

GAI'F'm

UNIVERSITY OF CALICUT

(Abstract)

Scheme and Syllabus of M.Sc Bio-informatics of affiliated colleges under Credit Semester System (CUCSS-PG-2010) implemented with effect from 2010 admission-orders issued.

GENERAL & ACADEMIC BRANCH-IV 'J' SECTION

No. GA IV/J1/7457/2005

Dated, Calicut University PO, 22.10.2010

Read: 1. U.O.No.GAIV/J1/1373/08 dated 23.07.2010.

2. Item No.(1) of the minutes of the meeting of the Board of Studies in Bioinformatics held on 06.09.2010.

3. Orders of the Vice-Chancellor in the file of even No.dated 20.10.2010.

ORDER

As per paper read as (1) above, Calicut University Credit Semester System at Post Graduate level in the affiliated Colleges (CUCSS-PG-2010)has been implemented from the academic year 2010 onwards.

The Board of Studies at its meeting, vide paper read as (2) above, restructured the scheme and syllabus as per the Credit Semester System pattern to be made effective from 2010-11 academic year onwards.

The Vice-Chancellor, in view of exigency, has approved the minutes of the meeting of the Board, subject to ratification by the Academic Council.

Sanction has therefore been accorded for implementing the scheme and syllabus of M.Sc. Bioinformatics programme of affiliated colleges under Credit Semester System with effect from 2010 admission.

Orders are issued accordingly. Scheme and Syllabus appended.

Sd/-

**DEPUTY REGISTRAR(G&A IV)
For REGISTRAR**

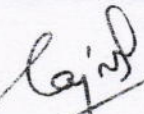
To

1. The Principals of all affiliated Colleges offering M.Sc. Bioinformatics
2. Self financing Centres of the University of Calicut offering M.Sc. Bioinformatics

Copy to:

PS to VC/PA to Registrar/CE/EX/Digital wing
(with a request to upload in the University website)/Enquiry/
Information centres/DR III (Exams)/EG-I/DR PG/Tabulation section/
GAI'F' 'G' sections/GAII/GAIII/SF/FC

Forwarded/By Order

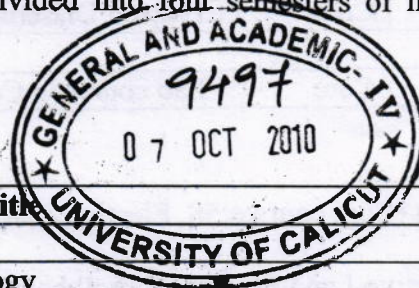

SECTION OFFICER

M.Sc. (Bioinformatics) Degree Programme under the Credit Semester System (CSS) for
 the Affiliated Colleges of University of Calicut
 Course Structure and Syllabus

(With effect from the Academic Year 2010-2011 onwards)

Duration of Programme: Two years (divided into four semesters of not less than 90 working days each)

Semester – I (Total credits: 20)



Course code	Type	Course Title	Credits
Theory			
BIO1C01	Core	Cell Biology	4
BIO1C02	Core	Mathematical and Statistical Techniques	4
BIO1C03	Core	Chemistry of Biomolecules	4
BIO1C04	Core	Basics of Computer and Networking	4
Practicals			
BIO1C05	Core	Lab course in Cell Biology	2
BIO1C06	Core	Lab course in IT Tools and Applications	2

Semester – II (Total credits:20)

Course code	Type	Course Title	Credits
Theory			
BIO2C07	Core	Introduction to Bioinformatics	4
BIO2C08	Core	Molecular Genetics	4
BIO2C09	Core	Introduction to Database systems	4
BIO2C10	Core	Computer Programming – 1	4
Practicals			
BIO2C11	Core	Lab course in Molecular Genetics	2
BIO2C12	Core	Lab course in Computer Programming-1	2

Semester – III (Total credits:16)

Course code	Type	Course Title	Credits
Theory			
BIO3C 13	Core	Genomics, Proteomics and Metabolomics	4
BIO3C 14	Core	Computer Programming – II	4
BIO3C 15	Core	Algorithm in Computational Biology	4
Practicals			
BIO2C16	Core	Lab course in Sequence Analysis	2
BIO2C17	Core	Lab course in Structure Prediction	2

Dr. D. GIRIJA
 Professor
 Dept. of Agricultural Microbiology
 College of Horticulture
 Kerala Agricultural University

Giri

01

EL-800816 4281W

GAN

07-10-10

Semester – IV (Total credits:18)

Course code	Type	Course Title	Credits
Theory			
BIO4E	Elective	Elective-I	4
BIO4E	Elective	Elective-II	4
BIO4C18	Core	Project/ Dissertation and General Viva-voce	8
Practicals			
BIO4C19	Core	Lab course in Computer Programming-II	2

Total Credits: 74 (Core courses:58, Elective courses:8, Project/ Dissertation:8)

The courses Elective-I and Elective-II shall be chosen from the following list

LIST OF ELECTIVES

Sl. No.	Course Title	Credits
E01	Structural Biology and Molecular Modelling	4
E02	Database Development	4
E03	Data Mining	4
E04	Chemoinformatics and Drug Discovery	4
E05	Applied Bioinformatics	4

DETAILED SYLLABI OF COURES

Semester-I

BIO1C01: Cell Biology (4 credits)

- The dynamic cell evolution and cell theory
- Cell organization - prokaryotic and eukaryotic cells, membranes, sub cellular organelles
- Cell membrane - structure, transport, channels, carriers, receptors, endocytosis, potentials
- Architecture of plant cell wall
- Structure, function and biogenesis of cellular organelles - mitochondria, chloroplasts, ER, golgi, lysosomes and peroxisomes, centriole, nucleus and nucleolus and organelle genomes
- Cell motility and shape, cytoskeletal elements, cilia and flagella; motor proteins
- Cell-cell interactions and signal transduction - intercellular junctions, signaling by hormones and neurotransmitters; receptors, G-proteins, protein kinases and secondary messengers
- Protein traffic in cells - protein sorting and signal sequences, protein translocation in ER and vesicular transport to golgi, lysosomes and plasma membrane; protein import into nuclei, mitochondria, chloroplasts and peroxisomes
- Cell cycle and its regulation; events during mitosis and meiosis

Dr. D. Girija

Dr. D. GIRIJA
Professor (02)
Dept. of Agricultural Microbiology
College of Horticulture
Kerala Agricultural University
Vellanikkara - 680 656

- protein interactions
- Nucleic acids - RNA and DNA, bases, nucleotide biosynthesis, A, B, Z forms of DNA, denaturation, renaturation and hybridization of DNA, different types of RNA, protein - nucleic acid interactions
- Enzymes - enzyme nomenclature and classification, units of enzyme activity, coenzymes and metal cofactors, temperature and pH effects, Michaelis - Menten kinetics, active site and catalytic mechanisms, allosteric enzymes, inhibitors and activators, covalent and non-covalent regulations
- Organization of metabolic systems - enzyme chains, multienzyme complexes and multifunctional enzymes, anaplerotic sequences and amphibolic pathways, feedback control of metabolic pathways, shuttle pathways
- Oxidation of glucose in cells - high energy bond, glycolysis, citric acid cycle and oxidative phosphorylation

References

- Lehinger 1984. Principles of Biochemistry. CBS Publishers and Distributors, New Delhi, India
- Rastogi.1993. Biochemistry. Tata McGraw- Hill Publishing Company Limited, New Delhi
- Sanger. 1984. Principles of Nucleic acid Structure. Springer Verlas
- Voet and Voet. Biochemistry. Wiley & Sons

BIO1C04: BASICS OF COMPUTER AND NETWORKING (4 credits)

- Overview and functions of a computer
- Input and output devices
- Storage devices - hard disk, diskette, magnetic tape, RAID, ZIP devices, digital tape, CD-ROM, DVD (capacity and access time)
- Main circuit board of a Personal computer-micro processor, ports, expansion slots
- Memory-register, buffer, RAM, ROM, PROM, EPROM, EEPROM (comparison)
- Types of processing - batch, real-time, online, offline
- History of computers-Evolution, generation of computers (I, II, III, IV, V), classification of computers (mainframes, mini computers, micro computers, special purpose)
- Types of modern computers-workstation, super computer, parallel processing computer
- An overview of computer viruses-virus symptoms-spread of virus-consequence and precautions
- Introduction to operating systems-concept, Windows 98/XP, Windows server NT/2000, UNIX/Linux
- Open System Interconnection (OSI) reference model
- Network goals and applications
- Network architecture
- Network protocols
- Networking gadgets - router, switch etc.,
- Local Area Network (LAN), Wide Area Network (WAN), Metropolitan Area

Dr. D. GIRIJA
 Professor
 Dept. of Agricultural Microbiology
 College of Horticulture
 Kerala Agricultural University
 Vellanikkara - 680 656

03

References

Buchanan *et al.*, 2001. Biochemistry and Molecular Biology of Plants. ASPB, USA
Lodish *et al.*, 2000. Molecular Cell Biology. Freeman and Company, England
Alberts, *et al.*, Molecular Biology of Cell. Garland Publishing Inc, New York

BIO1C02: MATHEMATICAL AND STATISTICAL TECHNIQUES (4 credits)

- Calculus - limits, complete differentials, partial differentials of functions with one variable and multiple variables.
- Integration - definite and non-definite integral, series, logarithms
- Ordinary differential equations (first order), partial differential equations, example from biology, special functions - Bessel, Legendre
- 2D coordinate geometry - equation of a line, circle, ellipse, parabola, hyperbola
- 3D geometry - equation of sphere, cone
- Trigonometric functions - Sin, Cos, Tan, Cot, series expansion of these functions and other related functions
- Vector- addition, subtraction, dot, cross, scalar triple product, divergence, curl of a vector, equation
- Matrix algebra - addition, subtraction, multiplication, transpose inverse, and conjugate systems
- Fundamentals of set theory
- Introduction to principles of statistical sampling from a population
- Random sampling
- Frequency distributions and associated statistical measures
- Probability Distributions
- Correlation and regression analysis
- Multivariate analysis
- Hypothesis testing

References

Manicavachagom Pillai *et al.*, Algebra Volume I (Containing Binomial, Exponential, Logarithmic series and theory of equations)
Manicavachagom Pillai. Calculus
Campbell. Statistics for Biologist.
Gupta and Kapoor. Fundamentals of Mathematics Statistics.

BIO1C03: CHEMISTRY OF BIOMOLECULES (4 credits)

- Water as the universal biological solvent, concept of osmolarity
- Carbohydrates-monosaccharides, oligosaccharides, polysaccharides, proteoglycans and glycoproteins.
- Lipids - fatty acids, acylglycerols, phospholipids, sphingolipids and cholesterol
- Proteins - physical and chemical properties of amino acids and polypeptides, primary, secondary, tertiary and quaternary structures, protein folding, protein -

Dr. D. GIRIJA
Professor 04
Dept. of Agricultural Microbiology
College of Horticulture
Kerala Agricultural University
Vellanikkara - 680 656

Network (MAN)

- Data communication -ISDN, VPN, DSL, cable modem, cellular modem
- Communication links-wire pairs, coaxial cables, fibre optics, microwave, satellite etc.
- Transmission characteristics-asynchronous and synchronous transmission, paths
- Network security - firewall, packet filtering
- Network management systems
- The internet and its resources-World Wide Web (WWW)-associated tools, services, resources

References


- Peter Bishop. Computing Science. ELBS
- Tanenbaum. Structured Computer Organization
- Tanenbaum. 1998. Computer Networks. PHI
- Peterson. 1995. TCP/IP Networking. Mc Graw Hill
- Stallings. 2000. Data and Computer Communication. PHI

BIO1C05: LAB COURSE IN CELL BIOLOGY (Practicals) (2 credits)

- Study of types of microscopes
- Study of different kinds of cells/tissues
- Cellular micrometry and quantitation of cells
- Histochemical techniques
- Study of mitotic and meiotic stages
- Sub cellular fractionation and marker enzymes
- Polytene chromosomes (salivary gland) of *Drosophila*-culture and growth of fruit fly larvae, isolation of salivary glands and squash preparation of polytene chromosomes
- Buccal smear preparation to demonstrate Barr body
- Demonstration of mitochondria by vital staining (Janus green) in buccal epithelial cells/baker's yeasts
- Human karyotype preparations from photographs

References

- Alberts, *et al.*, Molecular Biology of Cell. Garland Publishing Inc, New York
- Lodish *et al.*, Molecular Cell Biology. Scientific American Books, W.H. Freeman & Co.
- Prescott. Reproduction in Eukaryotic cells. Academic Press
- Gilbert. Developmental Biology. Sinauer Associates Inc.
- Wilson. Cell in Development and Inheritance. Mac Milan, New York
- Ethan Bier. The Coiled Spring. Cold Spring Harbor Press
- Longo. Fertilization. Chapman and Hall
- Freedman Birkhuser. Molecular Biology of Steroid and Nuclear Hormone Receptors. LP
- Karp. Cell and Molecular Biology, Concepts and Experiments. John Wiley & Sons Inc.


Dr. D. GIRIJA
Professor
Dept. of Agricultural Microbi
College of Horticulture
Kerala Agricultural Univers
Vellanikkara - 680 656

BIO1C06: LAB COURSE IN IT TOOLS AND APPLICATIONS (Practicals) (2 credits)

- Description of hardwares and assembly
- Hands on experience - tutorials (windows 98/XP, internet, Linux etc.), applications and utilities of windows 98/XP
- Web browsers - internet explorer and Netscape navigator, surfing, search engines, e-mail, ftp etc.
- Download and installing software/plugin on windows 98/XP (acrobat reader, post scripts viewer, etc.)
- Pine, telnet
- Word processing (MS word)
- Spread sheet applications (Microsoft excel)
- Database applications (Microsoft access)
- Creation of computer presentations with graphics (MS power point)
- Introduction to multi media tools and devices
- Creation of web pages


References

- Norton. Introduction to Computer. Mc Graw Hill
- MS-Office manual

SEMESTER – II

BIO2C07: INTRODUCTION TO BIOINFORMATICS (4 Credits)

- History and scope of Bioinformatics
- Biological databases - sequence, structure and specialized databases
- Introduction to nucleic acid and protein sequence databases - GenBank, EMBL, DDBJ, NBRF-PIR, Swiss-Prot
- Database file formats
- Procedure for depositing DNA and protein sequences
- Database search engines (ENTREZ, SRS)
- Web based and stand alone tools for DNA and protein sequence analysis
- Predictive methods in DNA and protein sequence analysis
- Sequence similarity search - pair wise sequence alignment, multiple sequence alignment of DNA and protein sequences
- BLAST and FASTA, PSI-BLAST search tools
- Phylogenetic analysis
- Protein structure databases - molecule visualization
- Protein - protein interactions databases and tools, docking
- Secondary databases
- Databases of patterns, motifs and profiles - PROSITE, BLOCKS, PRINTS, Pfam.
- Expressed sequence tag databases (dbEST), single nucleotide polymorphisms databases (dbSNP), metabolic pathway database (KEGG)
- Comparative genomics -databases, genome alignments and tools, comparison of


Dr. D. GIRIJA
Professor 06
Dept. of Agricultural Microbiology
College of Horticulture,
Kerala Agricultural University
Vellanikkara - 680 656

gene order

- Applications of bioinformatics

References


- Attwood and Parry-Smith. 2001. Introduction to Bioinformatics. Pearson Education Asia, New Delhi
- Baxevanis and Ouellette. 2001. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Wiley, New York
- Higgins and Taylor. 2000; Bioinformatics: Sequence, Structure and Databanks. Oxford University Press. Oxford
- Misener and Krawetz. 2001. Bioinformatics: Methods and protocols. Replica Press Pvt. Ltd, New Delhi
- Mount. 2001. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press, New York
- Rashidi and Buehler. 2000. Bioinformatics Basics: Applications in Biological Science and Medicine. CRC press, Boca Raton

BIO2C08: MOLECULAR GENETICS (4 Credits)

- Gene-gene concept, unit of function, replication, recombination and mutation, complementation analysis, fine structure of gene - bar locus, complex loci, rll locus, inborn errors of metabolism, one gene/one enzyme hypothesis, pathways of gene action
- Nucleic acid - types and properties, DNA as the genetic material, double helical structure of DNA, forms of DNA, structure of RNA
- Genome organization in prokaryotes and eukaryotes - denaturation and renaturation, DNA content and C - value paradox, repetitive and non-repetitive DNA, gene families, repetitive sequences, tandem and dispersed repeats, satellite DNA, types and importance of transposable elements in genome evolution, organelle genome
- Functional and structure organization of prokaryotic and eukaryotic genes
- DNA the central dogma of molecular biology - DNA replication mechanism and machinery in prokaryotes, mechanism of transcription and translation in prokaryotes and eukaryotes, control of gene expression, RNA processing and editing, transcriptional, post transcriptional, translational and post translational controls.
- Regulation of gene expression by hormones and environmental stresses
- DNA repair

References

- Primrose and Twyman. 2004. Principles of Genome Analysis and Genomics. Blackwell, UK
- Brown. 2001. Gene Cloning and DNA Analysis. Blackwell, UK
- Primrose et al., 2001. Principles of Gene Manipulation. Blackwell, UK
- Lewin. Genes. Oxford University Press, Oxford
- Gardner et al., Principles of Genetics. John Wiley and Sons
- Strickberger. 1985. Genetics. Macmillan New York
- Mickloss and Freyer. DNA Science: A First Course in Recombinant Technology,



Dr. D. GIRIJA
Professor
Dept. of Agricultural Microbiol
College of Horticulture
Kerala Agricultural Univers
Vellanikkara - 680 656

Cold Spring Harbour Laboratory Press, New York
BIO2C09: INTRODUCTION TO DATABASE SYSTEMS (4 Credits)

- Data abstraction, data models, instances and schemes
- E-R model - entity and entity sets, relations and relationship sets, E-R diagrams
- Database models concepts and applications - hierarchical, network, multimedia
- Indexing and hashing
- ISAM, B+ tree indexed files, B tree indexed files, static & dynamic hash functions Text databases
- Introduction to distributed data processing
- Relational database design
- Front end - Oracle, SQL and VB
- Oracle architecture
- Oracle objects - tables, views, indexes, sequences, synonyms, snapshots, clusters
- Database - table space, data files, blocks, extents, segments,
- Oracle background processes - PMON, SMON, LGWR, CKPT, oracle instance startup, shutdown, control files
- Oracle memory management, roll back segments, redo logs/archival, transaction control and locking/dead lock, security concepts, grants, roles, privileges
- Oracle utilities, server manager, export-import, backup and recovery, physical storage and logical storage
- Oracle report features, full integration with forms and graphics, data model and layout editors
- Layout objects - frames, repeating frames, fields, boiler plate, anchor
- Interface components, report formats, example reports, single query, multi query, matrix, master-detail relationship, user defined columns, PL/SQL interface, triggers, packaged procedure, calling report from a form
- Default menus, custom menus, menu objects, menu module, main menu, individual menus, sub menus, menu items, menu editor, PUSQL in menu modules, menu security
- SQL - statements, data definitions, data manipulation statements, data control statements
- Other database objects - views, sequences, synonyms
- Introduction to application development using VB
- Codes and forms, variables, procedures and controlling program executor, standard controls, data access using data control, connecting to oracle database using visual basic

References

- Desai. 1991. An Introduction to Database Systems. Galgotia
- Date. 1983. An Introduction to Database Systems. Addison Wesley
- Korth and Silberschatz. Database System Concepts. Tata Mac-Graw Hill
- Hansen and Hansen. Database Management and Design. PHI
- Martin. Introduction to Database Systems Organization. PHI
- Kolste and Peterson. Oracle: Power Objects Handbook
- Que Series. 2001. Using Visual Basics
- Cornell. 1999. Visual Basic 6. Tata Mc Graw Hill


Dr. D. GIRIJA
Professor
Dept. of Agricultural Microbiology
College of Horticulture
Kerala Agricultural University
Vellanikkara - 680 656

BIO2C10: COMPUTER PROGRAMMING – I (4 Credits)

- Algorithm design and analysis, flow charts, structured and object oriented programming
- Introduction and importance of programming with C
- Basic structure, data types, constants, variables, declaration and assigning variables
- Introduction to arrays, pointers, structures and functions
- File handling in C
- Fundamentals of C++ - classes, arrays, pointers, references, function overloading, introducing operator overloading, inheritance, introducing the C++ I/O, virtual functions
- Introduction to linux operating system
- Graphical interface, networking, prompt, shell account, processes, installation, common linux commands, LAN and internet exploration tools
- File systems - listing directories, file permissions, directory navigation and control, linking files, wildcards, working with files, find-find files
- Text processing commands
- Writing shell programs
- Introduction to PERL programming
- Basic format, name conventions, variables - scalars, arrays and associative arrays
- Operators - scalar operators, array operator, associative operators, functions
- Control structures, file input and output
- Applications - text processing functions, processing regular expressions
- Introduction to Bioperl, use object oriented programming, objects in Bioperl

References

- Balagurusamy. 2000. Programming in C. Tata Mc Graw
- Hutchison and Just. 1988. Programming using the C language. Mc Graw Hill
- Deitel and Deitel. 2002. C++ How to Program. Pearson Education
- Booch. Object Oriented Analysis and Design. Pearson Education
- Ellen Siever. Linux in a Nutshell
- Sobell. A practical guide to Linux® Commands, Editors & Shell Programming
- Tobler. Inside Linux. Sams
- Dwyer. Genomic Perl: From Bioinformatics Basics to Working Code
- Wall et al., Programming Perl

BIO2C11: LAB COURSE IN MOLECULAR GENETICS (Practicals) (2 Credits)

- Bacterial transformation, transduction, conjugation
- Isolation of plasmid DNA
- Restriction digestion and construction of plasmid restriction map
- Cloning in plasmid vectors
- Screening recombinants by Blue/White selection
- Isolation of genomic DNA
- Qualitative and quantitative check of genomic DNA



Dr. D. GIRIJA
Professor
Dept. of Agricultural Microbiol
College of Horticulture
Kerala Agricultural Universit
Vellanikk...

- Southern blotting
- Isolation of RNA and northern blotting
- DNA sequencing, PCR
- Extraction of protein and Western blotting
- Metabolic labeling of proteins

References

- Sambrook et al., Molecular Cloning: A Laboratory Manual. Cold Spring Harbor Laboratory Press, New York
- Glover and Hames. 1995. DNA Cloning: A Practical Approach. IRL Press, Oxford
- Kaufman et al., 1995. Molecular and Cellular Methods in Biology and Medicine. CRC
- Berger and Kimmel. 1996. Methods in Enzymology: Guide to Molecular Cloning Techniques (vol. 152). AP, San Diego
- Goeddel. 1990. Methods in Enzymology: Gene Expression Technology (vol. 185). AP, San Diego
- Primrose. 1994. Molecular Biotechnology. Blackwell, UK

BIO2C12: LAB COURSE IN COMPUTER PROGRAMMING – I (Practicals) (2 Credits)

Exercises based on the following topics

- C fundamentals - data types, operators and expressions, hierarchy of operators, C Instructions
- Control statements - decision (*if, if-else*), and loop (*while, do-while; for*) controls, branching (*switch, break and continue*)
- Functions - passing arguments to a function, function declaration, prototypes, call by value, pointers and call by reference, recursion
- Arrays - initializations, passing arrays to functions, multidimensional arrays, pointers and arrays
- Strings - standard library string functions, pointers and strings
- Input/Output in C - types of I/O, console I/O, disk I/O, formatted and unformatted I/O functions
- Structures - defining, accessing structure elements, array of structures, structures and pointers, passing structures to a function
- Some additional features of C - command line arguments, C preprocessor, macros, enumerations, user defined data types (*typedef*), type casting, memory allocation (*malloc, calloc*)
- Data structures - linked lists, binary trees, stacks and queues

References

- Balagurusamy. 2000. Programming in C. Tata Mc Graw
- Hutchison and Just. 1988. Programming using the C language. Mc Graw Hill
- Booch. Object Oriented Analysis and Design. Pearson Education

Girija D

Dr. D. GIRIJA
Professor
ept. of Agricultural Microbiology
College of Horticulture
Kerala Agricultural University
Vellanikkara - 680 656

SEMESTER –III

BIO3C13: GENOMICS, PROTEOMICS AND METABOLOMICS (4 Credits)

- Introduction to genome wide expression analysis
- Micro array - overview of array technologies (DNA and oligo array), image analysis and normalization, experimental design (variability and replication), cluster analysis, micro array databases
- SAGE - generation and evaluation of SAGE tags, statistical analysis, SAGE databases
- EST - generation, cluster analysis, interpretations, EST databases
- Strategies for protein separation- SDS-PAGE, PAGE, 2DGE, liquid chromatography
- Protein identification using mass spectrometry
- Strategies for protein quantification using 2DGE and mass spectrometry
- Protein modification - phosphorylation, glycosylation
- Protein chips - antibody arrays, antigen arrays
- Protein-protein interaction studies - yeast two hybrids, phage interaction display
- Protein interaction databases - ProNet, Biomolecular Interaction Network Database (BIND), Database of Interacting Proteins (DIP), Molecular Interactions Database (MINT)
- Classification of enzymes, metabolic pathways
- Metabolic pathway databases - KEGG, EMP
- Enzymes, compounds and reactions databases - LIGAND, ENZYME, BRENDA
- Comparison and engineering of metabolic pathways
- Metabolic networks

References

- Lockhart et al., 2000. Genomics, Gene Expression and DNA Arrays. Nature, 405, 827 -836
- Gwynne et al., 1999. Micro Array Analysis: The Next Revolution in Molecular Biology. Science, August issue
- Twyman. 2004. Principles of Proteomics. BIOS Scientific, UK
- Liebler. Introduction to Proteomics, Tools for the New Biology. Humana Press
- Lesk. 2004. Introduction to Protein Science: Architecture, Function and Genomics. Oxford
- Primrose and Twyman. Principles of Genome Analysis and Genomics. Blackwell
- Schuster et al., 1999. A General Definition of Metabolic Pathways Useful for Systematic Organization and Analysis of Metabolic Networks. Nature Biotechnology, 18, 326 – 332
- Schilling et al., 1998. The underlying pathway structure of biochemical reaction networks. PNAS, 95, 4193 – 8

BIO3C14: COMPUTER PROGRAMMING – II (4 Credits)

- Object oriented programming and Java
- How java differs from C?
- Java byte codes



Dr. D. GIRIJA
Professor
Dept. of Agricultural Microbiology
College of Horticulture
Kerala Agricultural University
Vellanikkara - 680 656

11

- Data types and variables
- Arrays, strings, conditionals and loops
- Classes and methods
- Declaring - class, objects, constructors, garbage collection
- Operators - arithmetic, bitwise, relational, boolean logical, assignment, the dot operator
- Modifiers, access control
- Inheritance, packages, interfaces, abstract classes, files handling
- Streams, input /output, linked lists
- Exception, multithreading
- Java applet class and interfaces
- Introduction to html
- History of html, html generations, html document
- Anchor tag, hyper links, head and body sections, header section, title, links
- Colorful pages, comments, body section
- Tabling handling – tables, creating table, width and cells of the table, cells spanning multiple rows/columns, coloring cells, column specification
- Heading -horizontal ruler, paragraph, tabs, images and pictures, lists and their types, nested lists, table handling

References

- Schildt. 2001. Java2 Complete Reference. Tata McGraw Hill
- Bayross. Java 2.0 (web enabled commercial application development) BPB
- Xavier. 2000. World Wide Web Design with HTML. TMH
- Niederest Web.Design in Nutshell. O'Reilly

BIO3C15: ALGORITHM IN COMPUTATIONAL BIOLOGY (4 Credits)

- Analysis of DNA and protein sequences - codon distributions, frequency statistics
- Genome sequence assembly - aligning overlaps
- Pair wise alignment - dynamic programming - global (Needleman and Wunsch) and local (Smith and Waterman) methodologies - scoring matrices (PAM, BLOSUM)
- Heuristic Algorithms for Database searching (BLAST, PSI-BLAST, FASTA)
- Multiple sequence alignment- genetic algorithms, progressive global multiple alignment, block based and motif based alignment
- Phylogenetic analysis - maximum parsimony, UPGMA, neighbor - joining, tree construction (TSP), boot strapping strategies
- Finding genes and regulatory elements - hidden markov model (HMM) and neural networks
- Secondary structural prediction in protein - Chou and Fasman and GOR
- 3D structure prediction, simulation and docking - genetic algorithms and Monte Carlo methods
- Structure optimization - steepest descent, conjugate gradient, Newton-Raphson

References

- Baxevani and Ouellette. 1998. Bioinformatics: A practical Guide to the Analysis of Genes and Proteins, John Wiley and Sons, New York

Girija D
 Dr. D. GIRIJA
 Professor
 Dept. of Agricultural Microbiology
 College of Horticulture
 Kerala Agricultural University
 Vellanikkara - 680 656

- Rastogi et al., Bioinformatics - Concepts, Skills, Applications
- Durbin et al., 1998. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press
- Bishop and Rawlings. 1997. DNA and Protein Sequence Analysis. A Practical approach, IRL Press, Oxford
- Doolittle. 1986. Computer Methods for Macromolecular Sequence Analysis (Methods in Enzymology, vol. 266). Academic Press, San Diego

BIO3C16: LAB COURSE IN SEQUENCE ANALYSIS (Practicals) (2 Credits)

- Web based bioinformatics resources (NCBI/EBI/EXPASY etc.) - tutorials
- Nucleic acid sequence databases (GenBank /EMBL/DDBJ)
- Protein sequence databases (SwissProt, NBRF-PIR, TrEMBL)
- Protein structure databases (PDB)
- Genome databases
- Database search engines (Entrez, SRS)
- Secondary databases
- Data base file formats
- Concepts of sequence analysis
- Analysis of protein and nucleotide sequences using EMBOSS or GCG Wisconsin package
- Sequence similarity – pair wise and multiple sequence alignment (Clustal X, Clustal W, dialign, T-coffee)
- Database similarity search (BLAST, FASTA)
- Gene finding
- Finding promoters and repeats
- Phylogenetic trees (Tree view, NJ- Plot, PHYLIP).
- Molecule visualization (RasMol, Cn3D, Qmol)
- Metabolic pathway database and tools using KEGG

References

- Baxevani and Ouellette, 1998, Bioinformatics: A practical Guide to the Analysis of Genes and Proteins, John Wiley and Sons, New York
- Durbin et al., 1998, Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, Cambridge University Press

BIO3C17: LAB COURSE IN STRUCTURE PREDICTION (Practicals) (2 Credits)

- Primary sequence analysis - physicochemical analysis of proteins
- Prediction of secondary structural element and trans-membrane regions
- Searching patterns, motifs and profiles in sequence (Prosite, Blocks, Prints, Pfam)
- Modeling small molecules - Chemdraw, Hyperchem
- Accessing protein structures from PDB
- Structural visualization - Rasmol, PyMol and Cn3D
- Structural macro-analysis (folds, classification, similarity) - CATH, SCOP, Dali
- Protein geometry -calculation of surface area, volume, radii and packing
- Comparative 3D structure prediction using SWISS-MODEL/What IF – model

Girija D

Dr. D. GIRIJA
 Professor (13)
 Dept. of Agricultural Microbiology
 College of Horticulture
 Kerala Agricultural University
 Vellanikkara - 680 656

generation, structure refinement, validation (VADAR) , molecular dynamics simulation

- Structural alignment - rms superimposition, scoring structural similarity
- Structure - function relationships
- Molecular docking - Hex, Gramm, Autodock or Dock

References

- Branden and Tooze. 1999. Introduction to Protein Structure
- Bourne. Structural Bioinformatics. John Wiley and Sons
- Andrew. Molecular Modeling: Principles and Applications
- Smith. Introduction to Theoretical Organic Chemistry and Molecular Modeling
- Cantor and Schimmel. 2004. Biophysical Chemistry. Part I: The Conformation of Biological Macromolecules. Freeman and Company, New York

SEMESTER - IV

BIO4C19: LAB COURSE IN COMPUTER PROGRAMMING – II (Practicals) (2 Credits)

- String conversion, extraction and printing
- Implementation of the concept of multiple inheritance using interfaces
- File processing
- Java applets program
- Exception handling and multithreading
- Designing and publish a web page- web designing tools, Microsoft front page express, working with text in web, pages, creating paragraphs and lists, font, title, head tags, picture gallery, images and colors, tables, links


References

- Schildt. 2001. Java2 Complete Reference. Tata McGraw Hill
- Bayross. Java 2.0 (web enabled commercial application development) BPB
- Xavier. 2000. World Wide Web Design with HTML. TMH
- Niederst Web Design in Nutshell. O'Reilly

ELECTIVES:

E01. STRUCTURAL BIOLOGY AND MOLECULAR MODELING (4 Credits)

- Internal and external co-ordinate system
- Generation of coordinates of biopolymers in Cartesian and cylindrical polar coordinate system
- Covalent and non covalent interactions, backbone and side chain conformations,
- Ramachandran plot, secondary structures, super secondary structures, tertiary structure and quaternary structure
- Principles of protein folding
- Experimental methods for structure determination in macromolecules (protein, nucleic acid, carbohydrates)-X-ray crystallography, UV spectroscopy, IR spectroscopy, NMR spectroscopy, Circular Dichroism (CD)
- X-ray crystallography of macromolecules - isolation and purification of proteins,


Dr. D. GIRIJA
Professor
Dept. of Agricultural Microbiology
College of Horticulture
Kerala Agricultural University
Vellanikkara - 680 656

14

crystallization, molecular replacement method and direct method, fiber diffraction, analysis of structure and correctness of structures, calculation of electron density map, structure refinement, submission of data to PDB

- Calculation of conformational energy for macromolecules
- Structural databanks - protein data bank, Cambridge small molecular crystal structure databank, secondary structure databases (SCOP, CATH, HSSP, FSSP)
- Methods for protein secondary and tertiary structure prediction - fold recognition, knowledge based structure prediction, *Ab initio* methods
- Methods for comparison of 3D structures of proteins
- Methods to predict 3D structures of DNA and RNA
- Molecular mechanics and molecular dynamics of oligopeptides, proteins, nucleic acid and small molecules -simulation of molecular mechanics and dynamics, Monte carlo simulations, simulation of free energy changes, empirical force fields, energy minimization techniques, techniques for efficient conformational search
- Molecular interactions - protein - protein, protein - DNA, protein - carbohydrate, DNA - small molecules
- Docking of Molecules and Molecular Design

References

- Branden and Tooze. 1999. Introduction to Protein Structure
- Bourne. Structural Bioinformatics. John Wiley and Sons
- Andrew. Molecular Modeling: Principles and Applications
- Smith. Introduction to Theoretical Organic Chemistry and Molecular Modeling
- Cantor and Schimmel. 2004. Biophysical Chemistry. Part I: The Conformation of Biological Macromolecules. Freeman and Company, New York

E02. DATABASE DEVELOPMENT (4 Credits)

- Introduction to Oracle features
- DDL statements (create, drop)
- DML statements (insert, update, delete, truncate)
- DCL statements (grant, revoke, commit, rollback)
- Data types
- Input data and retrieval
- Date and string functions, union and intersect operator
- Queries and sub queries
- Views, indexes, primary and foreign keys
- Creating reports
- Introduction application development using VB
- Data types
- Date and strings, arrays, loops, iterative statements, code and forms
- Variables, procedures and controlling program executor
- Standard controls
- Data access using data control
- Connecting to Oracle data base using Visual Basic



Dr. D. GIRIJA
Professor

Dept. of Agricultural Microbiology
College of Horticulture
Kerala Agricultural University
Vellanikkara - 680 656

References

- Desai. 1991. An Introduction to Database Systems. Galgotia
- Date. 1983. An Introduction to Database Systems. Addison Wesley
- Korth and Silberschatz. Database System Concepts. Tata Mac-Graw Hill
- Hansen and Hansen. Database Management and Design. PHI
- Martin. Introduction to Database Systems Organization. PHI
- Kolste and Peterson. Oracle: Power Objects Handbook
- Que Series. 2001. Using Visual Basics
- Cornell. 1999. Visual Basic 6. Tata Mc Graw Hill

E03. DATA MINING (4 Credits)

- Data analysis methods and classification
- Tools for web search
- Data retrieval tools
- Data mining of biological databases
- Biological data integration and management.
- Gene mapping
- Mining chemical compounds
- Discovery of frequent sequential and structured patterns

Reference:

- S.C.Rastogi, N.Mendiratta, P.Rastogi: Bioinformatics methods and application
- Wang, J.T.L., Zaki M.J., Toivonen H. Shasha D.E: Data mining in bioinformatics.

E04. CHEMOINFORMATICS AND DRUG DISCOVERY (4 Credits)

- History and evolution of chemoinformatics, chemical international resources
- General strategy and concepts
- Chemical databases – 2D and 3D database searching
- 3D pharmacophore
- Design of combinatorial libraries
- Drug design and discovery, development of new drugs, pro drugs and soft drugs
- Chemical and physicochemical parameters in drug design
- Structure activity relationships
- Therapeutic target selection
- Rationale for computer aided drug designing
- Drug design without a target 3D structure - conformational searching and pharmacophore mapping, QSAR computational screening of 3D chemical databases, virtual and high throughput screening of drug candidates
- 3D target structure-based drug design - docking, physicochemical parameters influencing binding, de novo drug design
- Impact of genomic science in drug design

Reference

- Uwe Scherf et al., 2000. A Gene Expression Database for the Molecular Modeling Pharmacology of Cancer. Nature Genetics, 24:236 -234
- Schilling et al.1998. The Underlying Pathway Structure of Biochemical Reaction


Dr. D. GIRIJA
Professor
Dept. of Agricultural Microbiology
College of Horticulture
Kerala Agricultural University
Vellanikkara - 680 656

16

- Networks. PNAS, 95:4193-8
- Stephen Schuster et al.1999. A General Definition of Metabolic Pathways Useful for Systematic Organization and Analysis of Metabolic Networks. Nature Biotechnology, 18:326 -332
 - King. Medicinal Chemistry: Principles and Practice
 - Combinatorial Chemistry, Genomics, and Cheminformatics. Glaxo SmithKline, UK

E05. APPLIED BIOINFORMATICS (4 Credits)

- Introduction to bioinformatics and application
- Data organization
- Sequence comparison
- Sequence based database searches
- Comparative genome analysis
- EST annotation
- Protein structure prediction
- Phylogenetic analysis
- Simulation of molecular interaction

Reference:

- S.C.Rastogi, N.Mendiratta, P.Rastogi: Bioinformatics methods and application
- Dr.K.Mani, N.Vijayaraj: Bioinformatics for Beginners
- Harisha S : Fundamentals of Bioinformatics

N. B. Students are advised to follow the latest editions of the books for their study.



Dr. D. GIRLIA
Professor
Dept. of Agricultural Microbiology
College of Horticulture
Kerala Agricultural University
Vellanikkara - 680 656

17

