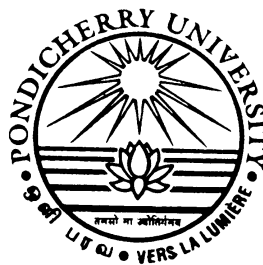# B.Sc. BIOINFORMATICS

REGULATIONS AND SYLLABI

(Effective from 2011-2012)

Centre for Bioinformatics

SCHOOL OF LIFE SCIENCES

PONDICHERRY UNIVERSITY

PUDUCHERRY

REGULATIONS - B.Sc. BIOINFORMATICS

Aim of the course:

The course of B.Sc. (Bioinformatics) aims to introduce to the students the field of science in which biology, computer science, and information technology merge into a single discipline to analyses biological information using computers and statistical techniques. At the end of the course, the students are expected to have good knowledge in mathematics, statistics and computer science and also will gain knowledge in bioinformatics databases, tools and software in sequence alignment, phylogenetic analysis and protein structure prediction.

Eligibility for admission:

Candidates for the admission to degree of B.Sc. Bioinformatics shall be required to have passed HSc., CBSE / equivalent examination with biology or computer science or mathematics as one of the subjects of study or an examination accepted as equivalent to there and 45% percentage of marks in aggregate, subject to such conditions as may be prescribed there for.

Lateral Entry: Not applicable.

Duration of the course:

The course shall be of three year's duration spread over six semesters. The maximum duration to complete the course shall be Five years.

Eligibility for admission to examination:

75% of attendance will be required for admission to examination.

Medium:

The medium of instruction shall be English.

Passing Minimum:

Passing eligibility & classification for the award of the degree is as follows:

Passing eligibility:

During the time of course the students have to score minimum 40% of marks in all the subjects including practical.

Classification for the award of the degree:

60-100 - First Class

50-59   - Second class

40-49   - Third Class

SCHEME OF THE EXAMINATION - B.SC BIOINFORMATICS

Paper	Title of the Paper	Hours of Instruction		Hours of Exam	Marks
		Theory	Practical		
Semester I					
Paper I	Language – I	6	-	3	100
Paper II	English – I	6	-	3	100
Major I	Fundamentals of Biological Systems	4	2	3	100
Major II	Introduction to Chemistry	4	2	3	100
Allied I	Introduction to Computer Science	4	2	3	100
Major - P1	Lab in Basic Biology and Chemistry	-	-	6	50
Allied - P1	Lab in Computer Science	-	-	3	50
Semester II					
Paper III	Language – II	6	-	3	100
Paper IV	English – II	6	-	3	100
Major III	Biomolecules	4	2	3	100
Major IV	Introduction to Mathematics	6	-	3	100
Allied II	Introduction to Physics	4	2	3	100
Major – P2	Lab in Biomolecules	-	-	6	50
Allied – P2	Lab in Physics	-	-	3	50
Semester III					
Paper V	Language – III	6	-	3	100
Paper VI	English – III	6	-	3	100
Major V	Introduction to Biological Databases	6	-	3	100
Major VI	Programming in C	4	2	3	100
Allied III	Biostatistics	4	2	3	100
Major – P3	Lab in C Programming	-	-	3	50
Allied – P3	Lab in Biostatistics	-	-	3	50
Semester IV					
Paper VII	Language – IV	6	-	3	100
Paper VIII	English – IV	6	-	3	100
Major VII	Microbiology and Immunology	4	2	3	100
Major VIII	Bioinformatics Algorithm	6	-	3	100
Allied IV	Introduction to DBMS & Information Technology	4	2	3	100
Major – P4	Lab in Microbiology and Immunology	-	-	6	50
Allied – P4	Lab in DBMS	-	-	3	50

Semester V						
Major IX	Biological Sequence Analysis	4	2	3	100	
Major X	Genetics and Evolution	4	2	3	100	
Major XI	Molecular Biology and Genetic Engineering	6	-	3	100	
Major XII	Structural Biology	6	-	3	100	
Major XIII	Operating Systems and the Networks	6	-	3	100	
Major – P5	Lab in Biological Sequence Analysis	-	-	3	100	
Major – P6	Lab in Biotechniques	-	-	3	100	
Semester VI						
Major XIV	Genomics & Proteomics	6	-	3	100	
Major XV	Perl Programming	4	2	3	100	
Major XVI	Molecular Modeling	4	2	3	100	
Major XVII	Biodiversity	6	-	3	100	
Major XVIII	Web Programming	4	2	3	100	
Major – P7	Lab in Molecular Modeling	-	-	3	100	
Major – P8	Lab in Web and Perl Programming	-	-	6	100	

MAJOR I: FUNDAMENTALS OF BIOLOGICAL SYSTEMS

UNIT-I   **13 Hours**

Introduction to cells: Cell as unit of life- Structure of prokaryotic and eukaryotic cells. Cell organelles (Mitochondria, chloroplasts, ER, Golgi, ribosomes, lysosomes and peroxysomes, nucleus and nucleolus)and their functions. Differences and similarities between plant and animal cells.

UNIT-II   **11 Hours**

Cell transport: Cell transport across plasma membrane. Mechanisms of transport. Cell reproduction, cell cycle, Check points, Mitosis and Meiosis

UNIT-III   **11 Hours**

Cell Energetics: Aerobic oxidation and photosynthesis, Utilization of glucose, Role of ATP in energy cycle- Phosphorylation

UNIT-IV   **13 Hours**

Taxonomic classification of Plant: Introduction-Definition and basic concepts of biosystematics and taxonomy. Plant identification – Plant ecology - Plant classification(Bentham and Hooker's) Cytotaxonomy – Chaemotaxonomy – Numerical Taxonomy – Nomenclature.

UNIT-V   **12 Hours**

Taxonomic classification of animals. Animal classification –Animal kingdom – Kingdom, phylum, Class, order, family, Genus, species- Importance and application of taxonomic classification.

TEXT BOOKS:
1. Biology by Martha R. Taylor, Neil A. Campbell, Jane B. Reece, 2007, Pearson/Benjamin Cummings.
2. Biological science-D.J.Taylor, N.P.O.Green, G.W.Stout, III-Edition Cambridge University press, New Delhi, 2007.

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I SEMESTER

MAJOR II: INTRODUCTION TO CHEMISTRY

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UNIT – I   **13 Hours**

Physical chemistry: Introduction to physical chemistry: The nature of gaseous state: States of matter - gas, liquid, solid. Gas laws – Boyle's law, Charles law, Gay- Lussac's law, Avogadro's hypothesis. Dalton's law of Partial Pressure, Graham's law – Combined gas law – ideal gas – Kinetic theory of gases – Deviations from the ideal gas law – van der Waals equation – real gases.

UNIT – II   **11 Hours**

Colloids: Definition, Classification, formation and properties of colloids – Dialysis and Ultrafiltration; Chemical energy: Heat of reaction – Definition, endothermic and exothermic reactions – Hess' law. First law of thermodynamics; Chemical equilibira: Arrhenius theory, ionization of water, ionic product of water, pH, pOH, pK – Bronsted-Lowry theory of acids and bases, acid-bases indicators.

UNIT – III   **11 Hours**

Inorganic Chemistry: Atomic structure – Discovery of the sub-atomic particles: electrons, protons, neutrons; Radioactivity – Becquerel and Curies, types of radiation. Determination of nucleus of atom, isotopes, Bohr theory; quantum numbers – n,l,m and s; electronic configurations- orbital designations – s,p,d,f orbitals. Shapes of s and p orbitals.

UNIT – IV   **12 Hours**

Types of chemical bonds: Ionic bonding – Covalent bonding- Orbital hybridization (Sp^3, Sp^2, Sp^1 only) – Multiple valency – electro negativities and electron affinities – Geometry of simple covalent compounds – coordinate covalent bonds.

UNIT – V   **13 Hours**

Crystallography: Solids (Crystalline & Amorphous) – Unit cell – Characteristic parameters – Body centered cubic structure (eg. CsCl) – Face centered cubic structure (eg. NaCl)

TEXT BOOKS:

1. G.S.Manku, Theoretical Principles of Inorganic Chemistry, McGraw-Hill Education, New Delhi-1982.
2. J.D.Lee. Concise Inorganic Chemistry, 5th Edition., Blackwell Science Ltd, Oxford, 2002.
3. J.E.Spice, Chemical bonding and structure, MacMillan, London 1964.
4. M.J.Winter, Chemical bonding, 1996, Oxford University Press

I SEMESTER

ALLIED I: INTRODUCTION TO COMPUTER SCIENCE

UNIT – I   **10 Hours**

Computer Organization: Fundamentals of computers – Block diagram of computer (input and output devices) – History - Generations – Memory devices – Advantages, Limitations and Applications of Computers.

UNIT – II   **10 Hours**

Operating System Concepts: Definition – Architecture – Functions and Services of operating system– Different types of operating system – Single user OS, Multi user OS, Multiprocessing OS, Multitasking OS & Real Time OS. Comparison of Client Server & Peer to peer OS.

UNIT – III   **15 Hours**

Number Systems: Non – positional and Positional number system – converting from one number system to another – Fractional numbers. Computer Codes: BCD, EBCDIC, ASCII, Unicode.

UNIT – IV   **13 Hours**

Information system and data storage system: Data – Information –Qualities of information –Data processing cycle – Types of data processing – Data processing system, Data storage system: Files - File organization-DBMS Advantage.

UNIT –V   **12 Hours**

Network & Internet Technologies : Network – Different types - Internet definition – Brief History - Services – Internet Terminologies (WWW, web page, website, web browser, Domain name, HTML, HTTP, TCP/IP , URL, search engine) – Web browsers – Uses of Internet.

TEXT BOOKS:

1. Computer Fundamentals – Fourth Edition – Pradeep K. Sinha , Priti Sinha, BPB Publication-2007.

2. Basic Computer Skills made easy, by Sherman, J., 2001 Butterworth-Heinemann Ltd, USA

I SEMESTER

MAJOR PRACTICAL - I

LAB IN BASIC BIOLOGY AND CHEMISTRY

Basic Biology

1. Identification of mitotic stages using Onion root tip.
2. Study of meiotic stage using pollen grains.
3. Isolation of Proteins (Caesin from Milk).
4. Estimation of chlorophyll pigments.
5. Paper chromatography.
6. Thin layer Chromatography.
7. Cell counting using Haemocytometer.

Chemistry

1. Acidimetry and alkalimetry
   a) Strong aciod vs strong base
   b) Weak acid vs strong base
2. Permanganimetry
   a) Estimation of ferrous sulphate
   b) Estimation of oxalic acid
3. Iodometry
   a) Estimation of copper
   b) Estimation of potassium dichromate
   c) Estimation of potassium permanganate
4. Gravimetric analysis – Soluble carbonate.
5. Preparation of Buffer and pH dertermination.

I SEMESTER

ALLIED PRACTICAL -I

LAB IN COMPUTER SCIENCE

1. Command line interface – Basic DOS commands – Create and delete directories – View the contents of a directory – Renaming a directory – Changing directory.
2. Changing drives – Copying files – Copying a group of files – Renaming files – Deleting files – Viewing files – Formatting a disc.
3. Component of a GUI – Desktop operation – Shutdown operation – Taskbar operation – Opening a program – Finding files – locating most recent files – using windows explorer – moving/copying files to different folders – Renaming a file or folder.Copying files into CD.
4. Word processing, Spreadsheet, Presentation.
5. Searching online databases. Eg. Pubmed.

MAJOR III: BIOMOLECULES

UNIT –I   **12 Hours**

Carbohydrates – Classification, Chemistry and properties, Glycogen metabolism, Glycolysis, Krebs cycle, Gluconeogenesis.

UNIT – II   **8 Hours**

Proteins – Amino acids, properties, Structure of naturally occurring amino acids, Orders of protein structure.

UNIT – III   **15 Hours**

Nucleic acids – Nucleotides, Nucleosides and polynucleotides, Structure and types of DNA and RNA. Nucleoproteins. Isolation and purification of DNA and RNA. Lipids – Nomenclature and classification. Properties of fatty acids. β oxidation and biosynthesis of fatty acids.

UNIT – IV   **10 Hours**

Amino acid synthesis: From intermediates of citric acid cycle and other major pathways, Purine and Pyrimidine biosynthesis.

UNIT – V   **15 Hours**

Enzymes – Definition, Nomenclature, Classification of enzymes, Properties of enzymes, specificity of enzymes, Structure and function of enzymes. Units of enzyme activity and turnover number, Kinetics and mechanism of enzyme action. Biological oxidation – Electron transport chain, Photophosphorylation. Photosynthesis.

TEXT BOOKS :

1. Murray. R.K., Granner.D.K., Mayes. P.A., Rodwell V.W., Harper's Biochemistry. 28th Edition. McGraw Hill. 2009.

MAJOR IV: INTRODUCTION TO MATHEMATICS

UNIT – I   **18 Hours**

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   **12 Hours**

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   **20 Hours**

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   **20 Hours**

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   **20 Hours**

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

TEXT BOOKS :
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, Schaum's Outline series. III-Edition 2003, McGraw-Hill Publication.

II SEMESTER

ALLIED II: INTRODUCTION TO PHYSICS

UNIT – I   **11 Hours**

Mechanics and General Properties of Matter: Newton's laws of motion and applications, Velocity and acceleration in Cartesian, polar and cylindrical coordinate systems, uniformly rotating frame, centrifugal and coriolis forces, Motion under a central force, Kepler's laws, Gravitational Law and field, Conservative and nonconservative forces. Systems of particles Centre of mass, equation of motion of the CM, Conservation of linear and angular momentum, Conservation of energy, variable mass systems. Elastic and inelastic collisions. Rigid body motion, fixed axis rotations, rotation and translation, moments of Inertia and products of Inertia. Principal moments and axes.

UNIT – II   **9 Hours**

Elasticity: Stress and strain in solids, Hook's law, Stress-Strain curves, Properties of fluids.

UNIT – III   **14 Hours**

Viscosity: Streamline and turbulent flow, Equation of continuity, Flow of liquids through capillaries, Poiseuille's Law. equation, Reynolds number, Concepts of pressure energy, Bernoulli's theorem and its applications. Venturi meter, Pitot's tube. Viscosity estimation by Oswald's viscometer, rotating cylinder, cone and plane.

UNIT - IV   **11 Hours**

Surface tension: Surface tension and surface energy, Capillary Action, Angle of contact, Wet ability, Relation between surface tension, excess pressure and curvature, surface tension by capillary rise method, Jaeger's method, quincke's method, Temperature dependence of surface tension, applications.

UNIT – V   **15 Hours**

Sound: Types of waves (Longitudinal and transverse wave), Principles of superposition, Audible, ultrasonic and infrasonic waves, Vibrating systems and source of sound, Beats, the Doppler effect. Thermometry: Principles of thermometry, Concept of temperature and its measurements, Kelvin, Celsius and Fahrenheit, Thermal energy, Platinum resistant thermometer, thermocouple and thermistor as thermometers.

TEXT BOOKS:

1. Concept Of Modern Physics (SIE)-Beiser, Arthur Publisher: Tata Mcgraw-hill Education Private Limited (2009)
2. Fundamentals of Mechanics – S.K.Saxena (Himalaya Publication)
3. Heat and Thermodynamics – Zemansky (McGraw Hill)-2006.

II SEMESTER

MAJOR PRACTICAL -II

LABORATORY IN BIOMOLECULES

1. Calculation of Moles, Millimoles, Micromoles and nanomoles.
2. Estimation of Free amino acids.
3. Estimation of protein.
4. Estimation of blood sugar.
5. Estimation of Glycogen
6. Estimation of Lipid.
7. Estimation of Nucleic acid
8. Qualitative tests for Carbohydrate, Protein and Lipid.
9. Effects of substrate concentration, pH, Temperature on the activity of any enzyme.

II SEMESTER

ALLIED PRACTICAL -II

LABORATORY IN PHYSICS

Typical experiments on

1. Determination of acceleration due to gravity moment of inertia etc – Simple Pendulum
2. Elastic constants determination using different methods – Young's modulus.
3. Measurement of thermal conductivity of bad conductors – Lee's disc apparatus.
4. Determination of surface tension of water, soap bubble etc - Jet Vibration, Simple Bubble method
5. Determination of Viscosity of a liquid – Viscometer
6. Determination of Velocity of sound in air - Speed of sound.

MAJOR V: INTRODUCTION TO BIOLOGICAL DATABASES

UNIT I **15 Hours**

Introduction: Aim and branches of Bioinformatics, Application of Bioinformatics, Role of internet and www in bioinformatics. Forms of biological information, Types of Nucleotide Sequence: Genomic DNA, Complementary DNA (cDNA), Recombinant DNA (rDNA), Expressed sequence tags (ESTs), Genomic survey sequences (GSSs).

UNIT II **12 Hours**

Organization of Data: Contents and formats of database entries, retrieval of data using text-based search tools – Entrez, SRS, sources of data (e.g. sequencing projects, individual scientists, patent offices etc.),method for deposition of data to databases and tools used (e.g. Webin, sequin), Expasy tools.

UNIT III **12 Hours**

Important Biological Databases: Nucleic acid sequence databases: GenBank, EMBL, DDBJ. Protein sequence databases: SWISS-PROT, TrEMBL, PIR_PSD.Genome Databases with special reference to model organisms (Yeast, Drosophila, C. elegans, Rat, Mouse) Human, plants such as Arabidopsis thaliana, Rice, etc.

UNIT IV **11 Hours**

Derived Databases: Concept of derived databases, sources of primary data and basic principles of the method for deriving the secondary data for Prosite, PRODOM, Pfam, PRINTS.Composite databases – NRDB, OWL, and Pattern databases.

UNIT V **10 Hours**

Other Databases: PDB- Structural database, Protein structural classification databases: CATH & SCOP. Metabolic pathway database - KEGG, Secondary structure assignments - DSSP, Comparing 3D structure - DALI.

TEXT BOOKS :

1. Bioinformatics- A Practical Guide to the Analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., III-Edition, 2004, John Wiley & Sons, UK.
2. Bioinformatics and Functional Genomics by Pevsner, J., 2003, John Wiley and Sons, New Jersey, USA

MAJOR VI: PROGRAMMING IN C

UNIT I   **11 Hours**

C Fundamentals: History – Features – General structure of C program – Editing and Executing a C program – Character set – Identifiers and Keywords – Data types – Constants – Variables – Expressions – Operators.

UNIT II   **14 Hours**

Input & Output Statement: Character Input and Output – String Input and Output – Formatted Input and Output - Looping Statement: while, do-while, for – nested loop. Control Statements: Branching statement (if – else, switch – case), Looping statement (while, do – while, for).

UNIT III   **12 Hours**

Single dimensional Array: Declaration – Memory representation - Compile and Runtime Initialization – Accessing – String Handling.

UNIT IV   **13 Hours**

Two dimensional Arrays: Declaration – Memory representation - Compile and Runtime Initialization – Accessing - Matrix manipulation – Sequence manipulation.

UNIT V   **10 Hours**

Built-in library function – User defined functions – Structure – Union – File handle: Read and Write character from a file

TEXT BOOKS:

1. Programming in ANSI C (4th Ed.) by E. Balagurusamy, 2007, Tata McGrawHill Publishing Company Limited.
2. Essential of Programming in C in life science S.Parthasarathy, Ane Student edition , 2008, Ane Books India .

III SEMESTER
ALLIED III: BIOSTATISTICS

UNIT – I   **11 Hours**

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

UNIT – II   **12 Hours**

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   **14 Hours**

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   **12 Hours**

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

UNIT – V   **11 Hours**

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

TEXT BOOK:

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.

III SEMESTER

MAJOR PRACTICAL -III

LAB IN C PROGRAMMING

1. Calculate the Body Mass Index of a person. [BMI = Weight in kgs/height in metre^2]
2. Reverse the given number.
3. Design pattern.
4. Matrix Manipulation.
5. Count the number of A, G, C, T in the given DNA sequence.
6. Sort the given amino acid names.
7. Protein Information Systems.
8. Read the fasta file.
9. DNA to RNA conversion using text file.

ALLIED PRACTICAL -III

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.

Note: the above mentioned statistical problems were solved using Spreadsheet.

IV SEMESTER

MAJOR VII: MICROBIOLOGY AND IMMUNOLOGY

UNIT – I   **14 Hours**

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

UNIT – II   **12 Hours**

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

UNIT – III   **11 Hours**

Biological control of microorganisms – Antimicrobial agents in therapy – Mode of action and side effects – Mechanism of drug resistance – Symbiotic and Asymbiotic N_2 fixation – Bio fertilizer.

UNIT – IV   **12 Hours**

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

UNIT – V   **11 Hours**

Immunological techniques: Precipitation test – Immunodiffusion – Immunoelectrophoresis – Immunofluorescence – HLA typing – ELISA – RIA.

TEXTBOOKS:

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.

MAJOR VIII: BIOINFORMATICS ALGORITHM

UNIT – I   **10 Hours**

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

UNIT – II   **10 Hours**

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

UNIT – III   **17 Hours**

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

UNIT – V   **13 Hours**
Trees Construction : Distance Based Tree Reconstruction – UPGMA, Neighbor Joining method, Character Based Tree Reconstruction – Maximum parsimony.

TEXT BOOKS:

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

ALLIED IV: INTRODUCTION TO DBMS AND INFORMATION TECHNOLOGY

UNIT-I   **13 Hours**

Introduction: Data abstraction, Data models, Instances & schemes E-R Model: Entity and entity
Sets, Relations and relationship sets, E-R diagrams, Data Model: Basic concepts, Hierarchical Data
Model: Network, Relational and Object- Oriented Models) – RDBMS: Relational Database
Management systems, distributed database processing

UNIT-II   **12 Hours**

Data definition languages – Data Manipulation language, Data Control language, Data and
String Functions, Union and intersect operator, Sub queries, Normal Form, Introduction to
PL/SQL, Data types in SQL, Simple PL/SQL programs.

UNIT III   **13 Hours**

Structured Query Language – Basic Structure, Set Operations, Aggregate Functions, Null
Values, Nested Sub queries, Views, Integrity: Domain constraints, Joined Relations, Data-
Definition Language

UNIT –IV   **10 Hours**

Telecommunications: introduction to telecommunications – computer networks – Communication
systems – distributed systems

UNIT –V   **12 Hours**

New technologies in IT; E- Commerce – hypermedia – data warehouses and data marts – data mining
– online analytical processing – Geographical information system.

TEXT BOOKS:

1. Database System Concepts (6th Ed.) by Silberschatz, Henry F. Korth, S. Sudarshan, McGraw-Hill,
2010.

2. Computer Networks (3rd Ed.) by Tananbaum A.S., 1999, PHI.

3. Data Mining Concepts and Techniques – Jiawei Hen, Micheline Kambler, 2006, Academic Press
Morgan kaufman Publishers.

IV SEMESTER

MAJOR PRACTICAL -IV

LABORATORY IN MICROBIOLOGY AND IMMUNOLOGY

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.

Immunology

1. Preparation of plasma and serum.
2. Blood grouping and Rh typing.
3. Precipitation reaction – single immunodiffusion, double immunodiffusion.
4. Passive agglutination test.

IV SEMESTER

ALLIED PRACTICAL – IV

LAB IN DBMS

1. Creating database, Selecting database, Deleting database, Creating table, Modifying Table,
2. Deleting table
3. Inserting, updating and deleting records
4. Retrieving Records
5. Retrieving specific rows and columns
6. Use of MySQL operators – Arithmetic operators, Comparison
7. Operators, Logical operators
8. Math functions, Aggregate functions
9. String operations
10. Limiting, Sorting and grouping query results
11. Handling null values
12. Renaming or aliasing table and column names

MAJOR IX: BIOLOGICAL SEQUENCE ANALYSIS

UNIT – I   **10 Hours**

Introduction to sequence analysis – why to analyse DNA sequence & Protein sequence. Basic concepts of sequence similarity & identity. Definitions of homology, orthology, paralogy and Analogy.Twilight Zone. Introduction to single letter code of amino acids, symbols used in nucleotides.

UNIT – II   **12 Hours**

Introduction to Sequence alignment, Substitution matrices, Scoring matrices –PAM and BLOSUM.Gap penalty. Pairwise database searching – Running BLAST and FASTA, Interpretation of results. Statistical significance of database searching.

UNIT – III   **17 Hours**

Mutliple alignment – Definition, Consensus.   Methods of multiple alignment – Dynamic programming, Progressive, iterative and the tools based on it. Advantages of Multiple alignment. Basic concepts in systematic, taxonomy and phylogeny; molecular evolution; nature of data used in Taxonomy and Phylogeny, Definition and description of phylogenetic trees and various types of trees representation – Phylogram, Cladogram, Dendogram. Evolutionary analysis: Bootstrapping strategies

UNIT – IV   **10 Hours**

Nucleic acid sequence analysis: Reading frames; Codon Usage analysis; Translational and transcriptional signals; Protein sequence analysis: Compositional analysis ; Hydrophobicity profiles; Amphiphilicity detection; Transmembrane prediction methods.

UNIT – V   **11 Hours**

Sequence patterns and profiles: Basic concept and definition of sequence patterns, motifs and Profiles, various types of pattern representations viz. consensus, regular expression (Prosite type) and sequence profiles; profile-based database searches using PSI-BLAST, analysis and interpretation of profile-based searches.

TEXT BOOKS:

1. Bioinformatics- A Practical Guide to the Analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., 1998, John Wiley & Sons, UK.

2. Bioinformatics and Functional Genomics by Pevsner, J., 2003, John Wiley and Sons, New Jersey, USA.

MAJOR X: GENETICS AND EVOLUTION

UNIT – I   **12Hours**

Principle and laws of Mendelian inheritance – genetic interactions – multiple alleles – sex determination – sex limited and sex – linked inheritance – non disjunction.

UNIT – II   **12 Hours**

Modern concepts of Prokaryotic and Eukaryotic genes – regulation of gene expression – Lac and Trp Operon, Chromosome mapping - Linkage and genetic mapping – Estimation of map distance.

UNIT –III   **12 Hours**

Human Genetics: Gene (point) mutation – mutagens – teratogens and induced birth defects-inborn errors of metabolism – human karyotype, chromosomal variations and syndromes in man.

UNIT – IV   **12 Hours**

Origin of life: Molecular evolution – concepts and theories of organic evolution – mechanisms producing genetic diversity – Phylogenetics using morphometric, biochemical and molecular tools.

UNIT – V   **12 Hours**

Genes in population – Hardy Weinberg equilibrium – genetic drift – evolutionary forces – isolating mechanism and speciation – adaptive radiation.

TEXT BOOKS:

1. Principle of Genetics by Robert.H.Tamarin, Pearson, 2004.
2. iGenetics – A Molecular Approach; by Peter Russell, International 3nd Edition, Benjamin Cummings, 2009.
3. Human Evolutionary Genetics: Origins, Peoples and Disease, M A Jobling, M E Hurles, C Tyler-Smith, Garland Publishing House, 2004.

MAJOR XI: MOLECULAR BIOLOGY & GENETIC ENGINEERING

UNIT-I   **12 Hours**
History of Molecular Biology-DNA and RNA as genetic materials-Experiments, Structure of DNA,Chargaff's rule, different forms of DNA and RNA, secondary structure in single stranded nucleic acids.

UNIT-II   **12 Hours**
Replication-Semi-conservative process, Transcription and Translation, inhibitors of transcription and translation. Reverse transcription,Genetic code,codon, anticodon.

UNIT III: **12 Hours**
Basis of recombinant DNA tools-Introduction to cloning-cloning vectors-plasmids & phage vectors,Expression of clones,gene selection-maximizing gene expression, restriction enzyme.

UNIT – IV   **12 Hours**
Gene library in a genomic library, cDNA library, phage lambda verses cosmid for gene libraries, mapping the DNA, restriction mapping – direct mapping, indirect mapping, DNA foot printing, chromosome walking, chromosome jumping.

UNIT – V   **12 Hours**
DNA sequencing – Maxam and Gilbert chemical method, Sanger and Olson enzymatic chain termination method – the primer, the template, the dideoxynucleotide termination and deoxynucleotides, the polymerases, Shot gun method using computer sequencing.

REFERENCES:

1. Principles of Gene Manipulation by R.W.Old and S.B.Primrose, 6th edition, Blackwell Science Limited-2006.
2. Gene Cloning – An Introduction by T.A. Brown, VNR (UK) Co.Ltd, England, 1995. Chapman and Hall.
3. Molecular Cell Biology by Lodish, Berk, Zipursky, Matsudaria, Baltimore, Darnell, W.H.Freeman Co, 4th edition 2002.
4. Molecular Biology of the Gene, 5th Ed by James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick. Pearson Education, 2004.

V SEMESTER

MAJOR XII: STRUCTURAL BIOLOGY

UNIT – I   10 Hours

Proteins: Principles of protein structure; anatomy of proteins – Hierarchical organization of protein structure - Primary. Secondary, Super secondary, Tertiary and quaternary structure; Internal coordinates of proteins; Ramachandran plot

UNIT – II   13 Hours

DNA and RNA: DNA and RNA: types of base pairing – Watson-Crick and Hoogstein; types of double helices A,B,Z and their geometrical as well as structural features; structural and geometrical parameters of each and their comparison

UNIT – III   12 Hours

Intermolecular Interactions: Protein-protein interactions, protein –DNA interactions, DNA binding proteins, Types of interactions of DNA with proteins and small molecules. Different forces involved in the interactions.

UNIT – IV   15 Hours

Introduction to X-ray Crystallography - Crystal system, Bragg's law, diffraction of crystals, crystallization, principles of structure solution, Structure validation. Basics of NMR spectroscopy, coupling constant and chemical shift, NOE, Application of NMR spectroscopy in protein structure determination

UNIT – V   10 Hours

Structure Visualization Tools Knowledge of Programs such as SPDBV, Rasmol, Pymol, Chimera, molmol, chime.

TEXT BOOKS:

1. Structural Bioinformatics by Philip E. Bourne and Helge Weissing, Wiley Blackwell, 2009.
2. Biophysics by Vasantha Pattabhi & N. Gautham, ,Kluwer Academic Publishers
Dordrecht, 2002

MAJOR XIII: OPERATING SYSTEMS AND THE NETWORKS

UNIT – I   **10 Hours**

Introduction to operating systems – MS windows commands – Unix/Linux basic commands – general purpose, file handling; Vi editor, basic commands – Shell programming.

UNIT – II   **12 Hours**

Reference Model, Network Topologies and Protocols, Types of Networks: Local Area Network (LAN), Wide Area Network (WAN), Metropolitan Area Network (MAN), Network services – OSI architecture

UNIT – III   **10 Hours**

Wireless communication – Network elements - Introduction to Internet – Internet architecture - resource H/W & S/W requirement of Internet

UNIT – IV   **15 Hours**

Domain naming system, registering our domain name – URL protocol server port relative URLs overview of web browser- ISDN dialup or leased line connection – internet service providers – internet services protocols concepts – internet client and internet server introduction to TCP/IP FTP SMTP POP3.

UNIT V   **13 Hours**

Network security: Internal and external threats – prevention and protection mechanisms – anti spam – antivirus – firewall – VPN - Intrusion Detection System (IDS)

TEXTBOOKS:
1. Operating Systems; by Madnick S.E. and Donovan J.J; McGraw –Hill, 2001
2. Computer Networks; by Andrew S. Tanenbaum; Fourth Edition, Prentice Hall, 2003.

MAJOR PRACTICAL -V

LAB IN BIOLOGICAL SEQUENCE ANALYSIS

1. Retrieving Protein and DNA Sequences using Entrez at NCBI
2. Retrieving Protein and DNA Sequences using SRS at EBI
3. To retrieve metabolic pathways using KEGG PATHWAY Database
4. Pair wise alignment tools- BLAST & FASTA
5. Multiple Sequence Alignment – CLUSTALW
6. Phylogenetic analysis – PHYLIP/MEGA
7. To retrieve metabolic pathways using Reactome.
8. Web browsing at SwisProt, PIR PSD, UniProtKB
9. Understanding the format of PDB and NDB files.
10. File format conversion tools.

V SEMESTER

MAJOR PRACTICAL -VI

LAB IN BIOTECHNIQUES

1. Quantitative analysis of proteins (Lowry's method).
2. Isolation of genomic DNA from plant and animal source.
3. Isolation of bacterial plasmids by Agarose gel electrophoresis.
4. SDS PAGE.
5. Study of DNA melting.
6. Study of absorption spectrum of chlorophyll.
7. Study of Restriction digestion.

MAJOR XIV: GENOMICS & PROTEOMICS

UNIT – I   **13 Hours**

Human Genome Project – Goals - Brief outlook of various genome projects and their outcome. Completely sequenced eukaryotic genomes – *Saccharomyces cerevisiae, Caenorhabditis elegans, Drosophila melanogaster, Arabidopsis thaliana, Homo sapiens*. Ethical, Legal, Social Issues of HGP - IPR & Patents.

UNIT – II   **10 Hours**

Organization of eukaryotic genomes – Unique organization & expression of the genes – Organelle genome - Mitochondria & Chloroplast genomes – Organization & Function.

UNIT – III   **13 Hours**

Mapping genomes by genetic techniques – Linkage Analysis, Mapping genomes by physical techniques – Restriction mapping, FISH, STS.

UNIT – IV   **10 Hours**

Introduction to Proteomics – Proteomics Vs Genomics – Classification of Proteomics Proteome projects and their significance – Codon Bias – Motif & Domain – Protein families.

UNIT – V   **14 Hours**

Proteomic Technologies – Protein separation technologies: 2D-PAGE for proteome analysis, Liquid chromatography. Protein detection – Protein identification and characterization: Mass spectrometry – EMI – MS, Tandem MS, TOF – MS, - HPLC: Peptide Mass Fingerprinting,

TEXT BOOKS:

1. Arthur M. Lesk., Introduction to Bioinformatics, Oxford University Press-2002.

2. Principles and Techniques of Practical Biochemistry 5th Ed. by Keith Wilson., John Walker., Cambridge University Press, 2000.

3. Introduction to Proteomics by Daniel C. Liebler., Humana Press, 2002.

MAJOR XV: PERL PROGRAMMING

UNIT – I   **13 Hours**

Introduction to Perl : Basic I/O, Lexical VS Global, Scalars/Arrays/Hashes, , Interpolation - variable and backslash interpolation , Context - scalar VS list context, Operators - operators, operator, precedence, File/Directory Access - open, opendir, close, < >, $/

UNIT – II   **10 Hours**

Built-In Functions - push, pop, shift, unshift, keys, values, sort, length, index, reverse, stat Command Line Arguments, Control Structures, Regular Expressions, Pattern Matching.

UNIT – III   **15 Hours**

Sequences and strings- Representing sequence data, a program to store a DNA sequence, concatenating DNA fragments, transcription: DNA to RNA using the perl, calculating the reverse complement in proteins, files and arrays, reading proteins in files.

UNIT – IV   **15 Hours**

BIOPERL: .Accessing sequence data from local and remote databases, Accessing remote databases (Bio::DB::GenBank, etc), Transforming sequence files (SeqIO)Transforming alignment files (AlignIO) Manipulating sequences , Searching for similar sequences, Running BLAST (using RemoteBlast.pm), Bioperl alphabets, Extended DNA / RNA alphabet, Amino Acid alphabet

UNIT – V   **10 Hours**

CGI Programming - CGI basics, forms, input types, param(), CGI.pm Module.

TEXT BOOKS:

1. Beginning Perl for Bioinformatics (1st Edition) by Tisdall, J., 2004, O'Reilly Publishers.
2. Learning Perl (5th Edition) by Randal L. Schwartz, Tom Phoenix and Brain D Foy, 2008, O'Reilly Publishers.
3. Programming Perl (3rd Edition) by Wall, W., Christiansen, T. and Orwant, J., 2000, O'Reilly Publishers.

MAJOR XVI: MOLECULAR MODELLING

UNIT I   **11 Hours**

Electric charges and their properties: Coulomb's Law, Pair wise additivity, Electric field, Work, Charge distribution, Potential Energy, Electrostatic Potential, Polarization, Dipole Polarizability.

UNIT II   **12 Hours**

Force between molecules: Pair Potential, Multipole Expansion, Charge–Dipole Interaction, Dipole–Dipole Interaction, Induction Energy, Dispersion Energy, Repulsive Contributions.

UNIT III   **13 Hours**

Balls on springs: Vibrational Motion, The Force Law – Harmonic Potential, A Simple Diatomic – Hooke's Law, Three Problems, The Morse Potential.

UNIT IV   **12 Hours**

Molecular Mechanics: Coordinates, Molecular Mechanics Force Fields: Bond Stretching, Bond Bending, Dihedral Motions, Out-of-Plane Angle Potential (Inversion), Non-bonded Interactions, Coulomb Interactions. Time saving approach - United Atoms, Cut-Offs.

UNIT V   **12 Hours**

The Molecular Potential Energy Surface: Multiple Minima, Saddle Points, Characterization – Internal Coordinates, Finding Minima, Multivariate Grid Search, Univariate Search. Derivative Methods: First-Order Methods - Steepest Descent, Conjugate Gradients.

TEXT BOOKS:

1. Molecular Modelling for Beginners by Alan Hinchliffe, 2nd Edition, JohnWiley & Sons Ltd, 2003.

MAJOR XVII: BIODIVERSITY

Unit I: 12 Hours

The meanings to Biodiversity: Conceptual framework of Biodiversity- Problems and scales of Biodiversity - Levels and Measures of Biodiversity, Interrelationship between Biodiversity measures, applications and integration of diversity measures- Process and pattern of local and regional biodiversity-Niche assembly theories, unified Neutral theory, Island biogeography model

Unit II: 14 hours

Threats to species diversity: Natural and Human induced threats and vulnerability of species to extinctions- Biodiversity and Rarity, Endemism and Biodiversity- Problem of Genetic diversity loss over time: Genetic drifts, Inbreeding depression- Effective and minimum viable population size, measurements and variations- Review of Risks to Biodiversity extinctions. Extinction vortex.

Unit III: 9 Hours

Global pattern of biodiversity: Diversity in biogeographically region and marine zones - Diversity clines in relation to area, latitude, altitude and deep sea - Theories on biodiversity dispersions

Unit IV: 14 Hours

Effect of human activities: Depletion of resources; Generation of waste; types (agricultural, municipal, industrial); Management of wastes and disposal (emphasis on concepts of reduce, reuse and recycle); Pollution of air, water, soil, noise, and due to radioactive substances; Causes and methods of prevention and control; Eutrophication; Bioremediation; Depletion of forests; Threats to biodiversity.

Unit V: 11 Hours

Sustainable Development: Definition; Threats to sustainable development, green technologies, eco-cities, Ecological footprint, National Environmental Policy. **Maintaining biodiversity**: General measures for conservation and sustainable use – Identification and maintaining –In-situ and Ex-suit conservation –Sustainable use of components of biological diversity –Incentive measures.

Text book:

1. Environmental Science by G.Tyler Miller, JR. XIII- Edition 2009, Cengage Learning.
2. Biodiversity-An Introduction by Kelvin J Gaston & John I Spicer II – Edition, Blackwell publication 2004.

MAJOR XVIII: WEB PROGRAMMING

UNIT – I   **12 Hours**

Introduction to HTML – Elementary tags in HTML – List in HTML – Displaying text in lists – Using ordered lists – using unordered lists – Directory list. Definition lists –Combining list types graphics and image format – graphics and HTML documents. Images and hyperlink anchors – Image maps – Tables frames – Forms – Background graphics and color.

UNIT – II   **13 Hours**

Introduction to DHTML – Introduction to style sheets – setting the default style sheet language – Inline style information – External style sheets – Cascading style sheet.

UNIT – III   **12 Hours**

Java Programming - Importance and features of java – Data types – Control statements – Program structure.

UNIT – IV   **10 Hours**

Applet Programming – Applet Basics – Applet Life cycle – Fonts and Colors – Simple Graphics

UNIT – V   **13 Hours**

Introduction to distributed computing environment (DCE) – DCE components – communication protocols – example of necessary transfer in OSI modules – message passing – desirable features of a good message passing systems.

TEXT BOOKS:

1. HTML and Web designing by Kris Jama and Konrad king, publisher Tata McGraw-Hill Education, 2002
2. Programming with Java, 4th Edition, E. Balagurusamy, Tata McGraw-Hill Education, 2009

VI SEMESTER

MAJOR PRACTICAL - VII

LAB IN MOLECULAR MODELLING

1. Protein Sequence analysis using Expasy:

a) Primary
b) Secondary
c) Tertiary

2. Homology based comparative protein modeling - Modeller

3. Validation of models.

a. WHATIF

b. PROSA

c. PROCHECK

d. VERIFY 3D

4. Energy minimization – SPD viewer

MAJOR PRACTICAL -VIII

LAB IN WEB and PERL PROGRAMMING

LAB: WEB PROGRAMMING

1. Usage of simple HTML commands, Graphics and image formats and hyperlinks
2. Use of tables, frames, forms, background graphics and color.
3. Simple Website using HTML
4. Simple DHTML and Cascading style sheet.
5. Creating a simple java program
6. Simple Applet program

LAB: PERL PROGRAMMING

1. File Handling using Perl.
2. Uses of Regular Expressions
3. Concatenation DNA fragments, Transcribing DNA into RNA
4. Calculating the Reverse complement of a DNA strand
5. Parsing Database sequence and storing in Files - Extract annotation and sequence from GenBank file, Extract sequence chains from PDB file
6. Creating forms using CGI