REGULATIONS, SCHEME AND

SYLLABUS FOR

M.Sc. BIOINFORMATICS PROGRAMME

(UNDER CSS)

AT AFFILIATED COLLEGES OF

MAHATMA GANDHI UNIVERSITY

KOTTAYAM, KERALA

(W.E.F 2012-2013)

REGULATIONS, SCHEME & SYLLABUS OF M.Sc. DEGREE PROGRAMME IN BIOINFORMATICS

1. ELIGIBILITY & ADMISSION

B.Sc in Biochemistry, Biophysics, Biotechnology, Plant Biotechnology, Bio-informatics, Botany, Zoology/Plant Biology/Chemistry/Computer Science, Computer Application, Electronics, Environmental Science, Mathematics, Microbiology, Physics, Statistics with not less than 55% marks in the subject concerned. MBBS, B.Tech and B.Sc. MLT degree holders can also apply.

2. CURRICULUM

The M.Sc. Bioinformatics Programme under the Credit and Semester System (CSS) consisting of 4 semesters shall extend over a period of 2 years. Semester means a term consisting of a minimum of 90 working days, inclusive of examination, distributed over a minimum of 18 weeks of 5 working days each. A student has to complete a minimum of 80 credits which would be distributed as following.

Core Course (PC)

a) Theory - 45 Credits

b) Practicals - 16 Credits

Elective Course (PE)

a) Theory - 12 Credits

b) Project - 4 Credits

c) Viva Voce – 3 Credits

'Course' means a segment of subject matter to be covered in a semester. **'Credit' (Cr)** of a course is a measure of the weekly unit of work assigned for that course in a semester.

'Course Credit' One credit of the course is defined as a minimum of one hour lecture /minimum of 2 hours lab/field work per week for 18 weeks in a semester.

The course will be considered as completed only by conducting the final examination. No regular student shall register for more than 24 credits and less than 16 credits per semester. The total minimum credits, required for completing a PG programme is 80.

'Programme Core course' (PC) means a course that the student admitted to a particular programme must successfully complete to receive the Degree and which cannot be substituted by any other course.

'**Programme Elective course' (PE)** means a course, which can be substituted, by equivalent course from the same subject and a minimum number of courses is required to complete the programme.

'Programme Project' means a regular project work with stated credits on which the student undergo a project under the supervision of a teacher in the parent department / any appropriate research center in order to submit a dissertation on the project work as specified.

'Academic week' is a unit of five working days in which distribution of work is organized from day one to day five, with five contact hours of one hour duration in each day. A sequence of 18 such academic week constitutes a semester.

Zero Semester means a semester in which a student is permitted to opt out due to unforeseen genuine reason.

Examination:

To be conducted as per rules and regulations framed under credit and semester system.

- There shall be University examination at the end of each semester.
- Practical examinations shall be conducted by the University at the end of each semester.
- Project evaluation and Viva -Voce shall be conducted at the end of the programme only. Project evaluation and Viva-Voce shall be conducted by two external examiners and one internal examiner.

- There shall be one end-semester examination of 3 hours duration in each lecture based course and practical course.
- A question paper may contain short answer type/annotation, short essay type questions/problems and long essay type questions. Different types of questions shall have different weightage to quantify their range. Weightage can vary from course to course depending on their comparative importance, but a general pattern may be followed by the Board of Studies.

EVALUATION AND GRADING

Evaluation: The evaluation scheme for each course shall contain two parts; (a) internal evaluation and (b) external evaluation. 25% weightage shall be given to internal evaluation and the remaining 75% to external evaluation and the ratio and weightage between internal and external is 1:3. Both internal and external evaluation shall be carried out using Direct-grading system.

Internal evaluation

The internal evaluation shall be based on predetermined transparent system involving periodic written tests, assignments, seminars and attendance in respect of theory courses and based on written tests, lab skill/records/viva and attendance in respect of practical courses. The weightage assigned to various components for internal evaluation is a follows.

Components Weightage

i) Assignment-------- 1

ii) Seminar ----------2

iii) Attendance -------- 1

iv) Two Test papers—2

Letter Grade	Performance	Grade point(G)	Grade Range
A	Excellent	4	3.50 to 4.00
B	Very Good	3	2.50 to 3.49
C	Good	2	1.50 to 2.49
D	Average	1	0.50 to 1.49

Grades for Attendance

% of Attendance	Grade
<90%	A
Between 85 and 90	B
Between 80 and below 85	C
Between 75 and below 80	D
<70%	E

Assignment

Components	Weights
Punctuality	1
Review	1
Content	2
Conclusion	1
Reference	1

Seminar

Components	Weights
Area/Topic Selected	1
Review/Reference	1
Content	2

Presentation	2
Conclusion	1

Practical-Internal

Components	Weights
Attendance	1
Laboratory Involvement	2
Written/Lab test	2
Record	2
Viva-Voce/Quiz	1

PROJECT EVALUATION

Internal

Components	Weights
Punctuality	1
Experimentation/Data Collection	1
Compilation	1
Content	1

External

Components	Weights
Area/Topics Selected	1
Objectives	2
Review	1
Materials & Methods	2
Analysis	2
Presentation	2
Conclusion/application	2

DIRECT GRADING SYSTEM

Direct Grading System based on a 5 - point scale is used to evaluate the performance (External and Internal Examination of students). The overall grade for a programme for certification shall be based on CGPA with a 7-point scale given below.

CGPA	Grade
3.80 to 4.00	A+
3.50 to 3.79	A
3.00 to 3.49	B+
2.50 to 2.99	B
2.00 to 2.49	C+
1.50 to 1.99	C
1.00 to 1.49	D

A separate minimum of C grade is required for a pass for both internal evaluation and external evaluation for every course. For a pass in a programme a separate minimum grade C required for all the courses and must score minimum CGPA of 1.50 or an overall grade of C and above.

After the successful completion of a semester, Semester Grade Point Average (SGPA) of a student in that semester is calculated using the formula given below. For the successful completion of semester, a student should pass all courses and score a minimum SGPA of 2.0. However, a student is permitted to move to the next semester irrespective of her/his SGPA.

For instance, if a student has registered for 'n' courses of credits C1, C2 ……,Cn in a semester and if she/he has scored credit points P1, P2……,Pn respectively in these courses, then SGPA of the student in that semester is calculated using the formula.

SGPA= (P1+P2+…….+Pn)/ (C1+C2+……+Cn)

CGPA = [(SGPA)1*S1 + (SGPA)2*S2 + (SGPA)3*S3 + (SGPA)4*S4]/ S1+S2+S3+S4)

Where S1, S2, S3, and S4 are the total credits in semester1, semester2, semester3 and semester 4.

Pattern of Questions

Questions shall be set to assess knowledge acquired, standard application of knowledge, application of knowledge in new situations, critical evaluation of knowledge and the ability to synthesize knowledge. The question setter shall ensure that questions covering all skills are set. He/she shall also submit a detailed scheme of evaluation along with the question paper. A question paper shall be a judicious mix of short answer type, short essay type/problem solving type and long essay type questions.

Weight: Different type of questions shall be given different weights to quantify their range as follows.

Sl.No.	Type of Questions	Weight	Number of questions to be answered
1	Short Answer type Questions(not exceeding one page)	1	5 out of 8
2	Short essay/Problem solving type questions(not exceeding 2 pages)	2	5 out of 8
3	Long Essay type questions	5	3 out of 6

GRADE CARD

The University under its seal shall issue to the students, a grade card on completion of each semester, which shall contain the following information. Name of the University, Name of college, Title of the PG Programme, Name of Semester, Name and Register Number of students, Code number, Title and

Credits of each course opted in the semester, Title and Credits of the Project Work.

In addition to these the grade card shall contain internal, external and total grade, Grade Point (G), Letter grade and Credit point (P) in each course opted in the semester, the total credit, total credit points and SGPA in the semester.

The Final Grade Card issued at the end of the final semester shall contain the details of all courses taken during the entire programme including those taken over and above the prescribed minimum credits for obtaining the degree. The Final Grade Card shall show the CGPA and the overall letter grade of a student for the entire programme.

SEMESTER	COURSE TITLE	HOURS/ WEEK	CREDIT	TOTAL CREDIT
I	**BIF1M001PC1-**Introduction to Cell Biology and Biomolecules	4	4	19
	BIF1M001PC2-Fundamentals of Applied Mathematics & Biostatistics	3	3	
	BIF1M001PC3-Genetics and Molecular Biology	4	4	
	BIF1M001PC4-Introduction to Computing and Bioinformatics	4	4	
	BIF1M001PP1-Laboratory Course 1	10	4	
II	**BIF2M002PC5-**Metabolism & Bioenergetics	4	4	19
	BIF2M002PC6 -General Microbiology	3	3	
	BIF2M002PC7 –Genomics	4	4	
	BIF2M002PC8 -Bioinformatics & PERL	4	4	
	BIF2M002PP2- Laboratory Course 2	10	4	
III	**BIF3M003PC9** – Proteomics	4	4	19
	BIF3M003PC10- Immunology	4	4	
	BIF3M003PC11 –DBMS & Biological Databases	4	4	
	BIF3M003PC12- Bioinformatics in the future	3	3	
	BIF3M003PP3 - Laboratory Course 3	10	4	
IV	**BIF4M004PE1 -** Genetic Engineering & IPR	5	4	23
	BIF4M004PE2 - CADD & Molecular Modelling	5	4	
	BIF4M004PE3 - Bioprogramming & Soft Computing Techniques	5	4	
	BIF4M004PP4 - Laboratory Course 4	10	4	
	BIF4M004PD - Project OR Dissertation	-	4	
	VIVA-VOCE	-	3	
Additional Electives of Fourth Semester	**BIF4M004PE4-** IPR &Bioethics	5	4	
	BIF4M004PE5- Pharmaceutical Chemistry & Action of Selected Drugs	5	4	
	BIF4M004PE6- Basics of Nanotechnology	5	4	

M.Sc. BIOINFORMATICS

1st Semester CBCSS

Paper I INTRODUCTION TO CELL BIOLOGY AND BIO MOLECULES

BIF1M001PC1– Credits – 4

Unit – 1

Life – Form & Function

Origin of Life

Prokaryotic & Eukaryotic Cells (Cellular Architecture)

Structural Organization and Function of Intracellular Organelles

Cell Membrane – Structure and Function

Membrane Transport

Unit – II

Genomic Organization in Prokaryotes & Eukaryotes,

Cell Division and Cell Cycle

Cellular Communication

Unit – III

Cell Signalling and Cancer

Unit – IV

Structural Units, Chemistry and Function of

Carbohydrates

Proteins

Lipids

Nucleic Acids

Unit – V

Structural Units, Chemistry and Function of

Plant & Animal Hormones

Plant & Animal Pigments

Neurotransmitters

Vitamins

References

1. Campbell, Essential Biology (Abridged), Cambridge.
2. Starr & Taggart, Biology : The Unity and Diversity of Life.
3. Lehninger : Principles of Biochemistry.
4. Lubert Stinger : Biochemistry
5. Donald Voet & Judith.G.Voet – Biochemistry.
6. Murary : Harper's Biochemistry
7. Geoffry.M Cooper and Robert.E.Hansmann : The Cell

Paper II FUNDAMENTALS OF APPLIED MATHEMATICS AND BIOSTATISTICS

BIF1M001PC2– Credits – 3

Unit I – Sets

Set Theory, Sets : Relations and Functions, Counting and Operation, Definition of Sets and Subsets, Combination, Demorgan's Laws Factorial, Permutation, Binonial Coefficients, Mathematical Induction

Unit II – Probability

Laws of Probability : Probability Events, Addition and Multiplication Theorem, Conditional Probability : Bayis Theorem, Random Variables : Probability Distribution, Binomial, Poisson, Normal, 't' etc; Sampling : Process : Probability Vectors, Stochastic matrices, Matrix chains.

Unit – III – Vectors & Matrices

Vectors : Scalars & Vectors;Addition, Subtraction, Dot, Cross and Scalar Triple Products.

Matrices : Types, Addition, Subtraction, Multiplication Transpose & Inverse, Determinants, Solutions of Simultaneous equations using matrices, Transformation Matrices For Scaling, Translation, Rotation, Reflection etc.

Unit – IV – Introduction to Graph Theory

Basic Terminology, Directed and Undirected Graphs, Vertices and Edges, Subgraphs, Isomorphism, Correctedness, Components, Weighted Graphs, Shortest paths in Weighted Graphs, Eulerian paths and Circuits, necessary and sufficient conditions Hamiltonian

Paths – Sufficient conditions Bipartite Graphs, Planar Graphs, Applications of Graphs in Bioinformatics & Computer

Unit – V – Introduction to Biostatistics

Collection, Classification & Diagrammatic Representation of Statistical Data, Frequency, Frequency Distribution Measures of Central Tendency: Mean, median, mode, geometric mean, harmonic mean, Percentile Measures of Dispersion : Range, Mean deviation, Variance & Standard Deviation Regression & Correlation, Chi-Square Test, Students T-test, ANOVA and other statistical Packages.

References

1. Ch.Liue : Elements of Discrete Mathematics
2. Harara F : Graph Theory
3. Briley N.J.T : Statistical Methods in Biology
4. Sokal R.R., Rohl E.J : Introduction to Biostatistics
5. Jenny Olive, Maths – A Self Study Guide, Cambridge University Press.
6. Alexander Isacev-Introduction to Mathematical Methods in Bioinformatics, Springer.
7. Sundar Rao & Richard-An Introduction to Biostatistics PH1, 3e.
8. Lipschutz-Theory & Problem of Probability : Schann's Outline' Series, Tata McGraw Hill.

Paper III – GENETICS AND MOLECULAR BIOLOGY

BIF1M001PC3– Credits – 4

Unit – 1 – Genetics

Heredity and Variation

Mendelism – Experiments in Garden Pea, Monohybrid & Dihybrid Crosses, Dominance, Segregation and Independent Assortment.

Concept of Gene – Alleles, Multiple Alleles, Gene Interactions, Epistasis, Pleiotropy, Complementation Tests.

Linkage, Crossing over and chromosome maps, chromosome theory of Inheritance.

Maternal effects and Cytoplasmic inheritance.

Unit – II

Genomic Organization in Prokaryotes and Eukaryotes. Chromosome and Chromatin Structure, Structural and Numerical alterations of Chromosomes. Gene Mutations and their molecular basis

Unit – III

DNA as genetic material, Watson – Crick Model, DNA Polymorphism, DNA Super Coiling

Functions of DNA and Experiments Proving genetic material is stored in DNA.

DNA replication in Prokaryotes and Eukaryotes

DNA replication in λphage and ϕ X174 (Rolling Circle Replication)

DNA damage, DNA repair, DNA recombination.

Mechanisms of Transpositions in eukaryotes and Viruses with specific examples.

Unit – IV

Expression of the Genome

Transcription in Prokaryotes and Eukaryotes

Post transcriptional processing in Prokaryotes and Eukaryotes

Structural and functional aspects of Genetic Code

Mechanism of Translation : Protein Synthesis and Post – Translational Modifications

Unit – V Regulation of Gene Expression

Constitutive, Inducible and Repressible gene expression.

Lac Operon, Tryptophan and Arabinose Operon in E.Coli

References:

1. Gardner E : Principles of Genetics
2. Gupta P.K : Cytology, Genetics and Evolution
3. Snustad, Simmons : Principles of Genetics.
4. Introduction to Genetic Analysis Eighth Edition, Griffiths, Wessler
5. Genes VIII : Lewin
6. Klug, Cummings : Concepts of Genetics
7. Molecular Biology of the Gene : James D.Watson
8. Robert F.Weaver : Molecular Biology
9. Gupta P.K : Cell and Molecular Biology

PAPER IV – INTRODUCTION TO COMPUTING AND BIOINFORMATICS

BIF1M001PC4– Credits – 4

Unit I – Introduction to Computer Systems

Introduction : Characteristics of Computer Systems; Functions and Components of Computer; Memory Units; Computer Software's : Operating Systems Functions and Classifications, Utilities, Compilers and Interpreter, Word Processor, DBMS, Image Processor; Programming Languages

MS Office – Making effective Power Point Presentations, Mobile Technologies – Android & Other Operating Systems.

Introduction to Bioinformatics

What is Bioinformatics Aim of Bioinformatics, Branches of Bioinformatics, Comparative Study of Bioinformatics and Computational Comparative Study of Bioinformatics and Computational Biology, Scope / Research Areas of Bioinformatics, Pharmaceutical, R&D and Bioinformatics industries and Institutions in India & World wide.

Unit – II – Networks & Internet

Networks : Introduction; Network Classification LAN, WAN, MAN, Connection Methods – Wired & Wireless Technologies.

Internet : WWW; Search engines, Intranet, URL, FTP, DNS, CDN, Web browser, Ethernet, News Graphs, IP address, e-mail & Chat.

Internet connections, Modems, ISP, Dial-up and Direct Connections, WLL, DSL, Leased Line Internet Security & Privacy, Viruses & Protection.

Unit – III – HTML & LINUX

HTML tags for formatting text, pictures, audio, forms, tables, Introduction to CSS, Special Tags in HTML, Introduction to XML Introduction to LINUX O/S and Basic commands

Unit – IV – Overview of C Programming: Introduction & Basic Structure of C Programs

Constants, Variables & Data types; Operators and Expressions; Managing I/P and O/P Operators; Decision making and Branching Decision making and Looping arrays.

Unit – V

Strings, Functions, Structures & Files

Handling of Character Strings; User defined Functions – Introduction, A Form of C Functions, Return Values and their types, Category of Functions, recursion.

Structures : Introduction, Structure : Definition, Giving Values to members, Structure Initilization, Comparision of Structure Variables, Arrays of Structure Variables, arrays of Structures Introduction to FILE Concept in C Language.

References

1. Alexis Leon & Mathews Leon – Fundamentals of IT
2. E.Balaguruswamy – Programming in ANSI C
3. Rhonda Abrams & Julie Valloul – Winning Presentation in a Day.
4. Barbara Wilson – Information Technology : The Basics
5. L.N.Charli – Bioinformatics and Bioprogramming in C
6. Wibas C, Jenbeck P – Developing Bioinformatics Computer Skills.

BIF1M001PP1-Laboratory Course 1

I.Identification of Carbohydrates, Proteins and Lipids by Qualitative Analysis (Colour Reactions)

- ∗ Identification of mixtures - Carbohydrates and Proteins
- ∗ Carbohydrates - Monosaccharides, Disaccharides and Polysaccharides
- ∗ Proteins - Albumin, Casein, Peptone
- ∗ Lipids - Cholesterol

II. Quantitative Analysis of Biomolecules

- a)Glucose - Anthrone, DNSA Methods
- b) Protein - Lowry's Method, Biuret method
- c) Cholesterol - Zak's method
- d) DNA - Diphenyl Amine Method
- e) RNA - Orcinol Method

III
1) Prepare reports in MS Word, MS Excel and Power point
2) Various Linux Commands
3) C Programs -10 Numerical analysis and 5 Biological analysis

Semester II

PAPER V – METABOLISM & BIOENERGETICS

BIF2M002PC5-Credits - 4

Unit-I – Metabolism of Carbohydrates

Digestion and Absorption of Carbohydrates.

Biosynthesis, Degradation and Regulation of Carbohydrates.

Glycolysis, Gluconeogenesis, Citric Acid Cycle, Glycogen Metabolism, Pentose Phosphate Pathway.

Unit – II Bioenergetics

Concept of Chemical Energy, Free Energy, Mitochondrial Respiratory Chain, Oxidative Phosphorylation, Respiratory Control, Transducing membrane structure in Mitochondria Oxidation Reduction Potential, Electron transport chain, and electron transfer complexes. Dependence of oxidative phosphorylatium on electron transfer, Synthesis of ATP. ATP as currency of energy. Hydrolysis of ATP and other high energy molecules.

Photosynthesis : An overview; Chloroplasts, Reaction Centres, Cyclic and Non Cyclic photophosphorylation, Calvin Cycle.

Unit-III – Metabolism of Lipids

Digestion & Absorption of Lipids.

Biosynthesis, Degradation and Regulation of Lipids Beta-oxidation Pathway, Formation of Ketone bodies, Fatty acid Biosynthesis, Biosynthesis of Membrane Lipids and sterols – Phosphatidate and cholesterol. Derivatives of Cholesterol.

Secondary Metabolites : Biosynthesis of Terpenes, Phenols and Nitrogenous compounds and their roles.

Unit – IV

Nucleotide Metabolism

Nucleotide biosynthesis; De Novo Pathway

Salvage Pathway

Catabolism of Purines and Pyrimidines

Unit V : Protein Metabolism

Digestion and Absorption of Dietary Proteins, Amino Acid degradation, Urea Cycle

Inborn Errors of Metabolism

Biosynthesis of Amino Acids

Amino Acids as precursors of Neurotransmitters, Porphyrins – Metabolic Pathway and Regulation, Nitrogen assimilation and fixation in microorganisms.

References:

1. Voet D & Voet J : Biochemsitry
2. Lehningers : Principles of Biochemistry.
3. Murray, Granner, Mayes, Rodwell : Harper's Illustrated Biochemistry.
4. Stryer : Biochemistry.
5. Mathews; Hold; Ahern : Biochemistry.

Paper VI – GENERAL MICROBIOLOGY

BIF2M002PC6- Credits – 3

Unit – I

Principles of Bacterial Taxonomy and Identification of Bacteria. Ultra Structures of Yeast.

History of Microbiology. Five Kingdom Classification of Living System. Study of Microbial morphology Microscopy, Specimen Preparation, Staining Methods, Ultra Structure of Bacterial Cells.

Unit – II

Transport & Storage of Microbes and impact of environmental parameters on growth of microorganisms. Microbial Physiology, Factors determining microbial growth. Nutrition, Growth curve, Growth Kinetics, Microbial metabolism, culture media and methods cultivation of bacteria.

Unit – III

Sterilization principles and Techniques – Disinfection, Mechanism of action of Antibiotics, Method of testing antimicrobial substances, Drug Resistance in Bacteria.

Unit – IV

Medically significant Bacteria; Prominent examples and their study:

Staphylococcus, Coryne bacterium, Bacillus anthracis, Mycobacterium, Mycoplasma.

Features and classification of Viruses.

Medically significant viruses; Prominent examples and their study:

Herpes, Oncogenic viruses, HIV, Arboviruses, Myxovirus, Bacteriophage Lambda : Life Cycle : Lysogeny and Lytic pathway.

Unit V

Plasmids, Protoplast & Spheroplast microbial genetics : Conjugation, transduction and transformation and genotypic changes.

Introduction to recombinatnt DNA technology using plasmids as vectors.

References:

1. Russel A.D : Principles and Practice of Disinfection Preservation and steriolization.
2. Bryan L.E : Antimicrobial Drug Resistance
3. Pelczar Jr Chan, Kreig : Microbiology concepts and applications
4. Prescott Harley & Klein : Microbiology
5. Ananthanarayanan & Jayaram Panicker : Textbook of Microbiology
6. Kucera and Myrvik : Fundamentals of Medical Virology.
7. Mackie and McCartney : Medical Microbiology
8. Kreig N.R., Williams and Wilkins : Bergey's Manual of Systematic Bacteriology.

Paper VII – GENOMICS

BIF2M002PC7– Credits 4

Unit – 1 – Sequence Architecture of Genomes

Organization of genome : Single sequence DNA, Intermediate repeat DNA, Highly repetitive DNA, Cpgislands, Gene Families, Pseudogenes, Duplicated genes,Tandemly repeated genes.

Non protein Coding genes, Split genes, Overlapping genes, Spacer regions, ORF's Cryptic genes. Multigene Families in Eukaryotes, LINE's, SINE's and Transposons (Bacteria, Eukaryoks and Retrotransposons), Microsatellites, Minisatellites and other molecular markers

Unit II – Mapping the Human Genome

Physical Maps and Genetic Maps

Physical Maps – Clone Maps, RH Maps, EST's, STS Maps, FISH (Fluroscent Insitu Hybridization)

Genetic Maps – Map Units, Informative and Non informative phases, Haplotype, CEPH Families, LOD – Score Analysis.

Unit – III – Sequencing the Human Genome

Celera Genomics and IHGSC – Strategies for sequencing

Sequencing technology – Sanger's dideoxy method (Automated whole Genome shotgun sequencing)

Making the Clone Map: Generating, Assembling and Finishing the sequence.

Ethical Issues related to Human Genome Project

Accessing genomes, SNP's, STS's, CpGislands, GC content

Annotating genomes: Gene prediction in Prokaryotes and Eukaryotes ORF prediction, Evaluation of gene prediction and functional annotation. Applications and uses, Advantages and breakthroughs of HGP

Unit-IV – Functional Genomics and Comparative Genomics.

Expression, regulation and cloning disease genes Vs normal genes.

Case study 1 – Breast Cancer

Case Study 2 – CFTR gene

Comparative Genomics – Purpose and Methods of Comparison, Comparison at nucleotide level, breakpoints level, gene cluster level, ontological and phylogenetic comparison. Application of comparative Genomics.

Microarray based technique – Analysis of gene expression at RNA and protein level

DNA Fingerprinting & DNA Foot printing

SNP Maps in population studies.

References:

1. Genomes 3 : T.A.Brown
2. Human Moleuclar Genetics 2nd Edition : Peter Sudbury
3. Sequence and Genome Analysis : David.W Mount
4. A.Malcolm Campbell, Laurie J.Heyer : Discovering Genomics, Proteomics and Bioinformatics
5. Bioinformatics: A practical guide to the Analysis of Genes and Proteins : Andreas DBaxeranis, B.F.Francis Ouelette.

6. Genomics and Cloning; Technology & Applications H.D.Kumar

7. Microarray Bioinformatics : Dv Stekel

8. Data Analysis and Visualization in Genomics and Proteomics : Azuaje and Dopazo.

Paper VIII –Bioinformatics & Perl

BIF2M002PC8–Credits -4

Unit I Biological sequence Analysis

Concept of sequence Alignment, Scoring matrices: PAM & BLOSUM; Alignment of Pairs of sequences: Dot Plot; Alignment Algorithms-Needleman and Wunsch Algorithm, Smith Waterman Algorithm, Search for Homologous sequences using BLAST & FASTA programs

Multiple Sequence Alignment: Dynamic Programming and progressive alignment. Tools: Clustal W, T-Coffee, Altavist and Gene Doc.

Unit II Evolutionary Analysis and Molecular Phylogeny: Concept of Molecular Phylogeny, Representation of Phylogeny, Types of trees, Molecular clock Hypothesis, distance based methods-UPGMA and NJ Algorithm. Character based methods: Maximum Parsimony and Maximum likelihood; validating trees, Boot strapping and Jack knifing, Study of Phylogenetic software-PHYLIP, Clustal X and PAUP, Tree viewing software.

Unit III PERL

Introduction to PERL, Variable Types, Data types, operators, control structures, lists and Arrays, Subroutines, Hash functions, other useful functions, Regular expressions.

Unit IV PERL Contd.

Basic Input output, special variable @ ARGV, Command live Args, File Handles and Tests, Directory Operations, CGI Programming: GET and Post Methods; PERL graphics.

Unit V BIOPERL

Introduction to BIO-PERL, BIO-PERL objects, implementation of Bioinformatics algorithms for searching and matching in PERL, BLAST parsing, handling PDB files, sequence retrieval, alignments.

References

1. C.A.Orango, D.T. Jones and J.M.Thornton-Bioinformatics –Genes Proteins and computers
2. Andreas D. Baxevaris Bioinformatics A Practical Guide to the Analysis of Genes and Proteins
3. Zhumur Ghosh & Mallick Bioinformatics Principles and Applications
4. Jeremy J. Ramsden –Bioinformatics: An Introduction
5. D.Maunt Bioinformatics sequence & Genome Analysis
6. James D Tisdall- Mastering Perl for Bioinformatics
7. Wall, Christian & Orwant- Programming Perl
8. Harshawardhan P.Bal - Perl Programming for Bioinformatics

BIF2M002PP2-Laboratory Course 2

I Sterilization techniques, Preparation of Nutrient media, Plating techniques, Isolation of Bacteria, Yeast and fungi, Growth of Bacteria, Growth curve by turbidity and colony counting Bacterial staining procedures.

II Isolation and characterization of bacteria of medical importance.

III 1) Working knowledge of Perl and Bio-Perl Programming
(15 Programs minimum)
2. Gene Structure and Function prediction. (Using Gene Mark and Gen Scan)
3. ORF Prediction(Using ORF Finder)
4. Sequence Similarity Searching (NCBI Blast, FASTA)
5. Multiple sequence Alignment (Clustal W/Clustal X)
6. Molecular Phylogeny (PHYLIP)
7. Analysis of Nucleic Acid Sequences (Using Bioinformatics Tools)

Semester III

Paper IX-Proteomics

BIF3M003PC9- Credits-4

Unit –I

Principles and Patterns of Protein structure and Conformation

Nature of chemical bonding; peptide bond; Forces stabilizing structure of protein (ionic, hydrophobic, Vanderwaals, hydrogen bonding and covalent bonding) levels of protein structure: primary, secondary, Tertiary and quaternary structures with examples.

Ramachandran plot

Unit –II

Exploring Proteins

Applications of UV-Visible, Fluoroscent Spectroscopy, CD and NMR spectroscopy to stereochemistry of proteins and nucleic acids. Applications of chromatography, centrifugation and Electrophoresis techniques in isolating, separating and purifying protein molecules. Protein sequencing and Mass spectrometry. Protein structure Determination by X-ray crystallography.

Unit III

Protein classification

Letter codes for Aminoacids, Helix, sheet, strand, Loop turns, Motifs, Leucine zipper, Zing finger, Helix Turn Helix, Helix Loop Helix, Blocks, class and Domains, Fold, PSSM, Profile.

Principles of classification based on structural features

CATH-Classification by class, Architecture, Topology, Homology

SCOP-Structural Classification of Protein, FSSP-Fold Classification based on structure.

Unit –IV

Protein Structure Prediction

Using sequence pattern, predicting DNA protein, RNA Protein, transmembrane and signal peptides. Secondary structure prediction: Chou-Fasman/GOR method, Nearest Neighbour method and tertiary structure prediction. Homology Modelling and Threading, High throughput Analysis for proteomes

Unit –V

Active site prediction

Nature and properties of enzymes

Active site mapping, Enzyme Kinetics, Enzyme Inhibition, Enzyme Regulation

Molecular Visualization-Rasmol & SPDBV

References

1. C.A.Drengo, D.T. Jones and J.MThornton Bioinformatics –Genes, Proteins and Computers
2. D.Mount-Bioinformatics Sequence & Genome Analysis
3. Timothy Palzkill - Proteomics
4. Ingvar Eidhammer, Inge Jonassen and William R Taylor - Protein Bioinformatics:An Algorithmic Approach to sequence and structure Analysis.
5. V.Pattabhi & N.Gautam - Biophysics
6. Carl Brandon and John Tooze - Introduction to Protein structure.
7. Kris Gevaent - Protein Identification Methods in Proteomics
8. S.R.Pennington and M.J.Dunn – Proteomics
9. Stryer-Biochemistry.

Paper X- Immunology

BIF3M003PC10-Credits-4

Unit I

Introduction to immunology, infection, immunity, types of immunity, Cells and organs of immune system. Hybridoma Technology, Monoclonal antibodies, immunoglobulins. Antigen, Antibodies, Antigen-antibody reactions. Complements and complement activation.

Unit II

Genetic basis of antibody diversity; B cell differentiation B Cell membrance proteins. T cell differentiation, T-cell receptor complex, Major histocompatiability complex, MHC restriction.

Unit III

Immunostimulants, immunomodulants and ELISA. Humoral and cellular immune response. Activation of T and B cells C ytokines. Immunoregulation, Immunologic tolerance.

Unit IV

Hypersensitivity, Auto immunity, Immuno deficiency diseases. Transplantation immunology, tumor immunology and immune hematology.

Unit V

Computational Immunology

MHC peptides –Structure and interactions QSAR based predictions of epitopes. Epitope modification, epitope mapping tools, Allergenicity prediction. Vaccine design and system immunology

Reference

1. Roitt Elbs: Essential Immunology
2. Kuby immunology Kindt Goldsby
3. DAVID J Hentges Microbiology and Immunology
4. Paul W.E Fundamental immunology
5. Helen Chappel $ Mansel Haeney Essential clinical immunology
6. R.Ananthanarayan and C.K. Jayaram: Text book of Microbiology
7. John W Kimball MAXWELL Introduction to immunology
8. Daren R. Flower Immunoinformatics predicting Immunogenicity In Silico.

Paper XI-DBMS and Biological Databases

BIF3M003PC11- Credits -4

Unit I

Database concept, working with forms, Data Definition Languages, Data Manipulation Language, Data Control Languages, Structural Query Language, creating triggers. Introduction to PL/SQL, SQL plus and SQLJ.

Unit II

Visual Basic- Introduction to Client/Server Technology, Introduction to VB, Features, Datatypes, Strings, Variant, Constant, Data Arrays, Looping and Interactive statements Functions in VB, Working with controls and procedures, Introduction to Data Connectivity, Different Database Connectivity.

Unit III

Biological Databases: Nature and diversity of data, classification and importance of Biological Databases, Nucleic Acid databases-Primary Sequence Databases and secondary sequence Databases, NCBI, Protein databases-sequence and structure, databases (Primary and secondary)

Unit IV

Literature Databases, Disease Databases, Microbiological databases, Genome Databases and other specialized Databases.

References

1. Hanery Korth and Abraham Silber Schatz: Database System concepts
2. Gibas C. Jembecl P: Dereloping Bioninformatics computer skills.
3. J.M. Martin : Introduction to Database system

4. Thayer Rob: Visual Basic 6

5. Cornel Gray: Visual Basic 6 From the group up

6. Jerike Noel: The Complete Reference Visual Basic 6.

7. Misner S, Krawetz : Bioinformatics-Method and Protocols.

Paper XII Bioinformatics in future

BIF3M003PC12–credits-3

Unit I

Microarray Bioinformatics: Concept of gene expression, Types of microarrays; Making Microarrays; Spotted Microarrays, Insitu synthesized Oligonucleotide arrays, Affymetrix technology, Using Microarrays, sample preparation and labeling, Hybridization, washing, image acquisition; Micro array image processing, Image formats, feature extraction, Normalization.

Unit II

Systems and Synthetic Biology

System concept –Properties of Biological systems, self organization, emergence, chaos in dynamical systems, linear stability, bifurcation analysis, limit cycles, attractors, stochastic and deterministic processes, continuous and discrete systems, Modularity and Abstraction, feedback, control Analysis, Well steirres system, Mathematical modeling; Biological Networks-Signal Pathway, GRN, PPIN, Flux Balance Analysis,
Systems biology Vs synthetic Biology, Parts, Device and systems; Biobricks, Circuitory and chassis,, Bacterial camera, Toggle switch, Logic gates, Oscillators, Softwares for synthetic Biology, Case study of Tinker Cell

Unit III

Pharmacogenomics

Introduction, History, Pharmacogenomics vs Pharmacogenetics, Pharmacokinetics and Pharmacodynamics, Human genetic variations, alleles, Types of Polymorphisms, SNP's at structural and functional level. SNP's and emergence of drug resistance Multidrug

Resistance in Tuberculosis concept of P4, Personalized Medicine and ethical issues in pharmacogenomics, Case study of Pharmacogenomics and Pharmacogenomic markers in Schizophrenia, Alcoholism & Neurodegenerative diseases.

Unit IV

Allied Topics in Bioinformatics

Cheminformatics, Toxicogenomics, Clinomics, Ayurinformatics, Mitochondrionics, Metabolomics, Transcriptomics, Next generation Sequencing.

References

1. Dav Stakel: Microarray Bioinformatics
2. Uri Alon-Introduction to Systems Biology Design, Principles of Biological Circuits
3. Stephen Krawetz-Bioinformatics for systems Biology
4. Joseph Seckback and Eitan Rubin-New Avenues in Bioinformatics
5. Yan and Qing-Pharmacogenomics in Drug Discovery and Development
6. P.N. Bannet and M.J.Brown Clinical Pharmacology
7. Darren R. Flower-Immune informatics
8. Kubinji and Muller –Chemogenomics in Drug Discovery

BIF3M003PP3-Laboratory Course 3

I
1) Visual Basic Programming
   a) Project to all six reading frames
   b) Project to convert DNA to RNA, RNA to Protein, DNA to Protein
   c) Project to Restriction site finder
   d) Project to Proteolytic cleavage
   e) Database Creation
      i) Disease database
      ii) Motif database
2) Biological databanks
   a) Sequence Databases
   b) Structure Databases
   c) Specialized Databases
3) Protein Sequence Analysis (Expasy Proteomics tools Any -5)
4) Molecuar Visualization using Rasmol or other programs
5) Microarray data Analysis using MAGIC Tool

II
1) Agglutination Reaction-ABO Blood Grops and Rh Typing
2) Immuno Diffusion Assays-Single radial Immuno Diffusion assay (Mancini Technique)Double diffusion Immuno assay (Ouchterlony Technique)
3) ELISA Tests
4) VIDAL and VDRL slide tests for Diagnosis of Typhoid and syphilis respectively

Semester-IV

Elective I-Genetic Engineering & IPR

BIF4M004PE1–Credits 4

Unit I

Recombinant DNA Technology, Techniques of Gene Manipulation and Enzymes involved.Vectors- Plasmids Phages, Artificial vectors –Cosmids, Phasmids, Fosmids, and Expression vectors, vectors used in Genome Sequencing strategies. Methods of Gene Transfer, Identification of recombinant DNA, Selection of transformants, Applications of rDNA Technology

Unit II

Isolation of Gene, Construction of gene libraries, cDNA and Genomic Library, Chromosome Walking, chromosome Jumping, Whole Genome shotgun Sequencing, Polymerase chain reaction and its variants Gene sequencing –Sanger's Dideoxy Method, Maxam and Gilbert Chemical Degradation Method.Detection of Target DNA- Colony Hybridization, Southern Hybridisation, Insitu Hybridisation, Insitu Hybridisation and other Blotting techniques

Unit III

Transgenic Organisms from C.*elegans* to Dolly to Humans: Methods, Strategies and techniques used in gene transfer. Invitro Mutagenesis and deletion techniques. Gene Knock outs in bacterial and eukaryotic cells.

Unit IV

Probes used in Molecular Biology, their nature and applications, Molecular markers-RFLP, RAPD & AFLP Techniques, DNA Finger printing and DNA foot printing, RNA interference, Micro RNA, SiRNA, Antisense RNA, Chemical Synthesis of Gene.

Unit V

IPR Awareness-Copyrights and Patents

IPR for Soft Wares and Life forms

IPR Laws in India

Patent Amendment -2005 and its impact

Economic benefits of IPR protection

Ethical Issues of Genetic Engineering.

References

1. Watson J.D: Molecular Biology of the Gene.
2. Old R.W Primrose: Principles and Techniques of Gene Manipulation
3. Lewin B: Gene VIII
4. Frefielder D : Essentials of Molecular Biology
5. T.A. Brown: Gene Cloning and DNA Analysis
6. Peter J Russell: Genetics A Molecular approach
7. Robert F.Wearer: Molecular Biology
8. B.Czcpulkowski: Analyzing Chromosomes
9. B.D.Singh: Molecular Biology, Genetic engineering and Applications of Biotechnology.
10. Banerji Rao, Intellectual property Rights: A Primer, Eastern Book Company

Elective II- CADD & Molecular Modelling

BIF4M004PE2-Credits -4

Unit I

Basic Concepts on Diseases, Overview of Human Physiology; Overview of disease types and causes; Human immune response system; Molecular basis of diseases; Molecular targets, target identification, target validation drugggability.

Drugs: Major Characteristics, Mode of Action, Against and Antagonist, Drug discovery, History of drugs and drug discovery classical drug discovery approaches, serendipity, concept of Hit and head; drug discovery pipeline.

Unit II

Introduction to the concept of Molecular Modelling, Molecular structure and Internal energy, Application of Molecular graphics Energy Minimization of small molecules; empirical representation of molecular energies, use of Force fields and the molecular mechanics method. Discussion of local and global energy minima.

Unit III

Technique of Molecular Dynamics and Monte Carlo simulation for conformational Analysis Abinito, dft and semi-empirical methods.

Unit IV

Introduction to macromolecular Modeling Design of ligands for known macromolecular target sites; Drug receptor interactions, classical QSAR studies and their implications to the 3D Modeler, 2D and 3D database searching. Pharmacophore identification and novel drug design.

Unit V

Finding new drug targets to treat disease, New targets for Anti-Cancer drugs. Structure based drug design for all classes of targets.

Reference

1. N.Clauden Cohen-Guide book on Molecular Modelling in Drug Design
2. Andrew R. Molecular Modelling Principles and Applications
3. V.Kothekar – Essentials of Drug designing
4. Paul.S Charifson –Practical application of computer Aided Drug Design.
5. Tamas Barl F; and Graham V. Lees- Drug Discovery
6. K.D. Tripathi –Essentials of Medical Pharmacology.

Elective III- Bioprogramming and Soft Computing Techniques

BIF4M004PE3 Credits 4

Unit –I

Introduction to R Programming

Overview of the R Language; Defining R Project; Obtaining R, where to get help Generating R Code –Basic Programming Concepts, Scripts, Text editors for R, Graphical User Interfaces (GUI's) for R; Vectors and Matrices, Data Frames and tests, Datasets included in R Packages; Manipulating objects, Graphics (Basics) Mathematical Operations, Basic Matrix computation Regular Sequences, Searches, strings and Pattern matching, Hypothesis testing and data handling; t-tests and ANOVA (Basics).

Unit II

Introduction to MATLAB

MATLAB as calculator, standard Matlab windows, operations with variables, arrays, writing script files, writing functions, simple graphics, Data types, File Input-output, Communication with external devices.

Unit III

Introduction to Python

Features of Python, Data types, Variables operators, Features of Python, Data types, Variables, operators and expressions, control flow tools, functions, Data structures, Input and Output, Introduction to object oriented programming CSS and Zope.

Unit- IV

Soft Computing Techniques and Algorithms, Introduction to Soft computing, Hidden Markov Models: Application in Bioinformatics ANN (Artificial Neural Networks) and

their applications in Bioinformatics. Concepts and Applications of SVM (Support Vector Machines) in Bioinformatics. Basic concepts and Applications of Genetic Algorithms.

References

1. Nathan Yan- The Art of R Programming
2. Rudra Prathap –Getting started with MATLAB
3. Pratihar- Soft Computing
4. D.M.Etter et al –Introduction to MATLAB-6
5. Mark Lutz Programming Python
6. David M.Beazly Python Essential Reference.

BIF4M004PP4-Laboratory Course 4

I 1) Working Knowledge of python and R Programming (any 10 simple programs)

II 1) Homology Modeling using SPDBV
2) Model Structure refinement using SPDBV
3) Model validation using What Check and Pro check
4) Docking using any docking tools
5) Study on PDB Sum
6) Analysis of Protein (Sequence and structure) and DNA (Any 10 tools)

III 1) Working Knowledge and Demonstration of PCR
2) Working knowledge and Demonstration of Electrophoresis, Centrifugation and Advanced Chromatographic techniques commonly employed for isolation, separation, and purification of protein and DNA.
3) Working knowledge of DNA sequencing (Sanger's Di-deoxy Method) and recombinant DNA Technology.

Additional Elective I- IPR & Bioethics
BIF4M004PE4- Credits 4

Unit I

Introduction to Intellectual Property

Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP. Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation

Unit II

Types of patents; Indian Patent Act 1970; Recent Amendments; Patent application- forms and guidelines, fee structure, time frames;Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs; Financial assistance for patenting-introduction to existing schemes.

Unit III

IPR and copyrights, Importance of protecting scientific discoveries, Qualification for a Patent – Novel, Commercial & Non-obvious, Jurisdiction of Patent laws, procedures Filing of a patent application; Precautions before patenting-disclosure/non-disclosure

Unit V

IPR policy of Government of India, Indian & International Patent laws, Indian Patent Act 1970; Recent Amendments; Financial assistance for patenting-introduction to existing schemes. Role of patents in Biotechnology and Bioinformatics. The patent ability of microorganisms - IPR and WTO regime - consumer protection and plant genetic resources-GATT and TRIPS, Patenting gene. Issues and case studies.

References

1.P. Narayanan, Intellectual Property Laws, Eastern Law House.2001

2.Meenu Paul, Intellectual Property Laws, Allahabad Law Agency.2009

3.Intellectual Property Law containing Acts and Rules, Universal Law Publication Company.

Additional Elective II-PHARMACEUTICAL CHEMISTRY & ACTION OF SELECTED DRUGS
BIF4M004PE5- Credits 4

Unit-I

Introduction to Antibiotics and mechanism of their action :Structure,chemistry and SAR of: Beta lactam Antibiotics, Pencillins, Cephalosporins, Tetracyclines, Macrolides,Aminoglycoside antibiotics and other miscellaneous antibiotics .

Antitubercular Agents and their mechanism of action.

AIDS

Life Cycle of HIV-Virus ,Potential Targets for Anti-HIV agents; Nucleoside and Non Nucleoside Analogues.

Unit-II

Introduction to Cancer; Classification of Anti cancer Agents, Structure, Chemistry, SAR and Mechanism of action of :-

- Alkylating Agents
- Antimetabolites
- Antibiotics.
- Plant Products.
- Miscellaneous Agents.

Unit-III

Antipyretics and Non-steroidal Anti-Inflammatory Drugs. Biosynthesis of Eicosanoids, Mechanism of Anti-Inflammatory Action and their side effects. Chemistry,Structure and SAR of

→ Salicylates - Aspirin as an example

→ p-Aminophenol derivatives-Paracetamol as an example.

→ Pyrazolidinedione derivatives- Any one example

→ Anthranilic acid derivatives.

- Indole acetic acid ,diclofenac etc as examples.

→ Oxicams

→ Miscellaneous examples.

Unit-IV

Anti-Parkinson's Agents, Chemistry,structure,Mechanism of Action and SAR of :-

- Dopamine agonists
- Dopa decarboxylase inhibitor
- Dopamine releasing agents
- Synthetic anticholinergics
- Other miscellaneous antiparkinson agents

Introduction to Dementia and Alzeheimer's Disease: Chemistry ,Structure, Mechanism of action and SAR of: Cholinergic Agonists and Acetyl Choline Esterase Inhibitors.

Unit-V

Narcotic Analgesics:

Chemistry of Morphine and its analogues

Chemistry of Piperidines, Diphenyl heptanones

Narcotic Antagonists.

Antidepressants and mechanism of action.

Role of monoamine oxidase.

REFERENCES

1) Essentials of Pharmaceutical Chemistry; Donald Cairns
2) Medicinal Chemistry;D.Sriram,P.Yogeeswari
3) An Introduction to Medicinal Chemistry ;Graham.L.Patrick ,John Spencer 2009
4) Medicinal Chemistry;Ashuthosh Khar Revised Third Edition,New Age Publishers
5) Textbook of Medicinal Chemistry,Volume 2;Prof.Dr.V.Alagarswamy
6) Pharmaceutical Chemistry 2;Dr.A.V.Kasture,Dr.S.G.Wadodkar

Additional Elective III- Basics of Nanotechnology
BIF4M004PE6- Credits 4

Unit I

Fundamental Concepts: Nanotechnology: Basic concepts and introduction; Nanomechanics- Nanotribology; Scanning probe microscopy; nanomaterials and its handling; nanobots and nanofuture, nano-fying Electronics, nanofibres, nanopore and nanotubes.

Unit II

Production and characterization of nanoparticles: Introduction to Nanoscience Techniques used in Nanobiotechnology: Optical Microscopy, Atomic Force, Microscopy, SEM; Production of nanoparticles: Collision / Coalescence mechanism of primary particleformation, nanoparticles agglomerates & aerogels.

Unit III

Nanoparticles for Cancer Drug Delivery: Cancer and current approach to its cure through nanoparticles, characteristics of tumor tissues, drug delivery to tumors, physio-chemical properties of nanoparticles in cancer therapy, site specific delivery of chemotherapeutic agents using nanoparticles.

Unit IV

Non-viral Gene Therapy with nanoparticles: Introduction, Hyperthermia, controlled delivery of chemotherapeutic drugs, nanoparticles to circumvent MDR, potential problems using nanoparticles. Application of Nanotechnology in Agriculture, Medicine, Communication technology, Biotechnology and Bioinformatics.

References

1. Bharat Bhushan., Nanotribology and Nanomechanics - An introduction, Springer.
2. Mark, Ratner Daniel Ratner, Nanobiotechnology- next big idea.
3. Challa S.S.R.Kumar, Joseph Hornes, Carola Leuschner, Nanofabrication towards Biomedical applications.