002	General Mathematics	3	0	0	3
3	CB8003	Biodiversity and IPR	3	0	0	3
4	CB8004	Biomedical Informatics	3	0	0	3
5	CB8005	Genomics and Proteomics	3	0	0	3
6	CB8006	Systems Biology	3	0	0	3

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

CB8101 ANALYTICAL METHODS IN BIOTECHNOLOGY L T P C
3 0 0 3

UNIT I MICROSCOPY 12

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 II SPECTROSCOPY 9

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

UNIT III SEPARATION METHODS 12

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

UNIT IV ELECTROANALYTICAL TECHNIQUES 6

Potentiometry, Coulometry, Voltametry

UNIT V BIOCHEMICAL TECHNIQUES 6

Estimation of Carbohydrates, Lipids, Proteins, Nucleic Acids

TOTAL: 45 PERIODS

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. ISBN 891-88449-15-6.

CB8102 BIOCHEMISTRY L T P C
3 0 0 3

UNIT I INTRODUCTION TO BIOMOLECULES 9

Amino Acids, Nucleic Acids, Covalent Structures of Proteins and Nucleic Acids, Three-Dimensional Structures of Proteins. Protein Folding, Dynamics, and Structural Evolution, Haemoglobin: Protein Function, Sugars and Polysaccharides. Lipids and Membranes.

UNIT II MECHANISM OF ENZYME ACTION 6

Introduction to Enzymes. Rates of Enzymatic Reactions. Enzymatic Catalysis.

UNIT III THERMODYNAMICS AND KINETICS 9

Bioenergetics and Thermodynamics, Phosphoryl Group Transfers and ATP, Biological Oxidation-Reduction Reactions

UNIT IV METABOLISM – I 12

Introduction to Metabolism, Glycolysis, Glycogen Metabolism, Citric Acid Cycle, Electron Transport and Oxidative Phosphorylation, Other Pathways of Carbohydrate Metabolism, Photosynthesis

UNIT V METABOLISM – II 12

Lipid Metabolism, Amino Acid Metabolism, Integration and Organ Specialization, Nucleotide Metabolism, Protein targeting

TOTAL: 45 PERIODS

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.

CB8103 CELL AND MOLECULAR BIOLOGY L T P C
3 0 0 3

UNIT I CELL ORGANISATION AND THE CELL CYCLE 9

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.

UNIT II TRANSPORT ACROSS MEMBRANE AND THE CYTOSKELETON 9

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 III SIGNAL TRANSDUCTION 9

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 – Notch delta

UNIT IV MOLECULAR BIOLOGY OF CLONING VECTORS 9

Restriction endonucleases – Cloning vectors – Plasmids – Phage DNA as vectors – Cosmids – Phasmids – Genomic and cDNA library construction

UNIT V APPLICATION OF RECOMBINANT DNA TECHNOLOGY 9

Site Directed mutagenesis – Gene silencing - Expression of recombinant proteins in microbes – Somatic cell nuclear transfer – Expression in plants – Molecular Diagnostics - Neonatal Screening – Gene therapy

TOTAL: 45 PERIODS

REFERENCES

1. Lodish et al, Molecular Cell Biology 6e – W H Freeman & Co. *2008* ISBN: 978-0-716-77601-7
2. Primrose and Twyman, Principle ofGene Maniuplation 7e – Wiley-Blackwell *2006* ISBN: 978-1-4051-3544-3.

CB8104 COMMUNICATION SKILLS FOR SCIENCE AND TECHNOLOGY L T P C
3 0 0 3

UNIT I BASICS OF TECHNICAL COMMUNICATION 9

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 II BARRIERS TO COMMUNICATION 9

Definition of Noise, Classification of Barriers

UNIT III ORAL COMMUNICATION 9

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 IV WRITTEN COMMUNICATION 9

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 V TECHNICAL PROPOSAL AND THESIS 9

TOTAL: 45 PERIODS

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

REFERENCES

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

CB8105 PROBABILITY AND STATISTICS L T P C
3 0 0 3

UNIT I PROBABILITY THEORY 9

Sample Space and Events, Axioms of Probability, Conditional Probability, Independent Events, Baye's Formula.

UNIT II NUMERICAL DESCRIPTION OF DATA 9

Discrete and Continuous variables, Mean, Median,Mode, Quartiles, Standard Deviation, Variance, Coefficient of Variation.

UNIT III DISCRETE AND CONTINUOUS DISTRIBUTIONS 9

Bernoulli, binomial, Geometric, Poisson's, Exponential, Gaussian, Chi-Square test, Student's t-Test, F-test, Z-test

UNIT IV ESTIMATION THEORY AND LIMIT THEOREMS 9

Unbiased Estimator, Confidence Intervals-population mean, population variances, Limits theorems-Central Limit Theorem, Hypothesis testing

UNIT V REGRESSION AND ANALYSIS OF VARIANCE 9

Spearman Ranking Coefficient, Regression Analysis, One-way ANOVA, Two-way ANOVA, Three-way ANOVA

TOTAL: 45 PERIODS

REFERENCES

1. Wayne W. Daniel, Biostatistics, 9e Wiley *2004* ISBN: 978-0-471-45654-4
2. Bernard Rosner, Fundamentals of Biostatistics 6e Thomson Brooks/Cole ISBN: 0-534-41820-1

CB8111 ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY LABORATORY L T P C
0 0 4 2

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

TOTAL : 60 PERIODS

CB8112 PROGRAMMING LANGUAGE LABORATORY L T P C
0 0 4 2

INTRODUCTION TO PROGRAMMING LANGUAGES C and PERL

C

Introduction to data types, variables, operators, input output, expressions, control flow constructs (conditional and loop statements), functions, arrays, structures and unions. Pointers, Data structures, File handling.

PERL

Data types: scalar data (numbers and strings), lists, arrays, variables, operators, expressions, operators, control flow constructs (conditional and loop statements), built in functions, building regular expressions, associative arrays hashes, functions, file handling.

Lab exercises based on the above topics

1. Understanding the structure of DNA, finding pitch of DNA, turn etc., Finding base composition and GC content
2. Codon Usage analysis, back translation of DNA, local alignments of sequences
3. Analysis of hydropathy plots
4. Dipeptide, tripeptide analysis on DNA sequences, motifs and repeats in DNA sequences
5. Sequence conversions, endonuclease identification
6. Analysis of protein 3-D structures
7. Curve Fitting
8. Databases: Retrieving sequences, putting in sequences

TOTAL: 60 PERIODS

REFERENCES

1. The C Programming Language by Kernighan and Ritchie, Prentice Hall of India.
2. Programming in ANSI C by E. Balagurusamy, Tata McGrawHill Publishing Company Limited.
3. Beginning PERL for Bioinformatics by James Tisdall O'Reilly publications.

CB8201 ALGORITHMS IN COMPUTATIONAL BIOLOGY L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Algorithm: History, Principles, types, development and its complexity.

UNIT II ALGORITHMS ISSUES AND PROBLEMS 9

Algorthims-Complexity of algorithms –NP complete problem-polynomial-Reducibilty-Travelling sales man problem-sorting problem and fibonaci Problem.

UNIT III USE OF DIFFERENT ALGORITHMS 9

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 IV DYNAMIC PROGRAMMING 9

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 V METHODS 9

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.

TOTAL: 45 PERIODS

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
5. Horowitz, S. Sahini, and Rajasekharan : Fundamentals of Computer Algorithms , Galgotia Publications

CB8202 DATABASE MANAGEMENT SYSTEMS L T P C

3 0 0 3

UNIT I Introduction 9

Introduction – concepts and overview – Types DBMS- Relational and transactional Database.

UNIT II DATABASE PLANNING AND DESIGN CONCEPTS 9

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 III RELATIONAL DB 9

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 IV INTERNALS OF RDBMS 9

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 V DATABASE TECHNOLOGIES: **9**

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.

TOTAL: 45 PERIODS

REFERENCES

1. Abraham Silberschatz, Henry F.Korth and S.Sudhashan (2005) Database system concepts. 5 Ed McGraw Hill Publications.
2. Date C.J. " Introduction to database management" (2009) Vol1, Vol2, Vol3 addison Wesley.
3. Elmasri Ramez and Novathe Shamkant, " Fundamentals of Database systems" (2007) Benjamin cummings Publishing Company. ISBN-10: 0321369572.
4. P. Ramakrishnan Rao: Database Management system, (2003) 3EdMcGraw Hill Publications. 9780071230575
5. Jim Gray and A.Reuter " Transaction processing : Concepts and Techniques" Morgan Kaufmann Press.(1997) ISBN-10: 1558601902
6. V.K .Jain. Database Management system (2002) Dreamtech Press ISBN 8177222279
   Ullman, JD " Principles of Database systems" (1992) Galgottia publication.
7. James Martin Principles of Database Management systems" (1985) PHI.

CB8203 MOLECULAR EVOLUTION L T P C
3 0 0 3

UNIT I INTRODUCTION 9

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 II LIFE PROCESSES 9

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 III PROCESS OF EVOLUTION 9

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 IV THEORY AND CLOCK 9

Molecular clock- Concepts and significance-molecular mechanisms of molecular clock- Neutral theory -gene family organization.

UNIT V EVOLUTION OF GENOME AND DATABASES 9

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

TOTAL: 45 PERIODS

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

CB8204 SEQUENCE ANALYSIS L T P C
3 0 0 3

UNIT I OVERVIEW 9

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

UNIT II DATA ALIGNMENT AND APPLICATIONS 9

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 III NUCLEIC ACID SEQUENCE ANALYSIS 9

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

UNIT IV MULTIPLE SEQUENCE ALIGNMENT AND APPLICATIONS 9

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 V PROTEIN SEQUENCE ANALYSIS 9

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

TOTAL: 45 PERIODS

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

CB8205 STRUCTURAL BIOLOGY L T P C

3 0 0 3

UNIT I 9

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

UNIT II 9

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 III 9

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

UNIT IV 9

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 V 9

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

TOTAL: 45 PERIODS

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

CB8211 DATABASE MANAGEMENT SYSTEMS LABORATORY L T P C
0 0 4 2

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.

TOTAL: 60 PERIODS

CB8212 SEQUENCE ANALYSIS LABORATORY L T P C
0 0 4 2

1. Introduction to sequence analysis software.
Installation of EMBOSS, Use of EMBOSS , BioEdit, Public Domain Software. internet access to software and 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.

TOTAL : 60 PERIODS

CB8301 ADVANCED PROGRAMMING LANGUAGE L T P C
3 0 0 3

UNIT I ADVANCED PROGRAMMING 9

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 II PERL & BIOPERL REGULAR EXPRESSIONS 9

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 II PYTHON PROGRAMMING FOR BIOINFORMATICS 9

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 IV OBJECT ORIENTED LANGUAGUE I 9

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

UNIT V OBJECT ORIENTED LANGUAGUE II 9

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 .

TOTAL: 45 PERIODS

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.
4. R.Decker, S. Hirshfield, “Programming Java: A introduction to programming using JAVA” (2000) Vikas Publication .
5. David M. Beazley, Python: Essential reference.(2001) New Riders.
6. Patrick Naughton and Herbertz Schildt, “Java2 The Complete Reference”, (1999) Tata McGraw Hill.

CB8302 DATA MINING AND MACHINE LEARNING L T P C
3 0 0 3

UNIT I 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 II 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 III DATA MINING TECHNOLOGIES

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

UNIT IV 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 V 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.

TOTAL: 45 PERIODS

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

CB8303 IMMUNOLOGY AND PHARMACOLOGY L T P C

3 0 0 3

UNIT I INTRODUCTION AND ANTIBODIES 9

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 II ANTIBODY GENERATION 9

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 III ANTIGEN AND ANTIBODY REACTION/INTERACTION 9

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 IV INTRODUCTION AND RECEPTORS: PHARMACOLOGY 9

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 V CHEMOTHERAPY 9

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.

TOTAL: 45 PERIODS

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

CB8304 MOLECULAR MODELING AND MOLECULAR DYNAMICS L T P C
3 0 0 3

UNIT I COMPUTATIONAL CHEMISTRY 9

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 II MOLECULAR MECHANICS 9

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 III ENERGY MINIMIZATION 9

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 IV SIMULATION METHODS 9

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 V DOCKING AND DRUG DESIGN 9

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.

TOTAL: 45 PERIODS

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.
5. Tamar Schlick: Molecular Modeling and Simulation – An interdisciplinary Guide, 2000, Springer-verlag

CB8311 ADVANCED PROGRAMMING LANGUAGE LABORATORY L T P C
0 0 4 2

Reading/Writing Protein/DNA sequences in files.

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

TOTAL: 60 PERIODS

CB8312 MOLECULAR MODELING AND MOLECULAR DYNAMICS LABORATORY L T P C
0 0 4 2

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

TOTAL: 60 PERIODS

CB8411 PROJECT WORK L T P C
0 0 0 12

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.

ELECTIVE I

CB8001 GENERAL BIOLOGY **L T P C**
3 0 0 3

UNIT I CELLS **9**

The Cell- structure and function, introduction to metabolism, cellular respiration, biochemical cycles, cell communication, cell cycle.

UNIT II GENETICS AND MOLECULAR BIOLOGY **9**

Genetics- Mendelian genetics, chromosomal, DNA replication, molecular basis of inheritance, from gene to protein- transcription, translation, protein metabolism; Genetics of viruses and bacteria, Eukaryotic genomics-organization, regulation, evolution.
DNA technology and genomics.

UNIT III PLANT BIOLOGY **9**

Plant structure, growth and Development, Plant nutrition, transport in vascular plants, Plant reproduction- Angiosperm reproduction and Biotechnology.

UNIT IV ANIMAL BIOLOGY **9**

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

UNIT V ECOLOGY **9**

Ecology- An introduction; Population ecology, community ecology, Behavioural ecology; Ecosystems, Conservation Biology and restoration Ecology.

TOTAL: 45 PERIODS

REFERENCE

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

CB8002 GENERAL MATHEMATICS **L T P C**
3 0 0 3

UNIT I BASIC OVERVIEW AND GEOMETRY **9**

2D geometry, 3D geometry, Area under curves, Areas of Polygons, Trigonometry, Complex numbers, Coordinate system, Cartesian coordinates, Polar coordinates, Vectors, Vector Geometry, Logarithms and Exponentials

UNIT II MATRICES AND DETERMINANTS **9**

Set theory, Matrix multiplication, linear equations, linear transformations, square matrices, determinant, Eigen values and eigenvector, Matrix decomposition methods, Graph Theory

UNIT III DIFFERENTIAL CALCULUS **9**

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 IV INTEGRAL CALCULUS 9

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 V NUMERICAL METHODS 9

Solution of equations by iteration, Interpolation by polynomials, 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.

TOTAL: 45 PERIODS

REFERENCES

1. Philip Schmidt, Frank Ayres Schaum's Outline of College Mathematics McGraw Hill *2003* 9780071402279

ELECTIVE II

CB8003 BIODIVERSITY AND IPR L T P C

3 0 0 3

UNIT I INTRODUCTION TO BIOLOGICAL DIVERSITY 9

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 II BIODIVERSITY AND CLIMATE CHANGE 9

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 III CONVENTION ON BIOLOGICAL DIVERSITY 9

(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 IV LAWS AND AGREEMENTS : **9**

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 V METHODS 9

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

TOTAL: 45 PERIODS

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.

CB8004 BIOMEDICAL INFORMATICS L T P C
3 0 0 3

UNIT I INTRODUCTION 9

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

UNIT II ELECTONIC HEALTH RECORDS (EMR) 9

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 III NETWORKING 9

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 IV METHODS AND EVALUATION 9

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 V HEALTHCARE INFORMATICS 9

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.

TOTAL: 45 PERIODS

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.

ELECTIVE III

CB8005 GENOMICS AND PROTEOMICS L T P C
3 0 0 3

UNIT I OVERVIEW OF GENOMES 9

Genomes of Bacteria, archae and eukaryote.

UNIT II MAPS 9

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 III FUNCTIONAL GENOMICS 9

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 IV PROTEOMICS TECHNIQUES 9

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 V DATABASES 9

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.

TOTAL: 45 PERIODS

REFERENCES

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

CB8006 SYSTEMS BIOLOGY L T P C

3 0 0 3

UNIT I INTRODUCTION 9

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 II SIMULATION AND PATHWAYS 9

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 III SIGNALLING & EXPERIMENTAL METHODS IN SYSTEMS BIOLOGY 9

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-the biochemical paradigm-the genetic paradigm- the systems paradigm. Linking models and measurement-concepts- calibration and identification –data Vs metadata.

UNIT IV DESIGN OF CIRCUITS AND DATABASES 9

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.

UNIT V SYNTHETIC BIOLOGY 9

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

TOTAL: 45 PERIODS

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
5. Pengcheng Fu, Sven Panke,Systems Biology and Synthetic Biology 2009, Wiley InterScience