MANONMANIAM SUNDARANAR UNIVERSITY
TIRUNELVELI

UG COURSES – AFFILIATED COLLEGES

B.Sc. Bioinformatics

(Choice Based Credit System)

(with effect from the academic year 2016-2017 onwards)

(44th SCAA meeting held on 30.05.2016)

Sem.	Pt. I/II/ III/ IV/V	Sub No.	Subject status	Subject Title	Hrs./ week	Cre-dits	Marks				
							Maximum			Passing minimum	
							Int.	Ext.	Tot.	Ext.	Tot.
III	I	17	Language	Tamil/Other Language	6	3	25	75	100	30	40
	II	18	Language	English	6	3	25	75	100	30	40
	III	19	Core - 5	MICROBIOLOGY & IMMUNOLOGY	4	4	25	75	100	30	40
		20	Major Practical - III	LAB IN MICROBIOLOGY & IMMUNOLOGY	2	-	50	50	100	20	40
		21	Allied -III	BASIC MATHEMATICS	4	4	25	75	100	30	40
		22	Allied Practical - III	LAB IN BASIC MATHEMATICS & BIOSTATISTICS	2	-	50	50	100	20	40
	IV	23	Skilled Based subject - I	BASIC BIOINFORMATICS	4	4	25	75	100	30	40
	IV	24	Non-Major Elective - I	A).FUNDAMENTALS OF COMPUTER AND NETWORKS **(OR)** B).FUNDAMENTALS OF BIOINFORMATICS	2	2	25	75	100	30	40
Subtotal					30	20					

Sem.	Pt. I/II/ III/ IV/V	Sub. No.	Subject status	Subject Title	Hrs./ week	Cre-dits	Marks				
							Maximum			Passing minimum	
							Int.	Ext.	Tot.	Ext.	Tot.
IV	I	25	Language	Tamil/Other Language	6	3	25	75	100	30	40
	II	26	Language	English	6	3	25	75	100	30	40
	III	27	Core - 6	BIOINFORMATICS ALGORITHMS	4	4	25	75	100	30	40
	III	28	Major Practical-IV	LAB IN BIOINFORMATICS ALGORITHMS	2	2	50	50	100	20	40
	III	29	Allied -IV	BIOSTATISTICS	4	4	25	75	100	30	40
	III	30	Allied Practical - IV	LAB IN BIOSTATISTICS	2	2	50	50	100	20	40
	IV	31	Skill Based Subject - II	PROGRAMMING IN PERL	4	4	25	75	100	30	40
	IV	32	Non-Major Elective - II	A). BIOLOGICAL DATABASES & SEQUENCE ANALYSIS **(OR)** B). APPLIED BIOINFORMATICS	2	2	25	75	100	30	40
	V		Extension Activity	NCC,NSS, YRC, YWF		1					
Subtotal					30	25					

MICROBIOLOGY AND IMMUNOLOGY

UNIT – I: Diversity of Microorganisms – Salient features of Bacteria, Virus, Phages, Algae, Fungi and Protozoan. Industrial applications of microorganisms in various fields.

UNIT – II: Structure , Life history and Genomic Biology of *E.coli*, Helicobacter, Salmonella, Influenza, Polio, Poxvirus, Diatoms, Chlorella, Spirulina, Aspergillus, Penicillum, Plasmodium, Entamoeba.

UNIT – III: Biological control of microorganisms – sterilization methods, Antimicrobial agents in therapy – Mode of action and side effects – Mechanism of drug resistance – Symbiotic and Asymbiotic N2 fixation – Bio fertilizer, Biopesticides (bacteria & virus).

UNIT – IV: Types of Immunity – Lymphoid organs – Lymphocytes – Cell maturation and differentiation – Immune response – Structure and Biological properties of Immunoglobulin.

UNIT – V: Immunological techniques: Precipitation test – Immunodiffusion – Immunoelectrophoresis – Immunofluorescence –- HLA typing – ELISA – RIA. MHC molecules & hypersensitivity reaction.

REFERENCES:
1. I.M.Roitt, J.Brostoff and D.K.Male, Immunology, Gower Medical Publishing, London, VII-Edition, Elsevier Health Sciences, 2006.

2. M.J.Pelczar, Jr.,E.C.S. Chang and N.R.Krieg, Microbiology, V-Edition Tata McGraw-Hill Education, 2001.

3. Kuby Immunology by Thomas J.Kindt , barbaraA. Osborne and Richard A. Goldsby, VI Edition, 2006. W.H.Freeman Publications

4. Text Book of Microbiology by Ananthanarayan, R. & paniker, CK Jayaram, VIII edition, 2010, Universities Press.

Lab in Microbiology and Immunology Bioinformatics Algorithms

Lab in Microbiology

1. Preparation of media: Basal, Selective, Differential and Enriched media
2. Staining methods: Simple, Gram and Acid –fast and Lacto phenol cotton blue, staining. Flagella staining.
3. Isolation of pure culture: Pour plate, spread plate and streak plate.
4. Biochemical tests: IMVIC test, catalase test.
5. Isolation of microbes from soil, water and air.
6. Preservation of cultures.
7. Motility test of bacteria: hanging drop and STAB culture.
8. MBRT for milk analysis
9. MPN test for water analysis.
10. Antibiotic sensitivity test- disc diffusion.
11. Blood grouping and Rh typing.
12. Precipitation reaction – single immunodiffusion, double immunodiffusion.
13. Passive agglutination test.

Lab in Bioinformatics Algorithms

1. Search on NCBI – PubMed bibliographic search – different options – author name, keyword in title, abstract, title and/or abstract, related articles – different display options
2. Search on EMBL for nucleic acid sequences
3. Perform a similarity search of PIR & SwissProt database for the given protein sequence
4. Pairwise sequence alignment by LALIGN tool
5. Sequence similarity search using NCBI-BLAST tool
6. Perform multiple sequence alignment using ClustalW, and display the phylogenetic relationship of sequences in NJplot
7. Phylogentic analysis using MEGA and Treeview
8. Gene Finding using GenScan/Grail
9. Gene function prediction using GeneMark
10. Protein sequence analysis (ExPASY proteomics tools)

BASIC MATHEMATICS

UNIT – I: Sets – Set Operation – Union Intersection – Complementation – Symmetric Difference – Power sets Cartesian Product – Relations – Functions – Inverse Functions and composition of functions – Groups – Types – Simple properties of groups – Cyclic groups and subgroups.

UNIT – II: Elementary Trigonometry: Addition, Subtraction, Sine and Cosine formulas, Concept of Arithmetic Progression and Geometric Progression -Trigonometry function and acute angle, Radian and degree measures of angle, solving of right angled triangle.

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

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

UNIT – V : Fourier series: Definition –Fourier formula for 2-periodic functions using sines and cosines –Simple Fourier series –Fourier motivation –Exponential Fourier series.

REFERENCES :

1. Algebra (3rd Ed.) by Serge A. Lang, 2003, Pearson education.

2. Introduction to Calculus & Analysis, Vol I and II by Richard Courant & Fritz John, 1999, Springer publisher.
3. Trignometry, Algebra and Calculus (3rdEd.) by Veerarajan, T., 2003, Tata McGraw Hill Publishing Co. Ltd, New Delhi.
4. Basic Mathematics by Serge A. Lang, 1988, Springer publisher

5. Higher Engineering Mathematics (40thEd.) by B.S. Grewal and J.S. Grewal, 2007, Khanna Publishers, New Delhi.
6. Schaum's outline of college mathematics by Philip Schmidt and Frank Ayres

SEMESTER – III & IV

Lab in Basic Mathematics and Biostatistics

Lab in Basic Mathematics

1. Perform all matrix operations
2. Compute Eigen values and Eigen vectors of a given matrix
3. Verify Cayley-Hamilton Theorem for a given matrix
4. Perform vector addition, subtraction, dot and cross products.
5. Compute angle between two vectors
6. Perform differentiation of simple functions.
7. Compute maxima and minima
8. Perform integration of simple functions.

Lab in Biostatistics

1. Diagrammatic Representation: Bar Charts, Pie diagrams.
2. Graphical representation of data – Histograms, Frequency polygon.
3. Measures of Central tendency – Arithmetic mean, median, mode.
4. Measure of dispersion
5. Skewness and Kurtosis.
6. Simple correlation.
7. Regression – lines of regression
8. Tests of significance based on Student's t test.
9. Tests of significance based on chi-square test.

Skilled Based -I

Basic Bioinformatics

Unit I: Introduction to Bioinformatics: Definition and Scope of Bioinformatics, Applications of Bioinformatics in various areas, Overview of available Bioinformatics Resources on the Web, Proteome and Genome; Information Resources and Analysis Tools; Established Techniques and Methods; Sequence File Formats FASTA, GenBank and Structured File Formats.

Unit II: Biological Databases: Protein Sequence and Structural Databases, Nucleotide Sequence Databases; NCBI, PubMed, Protein Data Bank (PDB), PIR, SwissProt, EMBL. GenBank, DDBJ, UniGene, SGD and EMI Genomes. Specialized Databases: Pfam, SCOP, GO, GenBank, Genome Net, EST, SNP, Metabolic Pathways Databases, EMBL, Similar Sequence Search BLAST, Gene/Protein Sequences and its Implications. Sequence Alignment: Pair-wise Alignments, Scoring Matrix, PAM, BLOSUM and Gap Penalty.

Unit III: Secondary Structure Analysis Tools/Server: Sequence Motif Databases, Pfam, PROSITE, Protein Structure Classification; SCOP, CATH, Other Relevant Databases, KEGG, PQS, PMDB, MPDB. Protein Structure Alignments; Structure Superposition, RMSD, Different Structure Alignment Algorithms, DALI, and TM-align.

Unit IV: Methods of Sequence Analysis: Heuristic Methods; FASTA, Statistics of Sequence Alignment Score; E-Value, P-Value, Multiple Sequence Alignments; ClustalW, Profile, Profile-Sequence Alignment, Profile-Profile Alignment, PSI-BLAST, Hidden Markov Models, Viterbi Algorithm and HMM Based Multiple-Sequence Alignment.

Unit V: Phylogenetic Analysis: Distance and Character Based Methods and Software, Computing Tools for Phylogenetic Analysis, Distances, GROWTREE, PAUP, PHYLIP and MEGA; Construction and Visualization of Phylogenetic Tree; and Application of Phyolgenetic Analysis.

REFERENCES:

1. Anna Tramontano, 2007; "Introduction to Bioinformatics", Chapman and Hall Series.
2. Jason T.L .Wang, Mohammed J. Zaki, Hannu T.T. Toivonene and Dennis Shasha, 2005; "Data Mining in Bioinformatics", Springer International Edition.
3. Yi-Ping Phoebe Chen, 2007; "Bioinformatics Technologies", Springer International Edition.
4. Mount, D.W., 2001; "Bioinformatics: Sequence and Genome analysis", Cold Spring Harbour Laboratory Press.

Fundamentals of Computer and Networks

Unit I: Fundamentals of computers – Block diagram of computer (input and output devices) – History **-** Generations – Memory devices - Advantages and Limitations of Computers – Comparison of different operating systems DOS, Windows NT & XP, Application Softwares.

Unit II: Communication Technology – Networking Elements: Networking Hardware, Networking services: Types of Networks – LAN, WAN & MAN, Intranet–Wireless communication – Internet services, Uses of Internet

Unit III: Fundamentals of database - Database models (Hierarchical, Network, Relational and Object- Oriented Models) – RDBMS: Relational Database Management systems - Database System Applications and Security.

Unit IV: Algorithm – Flowchart – Programming language – Compiling and Linking – Testing and Debugging – Documentation – Maintenance - Utility programs.

Unit V: Web Services – WWW, URL, Servers: Client / Server essentials - Domain Name Server, FTP server, E-mail server, WEB servers, Web publishing – Browsers - IP Addressing, IPv6.

REFERENCES:

1. Basic Computer Skills made easy, by Sherman, J., 2001 Butterworth-Heinemann Ltd, USA
2. Computer Fundamentals and Applications (2nd Ed.) by Balaguruswamy, E., 1985, Tata McGraw-Hill Publishing Co. Ltd.
3. Peter Norton, *Peter Norton's Introduction to Computers*, Fifth Edition Student Edition with Electronic Workbook CD-ROM, McGraw-Hill Technology Education, 2003.

Fundamentals of Bioinformatics

Unit I: Bioinformatics – An overview, Definition & History; Information Networks – Internet in Bioinformatics – Bioinformatics databases & tools on the Internet.

Unit II: Biological Sequence analysis – Pairwise sequence comparison – Sequence queries against biological databases – BLAST and FASTA algorithm - Multiple sequence alignments - Phylogenetic alignment.

Unit III: Introduction to –omics, Genomics and Proteomics – Sequencing genomes – Genome databases on the web.

Unit IV: Proteins – Amino acids – Peptide bond – Levels of protein structure – α-helix, β-sheet and β-turns – Ramachandran Map – Super secondary structures – Domains – quaternary structure – DNA and RNA structure – Watson and Crick model – A, B and Z forms of DNA – RNA secondary structure.

Unit V: Protein structure visualization tools – RasMol, Swiss PDB Viewer, PyMol – Protein structure prediction tools, Molecular modeling and docking tools.

REFERENCES:

1. T.K. Attwood and D.J. Parry-Smith, Introduction to Bioinformatics, Pearson Education Ltd., New Delhi (2004).
2. D.R. Westhead, J.H. Paris and R.M. Twyman, Instant Notes: Bioinformatics – Viva Books Private Ltd, New Delhi (2003).
3. Arthur M. Lesk, Introduction to Bioinformatics, Oxford University Press, New Delhi (2003).
4. D. Higgins and W. Taylor (Eds), Bioinformatics - Sequence, structure and databanks, Oxford University Press, New Delhi (2000).

Bioinformatics Algorithms

UNIT – I Introduction: Algorithm – Definition and concepts. Biological versus computer algorithm. Big notation Types of algorithm (Fast Vs slow, Iterative Vs Recursive)

UNIT – II Sequence alignment using Dotplot , Advantages and Disadvantages. Dynamic Programming : Definition. Global sequence alignment -Needleman wunsch algorithm. Local sequence alignment- Smith Waterman algorithm.

UNIT – III Heruistics Algorithm: BLAST algorithm FASTA algorithm.Multiple alignment algorithm : Algorithm of CLUSTALW and PileUp. Genetic algorithm: Basic concepts, Reproduction, Cross over, Mutation, Fitness value.

UNIT – IV Gene finding algorithm : Context based - Gene, ORF. Signal based - Transcription, Translation signals. Tools used for gene prediction – GenScan, GeneMark.

UNIT – V Trees Construction : Distance Based Tree Reconstruction – UPGMA, Neighbor Joining method, Character Based Tree Reconstruction – Maximum parsimony.

REFERENCES:
1. An Introduction to Bioinformatics Algorithms by Neil C. Jones, Pavel Pevzner, 2004, MIT Press.
2. Essential Bioinformatics-Jin Xiong, Cambridge University Press. 2006

SEMESTER – III & IV

Lab in Microbiology and Bioinformatics Algorithms

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1. Preparation of media: Basal, Selective, Differential and Enriched media

2. Staining methods: Simple, Gram and Acid –fast and Lacto phenol cotton blue, staining. Flagella staining.

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4. Biochemical tests: IMVIC test, catalase test.

5. Isolation of microbes from soil, water and air.

6. Preservation of cultures.

7. Motility test of bacteria: hanging drop and STAB culture.

8. MBRT for milk analysis

9. MPN test for water analysis.

10. Antibiotic sensitivity test- disc diffusion.

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12. Precipitation reaction – single immunodiffusion, double immunodiffusion.

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7. Phylogentic analysis using MEGA and Treeview
8. Gene Finding using GenScan/Grail
9. Gene function prediction using GeneMark
10. Protein sequence analysis (ExPASY proteomics tools)

Biostatistics

UNIT – I: Statistics – Definition – Statistical methods – Basic principles – Variables – Measurements, functions, limitation and uses of statistics.

UNIT – II: Collection of Data – Primary and Secondary – Types and methods of data collection – Procedure – Merits and Demerits – Classification and tabulation of data – Diagrams and graphs.

UNIT – III: Measures of Central tendency – Mean, Median, Mode, Geometric Mean – Merits and Demerits – Dispersion and measure of dispersion – Range, Standard deviation, quartile deviation – Merits and Demerits – Co-efficient of variations.

UNIT – IV: Skewness and Kurtosis – Correlation – Types and method of correlation – Regression – Simple regression equation fitting – Prediction, similarities and dissimilarities of correlation and regression.

UNIT – V: Distribution – Binomial, Poisson, Normal – Statistical inference – Sampling methods – Simple hypothesis testing – Students "t"- test – Chi square test.

REFERNCES:
1. Schaum's Outline Statistics by Murray.R, Spiegel, Larry.J.Stephens, 4th edition, McGraw Hill Companies.

2. An introduction to Bio-Statistics by N.Gurumani.2009 – MJP Publications.

Lab in Biostatistics

1. Diagrammatic Representation: Bar Charts, Pie diagrams.

2. Graphical representation of data – Histograms, Frequency polygon.

3. Measures of Central tendency – Arithmetic mean, median, mode.

4. Measure of dispersion

5. Skewness and Kurtosis.

6. Simple correlation.

7. Regression – lines of regression

8. Tests of significance based on Student's t test.

9. Tests of significance based on chi-square test.

Programming in PERL

Unit I: Introduction: History of Perl, Availability, Support, Versions, Installation. Basic Concepts, Significance of Perl in Bioinformatics.

Unit II: Basics Constructs: Scalar Data, Numbers, Strings, Scalar Operators, Scalar Variables, Scalar Operators and Functions. Arrays and List Data: What is a List or Array? Literal Representation, Variables, Array Operators and Functions, Scalar and List Context. Hashes: What is a Hash? Hash Variables, Literal Representation of a Hash, Hash Functions, Hash Slices. Control Structures: Statement blocks, Loops and conditions. Basic Input / Output.

Unit III: Advance Constructs and Features: Regular Expressions: Concepts about Regular Expressions, Simple Uses of Regular Expressions, Patterns, Matching Operator, Substitutions, The split and join functions, Subroutines: System and User Functions, The local Operator, Variable-length, Parameter Lists, Lexical Variables, File handles and File Tests: File Handle, Opening and Closing a File handle, Using Pathnames and Filenames, die, Using File handles.

Unit IV: Object-Oriented Perl: Introduction to Modules, Creating Objects and References. CGI Programming: The CGI.pm Module, CGI Program in Context, Simple CGI Programs, Passing Parameters via CGI, Perl and the Web.

Unit V: BioPerl: BioPerl Overview and Installation Procedures; Fundamental Constructs and Special Features; BioPerl Modules, Creating BioPerl Objects. Applications of BioPerl, Utility and its Applications.

REFERENCES:

1. James D. Tisdall, 2001; "Beginning Perl for Bioinformatics", O'Rilley and Association.
2. Cynthi Gibas & Per Jamesbeck, 2000; "Developing Bioinformatics Computer Skills", O'Rilley & Association.
3. Harshawardhan P Bal, 2003; "Perl Programming for Bioinformatics", Tata McGraw Hill.
4. Randal L. Schwartz and Tom Phoenix, 2005; "Learning Perl", 3rd Edition, O'Rilley.

Biological Database and Sequence Analysis

Unit I: Literature Databases: PubMed, BioMed, Google Scholar, PMC, Quertle

Unit II: Sequence Databases: Nucleic acid sequence databases: GenBank, EMBL, DDBJ, UniGene, Protein sequence databases: Uniprot-KB: SWISS-PROT, TrEMBL, PIR-PSD. Repositories for high throughput genomic sequences: EST, STS GSS, etc. Genome Databases at NCBI, EBI, TIGR, SANGER. Viral Genomes, Archeal and Bacterial Genomes.

Unit III: Structural Databases: 3D Structure Database: PDB, NDB, CSD, MMDB, Chemical Structure database: PubChem, DrugBank, ChemSpider, Gene Expression database: GEO, SAGE,

Unit IV: Derived Databases: Sequence: InterPro, Prosite, Pfam, ProDom, Gene Ontology, Structure classification database: CATH, SCOP, FSSP, DSSP, HSSP, Protein-Protein interaction database: STRING

Unit V: Database Access & Analysis Tools: Keyword-based searches using tools like ENTREZ and SRS. Sequence-based searches: BLAST and FASTA, Structure-based searches: BLAST with PDB.

REFERENCES:

1. T.K. Attwood and D.J. Parry-Smith, Introduction to Bioinformatics, Pearson Education Ltd., New Delhi (2004).
2. D.R. Westhead, J.H. Paris and R.M. Twyman, Instant Notes: Bioinformatics – Viva Books Private Ltd, New Delhi (2003).

Applied Bioinformatics

Unit I: Commercial bioinformatics – Survey of bioinformatics companies in India and abroad – Economics prospects – pharma-informatics – combinatorial chemistry – HT screening – in silico screening - from lead to commercialization.

Unit II: Sequence assembly and Finishing methods - Sequence assemblers – finishing and visualization programmes - SNP – Types - SNP discovery methods.

Unit III: Application of genomics to agriculture - gene discovery and gene function - model systems – technologies -methods to introduce novel genes – Pharmaceutical bioinformatics and drug discovery – Introduction - novel gene discovery - methods for identifying novel targets - protein classification and functional assignments – Disease - target gene relationship.

Unit IV: Intellectual Property Rights(IPR): IPR - Importance of IPR, Organization - WIPO & WTO - Agreements and Treaties - GATT-TRIPS - Types of IPR – patents – copyrights - trademarks and trade secrets - IPR in India - IPR impacts on Biotechnology Research in India - significance biotechnological patents in India..

Unit V: Biosafety & Bioethics: Biosafety - Topics of concern - Hazards of Genetically Engineered Microorganisms – Bioremediation - Framework of biosafety regulations in India – Bioethics - The ethical and social impacts of biotechnology and bioinformatics.

REFERENCES:

1. T. A. Brown, Genomes, 2nd Edition, BIOS Scientific Publishers, Ltd., Oxford, UK, 2002.
2. S.R.Pennington and M.J.Dunn, Proteomics, Viva Books Pvt. Ltd., New Delhi, 2002.
3. N.R.Subbaram, What everyone should know about patents?, 2nd Edition, Pharma Book Syndicate, Hyderabad, 2006.
4. Philip W.Grubb, Patents for Chemicals, Pharmaceuticals and Biotechnology-Fundamentals of Global Law practices and strategy, 4th Edition, Oxford University Press, 2006.
5. R.C. Dubey, A Textbook of Biotechnology, S.Chand & Company, 1993.
6. Ben Mepham, Bioethics-an Introduction for the biosciences, Oxford University Press, 2005.