

**D.R. BABASAHEB AMBEDKAR  
MARATHWADA UNIVERSITY,  
AURANGABAD.**



**Revised Syllabus of**

**B. SC. FIRST YEAR**

**BIOINFORMATICS**

**Semester-I, II, III & IV**

**THREE YEARS DEGREE COURSE**

**[ Effective for 2014-15 ]**

## B.Sc. Bioinformatics (3 year 6 Semester ) Course Syllabus

| Semester-I   | Semester- II  |
|--|---|
| Paper-I-Basic Biophysics-I                                   | Paper- VII- Basic Biophysics-II                               |
| Paper-II- Fundamentals of Biology-I                          | Paper-VIII- Fundamentals of Biology-II                        |
| Paper-III- Basic chemistry-I                                 | Paper-IX-Basic Chemistry-II                                   |
| Paper-IV- Basic Mathematics & Statistics-I                   | Paper-X- Basic Math & Statistics-II                           |
| Paper-V-Basics of Computers                                  | Paper-XI- Programming in C                                    |
| Paper-VI- Introduction to Cell Biology                       | Paper-XII- Introduction to Genetics                           |
| LC-I-Basic Biophysics-I and Basic Chemistry-I                | LC-IV-Basic Biophysics-II & Basic Mathematics & Statistics-II |
| LC-II-Basic Mathematics & Statistics-I & Basics of Computers | LC-V-Basic Chemistry-II & Introduction to Genetics            |
| LC-III-Fundamentals of Biology-I & Cell Biology              | LC-VI-Programming in C  |

| Semester-III                                    | Semester- IV  |
|---|---|
| Paper-XIII- Biomolecules                        | Paper-XIX Metabolism                                |
| Paper-XIV-Database Management System            | Paper-XX Introduction to Data Structure & Algorithm |
| Paper-XV-Molecular structures & Enzyme Kinetics | Paper-XXI- Central Dogma                            |
| Paper-XVI- Basic Techniques in Biology          | Paper-XXII- Advanced JAVA                           |
| Paper-XVII- OOPs using JAVA                     | Paper-XXIII- Introduction to chemoinformatics       |
| Paper-XVIII- Introduction to Bioinformatics     | Paper-XXIV-Genomics & Proteomics                    |
| LC-VII-Biomolecules & Biotechniques             | LC-X- OOPs using JAVA                               |
| LC-VIII-PL/SQL                                  | LC-XI-Techniques in Bioinformatics                  |
| LC-IX- Basic Bioinformatics                     | LC-XII-Structural Bioinformatics                    |

## Semester I

| <b>Semester-I</b> |  |                     |                        |              |
|-------------------|--|---------------------|------------------------|--------------|
| <b>Paper No</b>   | <b>Subject Name</b>                    | <b>Theory Marks</b> | <b>Practical Marks</b> | <b>Total</b> |
| Paper-I-          | Basic Biophysics-I                     | 50                  | 00                     | 50           |
| PaperII-          | Fundamentals of Biology-I              | 50                  | 00                     | 50           |
| Paper-III         | - Basic chemistry-I                    | 50                  | 00                     | 50           |
| PaperIV-          | Basic Math & Statistics-I              | 50                  | 00                     | 50           |
| Paper-V           | -Basic Computer                        | 50                  | 00                     | 50           |
| PaperVI-          | Introduction to Cell Biology           | 50                  | 00                     | 50           |
| LC-I-             | Biophysics and Basic Chemistry         | 00                  | 50                     | 50           |
| LC-II             | -Maths & Computers                     | 00                  | 50                     | 50           |
| LC-III            | Fundamentals of biology & Cell Biology | 00                  | 50                     | 50           |
|                   | <b>Total</b>                           |                     |                        | <b>450</b>   |

### **Paper I – Basic Biophysics-I**

**Theory Marks 50**

**Total Hrs-40**

#### **UNIT 1: Motion of Objects**

Units and Measurements; International Standards of Units; Position, Distance, Displacement; Average Velocity, Average speed; Kinematic Equations; Relative Velocity; Vector representation of Physical quantities; Projectile Motion, Circular Motion

#### **UNIT 2: Laws of Motion**

Law of Inertia; Newton's 1<sup>st</sup> law, 2<sup>nd</sup> law and 3<sup>rd</sup> law of motion; conservation of momentum; equilibrium of a particle, common forces in mechanics

#### **UNIT 3: Work, Energy and Power**

Notions of work; Force and Work; Kinetic Energy; Potential Energy; Conservation of mechanical energy; Potential energy of a spring; Power ; Collisions

#### **UNIT 4: Rotational Motion and Oscillations**

Centroid; Center of mass; Linear Momentum; Angular Velocity Vs Linear velocity, inter-relationship; Torque, angular momentum; Rigid bodies; Moment of Intertia; Definition of perpendicular and parallel axes, Kinematics & Dynamics about an axis;

**UNIT 5:**

Simple Harmonic motion; The force law of SHM; Energy; Angular SHM; Pendulums; Damped Oscillations; Forced Oscillations

**Reference Books:**

1. Resnik & Haliday Part I
2. Casey E.J. (1967), Biophysics, concepts and mechanisms. Affiliated East west
3. Ackerman E.A. Ellis, L.E.E. & Williams L.E. (1979), Biophysical Science, Prentice-Hall Inc.press
4. Physical Chemistry for Life Sciences by Barrow C, MC-Grow Hill
5. Biophysical Chemistry by Bloomfield V A and Harrington R E, W A Freeman and Co.
6. Biophysical Chemistry by Cantor C R and Schimmel, P R, W A Freeman and Co.
7. Protein, by Hasehemyer R N and Hasehemyer ACBV, John Willy and Sons
8. Aspects of Biophysics, Hughe S W, John Willy and Sons.
9. Introduction of Biophysics by Pranab Kumar Banargy, S Chand and Co.
10. Principles of Nuclie acid structure by Saenge W, Springer-verlag.
11. Principles of Protein Structure by Schule G E and Schirmer R H, Springer-Verlag.
12. Biochemistry by Stryer L, W A Freeman and Co.
13. Essentials of Biophysics by P Narayanan, New Age International Publishers

## **Paper II – Fundamentals of Biology-I      Theory Marks 50**

**Total Hrs-40**

### **UNIT I – Classification of Organisms**

Classification of organisms (Binomial system), Species, Species name, taxonomic hierarchy. Three Domains of life- Archaeobacteria, Eubacteria, Eukarya, Five Kingdom classification, Viruses – a special case as exception.

### **UNIT II – Bacteria**

Prevalance of bacteria, bacterial forms, basic structure (surface and interior), Bacterial Diversity, Classification of bacteria, Importance of bacteria

### **UNIT III – Plants**

Plant Kingdom, Histology, Tissue types - Meristematic, permanent, Types of Vascular Bundles, Stellar types and evolution, Plant physiology, Absorption of water and nutrients, translocation of solutes, transpiration, photosynthesis, photorespiration; Plant growth, differentiation, dedifferentiation, redifferentiation, development of plant, plant hormones, photoperiodism, vernalization

### **UNIT IV – Animals**

Animal structure & function, Nutrition and digestion, Gas exchange, Circulation, Immune System, homeostasis, hormones and endocrine systems, reproduction & embryonic development, Nervous system, Motion, Sense organs

### **UNIT V – Origin and Evolution of life**

Origin of life, Evolution of life forms, Evidences of evolution, Mechanism of evolution, Hardy - Weinberg Principle, A brief account of evolution.

### **Reference Books:**

1. Brock Biology of Microorganisms - Madigan et al, 9th ed.
2. Biology by Raven and Johnson
3. Biology by Campbell and Reece
4. Exploring creation with Biology – Wile and Durnell,

5. Biology: Understanding Life by S.Alters & B.Alters, John Wiley & Sons
6. The Living World, 4th Edition by G.B. Johnson, John Wiley & Sons

**Paper No-III- Basic Chemistry-I      Theory Marks 50      Total Hrs-40**

**UNIT 1: Introduction**

Importance of Chemistry, basic physical quantities and their measurements, SI Units, Dimensional Analysis, matter and its nature, atomic and molecular masses, molar masses, laws of chemical combinations, molecular formula.

**UNIT 2: Atomic Structure**

Bohr's Atomic models,, Limitations of Bohr's Model, quantum mechanical model of atom, quantum numbers, atomic orbitals, Heisenberg uncertainty principle, Pauli's exclusion principle, Aufbau principle, Hund's rule, Electronic configuration of elements.

**UNIT 3: Chemical Bonding & Molecular Structure**

Ionic bonds, covalent bonds, polarity of bonds, VSEPR theory, shapes of simple molecules, Valence band theory, hybridization of s, p, d orbitals, shapes of molecules, intermolecular forces, Hydrogen bonding, concept of acids and bases: Arrhenius concept, bronsted-lowry theory, Lewis concept.

**UNIT 4: Solutions and chemical kinetics**

Colligative properties of solutions, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Rate of chemical Reaction, factors influencing rate of reaction, order of reaction, integrated rate equations of Zero order, first order and second order, Molecularity of reactions, activation energy, Collision theory.

**UNIT 5: Periodic Table**

Mosley's Modern periodic law, Periodic trends: Electronegativity, Ionization energy, Atom Size, Electron affinity. General characteristics s-,p-,d- and f-Block Elements.

Biological importance of alkali and alkaline earth metals, Group 14 elements (carbon Family): Introduction, physical properties and chemical reactivity.

**Reference Books:**

1. N. N. Greenwood, A. Earnshaw: Chemistry of the Elements
2. D. F. Shriver, P. W. Atkins, C.H. Langford: Inorganic Chemistry
3. A. G. Sharpe: Inorganic Chemistry
4. J. March: Advanced Organic Chemistry
5. I. L. Finar: Organic Chemistry (Vol. I)
6. D. A. Mcquarrie and J. D. Simon: Physical Chemistry – A Molecular Approach
7. I. N. Levine: Physical Chemistry
8. G. W. Castellan: Physical Chemistry
9. P. W. Atkins: Physical Chemistry

## **Paper No-IV-Basic Statistics & Mathematics –I**

**Theory Marks 50**

**Total Hrs-40**

### **Unit I: Introduction**

Introduction to Biostatistics: Common terms and notations, applications. Sampling: Representative sample, sample size, sampling bias and sampling techniques. Data: collection and presentation: Types of data, methods of collection of primary and secondary data, methods of data presentation, graphical representation by histogram, polygon, ogive curve, pie diagram

### **Unit II: Central Tendency & Dispersion measures**

Measures of central tendency: Mean, Median, & Mode, Measures of variability: Standard Deviation, Standard Error, Range, mean deviation, coefficient of variation. Correlation and Regression: Positive and Negative Correlation, Calculation of correlation coefficient, regression, linear regression, and regression equation, ANOVA, one and two way classification.

### **Unit III: Test of Significance**

Parametric and Non-parametric hypothesis testing, Types of Errors, F-test, t-test, Z-test and chi-square test

### **Unit IV: Matrix algebra**

Definition, types of matrices, matrix algebra, addition, subtraction & multiplication. Transpose inverse of matrix.

### **Unit V: Vector algebra and calculus**

Vector Algebra--Addition, subtraction, dot, cross, scalar triple product, divergence, curl of a vector, equation of normal

### Reference Books:

1. Introductory Biostatistics: Chap T Le, Wiley interscience publication.
2. Jenny Olive – Maths :- a self study Guide – Cambridge Low prices edition
3. R.G. Bartle and D.R. Sherbert (2nd edition)-1992, JohnWiley, New York
4. E.D. Rainville and P.E. Bedient (1989), Elementary
5. Campbell R.C.–Statistics for Biologist, Cambridge University Press, Cambridge
6. Ward Law A.C. (1985)–Practical Statistics for Experimental Biologists
7. Daily N.T.J.–Statistical Methods in Biology, English University Press
8. P.S.S. Sunderrao & J. Richard–An Introduction to Biostatistics, Prenticed hall Pvt. Ltd. India

## **Paper No-V-Basics of Computers Theory Marks 50 Total Hrs-40**

### **Unit-I**

What is computer, characteristics of computers, applications of computer, computer generation, classification of computers, components of computer system. Input/Output Units: Keyboard, Mouse, Trackball, Joystick, Digitizing tablet, Scanners, Digital Camera, MICR, OCR, OMR, Bar-code Reader, Voice Recognition, Light pen, Touch Screen, CRT, LCD, LED Monitors.

### **Unit-II**

Number systems-Binary, Octal, Decimal, Hexadecimal. Introduction to Operating Systems, Functions and Characteristics of Operating Systems. Concept of multiprogramming, multitasking, timesharing and Batch OS, World of Internet.

### **Unit-III**

Computer Networking, Network Topologies and Protocols, Networking gadgets (Router, Switch, etc), Communication Links (Wire pairs, Coaxial cables, Fiber optics, Microwave, Satellite, etc) .Local Area Network



(LAN), Wide Area Network (WAN), Metropolitan Area Network (MAN) ,OSI Reference Model Network Attacks, Network Security : Firewall, Packet filtering, Honeypots. Data Security : Encryption/Decryption

#### **Unit-IV**

Introduction of MS-Office, Different elements of word processing (MS-WORD), Spreadsheets (MS EXCEL), Data storage (MS ACCESS) and PowerPoint presentation (MS POWERPOINT)

#### **Unit-V**

Computer Networking, Network Topologies and Protocols, Networking gadgets (Router, Switch, etc), Communication Links (Wire pairs, Coaxial cables, Fiber optics, Microwave, Satellite, etc) .Local Area Network (LAN), Wide Area Network (WAN), Metropolitan Area Network (MAN) ,OSI Reference Model Network Attacks, Network Security : Firewall, Packet filtering, Honeypots. Data Security : Encryption/Decryption

#### **Reference Books:**

- 1.Trainer T., et al, "Computers", McGraw Hill.
- 2.Norton, Peter, "Introduction to Computers, Mc-Graw-Hill.
- 3.Microsoft Web Publishing Step by Step, Active Education
4. Information technology concepts by Dr. Madhulika Jain, Shashank & Satish Jain, [BPB Publication, New Delhi.]
5. Fundamentals of Information Technology By Alexis And Mathews Leon [Leon Press, Chennai & Vikas Publishing House Pvt Ltd, New Delhi

**Paper No-VI-Introduction to Cell Biology**

**Theory Marks 50**

**Total Hrs-40**

**Unit I :**

Definition of Cell, Cell theory, Diversity of cell size and shape

Overview of cell specialization – Plants – epidermis, vascular tissue and cortex. Special properties of plant cells- cell wall, vacuoles and chloroplasts

Animals- epithelia, connective tissue, nervous tissue, muscle, blood, germ cells and sensory cells

**Unit II**

Structure and organization of prokaryotic and eukaryotic cells, differences

**Unit-III**

Endoplasmic reticulum, lysosomes, Golgi apparatus, mitochondria, cytoskeleton- microtubules, intermediate and actin filaments, cilia and flagella, nucleus, ribosomes

**Unit IV**

Structure of model membranes- Plasma membranes, Endoplasmic reticulum membrane, nucleus, mitochondrial and chloroplast membranes. Lipid bilayer, membrane proteins and their functions.

**Unit V**

Transport across membranes, Types of membrane transports- active and passive Transport, Passive transport- Simple and facilitated diffusion, transporters- Uniporters, cotransporters and channel proteins. Active transport- Pumps, Group translocations and electrochemical gradients.

**Reference Books:**

1. Microbial Physiology – Moat and Foster
2. Molecular Biology of Cell, (2002), 4th Edition; Albert's et al.
3. Molecular Cell Biology (2004), Lodish et al.

4. Cell and Molecular Biology; Concepts & Experiments (2004).Karp, G.
5. The Cell: A molecular Approach (2004), Cooper, G.M
6. Cell &Molecular biology, de Robertis & df Robertis.
7. Cell proliferation and apoptosis (2003); Hughes & Mehnet.
8. Biochemistry &Molecular Biology of plants (2004); Buchanan et al.
9. Lehninger Principles of Biochemistry, (2005) Nelson & Cox

## **LC-I- Basic Biophysics and Basic Chemistry**

### **Section A- Basic Biophysics-I**

Practical course content of this subject will be conveyed at the time of starting this course.

### **Section A- Basic Chemistry-I**

#### **Practicals:**

1. Prepare standard solution oxalic acid and standardize given NaOH solution.
2. Prepare standard solution oxalic acid and standardize given KMnO<sub>4</sub> solution.
3. Determine the water of crystallization in given salt – BaCl<sub>2</sub>.2H<sub>2</sub>O
4. To determine the specific reaction rate of the hydrolysis of methyl acetate/ ethyl Acetate catalyzed by hydrogen ion at room temperature
5. To study and perform kinetically the reaction rate of decomposition of iodide by H<sub>2</sub>O<sub>2</sub>.
6. To determine the percentage composition of a given mixture by viscosity methods
7. To determine the percentage composition of a given binary mixture by surface tension method

## **LC-II Mathematics & Statistics-I & Basics of Computers**

### **Section A- Mathematics & Statistics**

#### **1. Introduction to Biostatistics-**

Terminologies used in Biostatistics and their definitions.

#### **2. Data Representation methods-**

Types of data, examples on graphical representations of data by histogram, bar graph, polygon, ogive curve, pie diagram.

**3.Sampling Techniques-**

Introduction to sample and population, Sampling methods and examples of sampling methods.

**4. Measures of Central Tendency**

Problem solution of all measures of central tendencies.

**5. Measures of Dispersion**

Problem solution of all measures of dispersion.

**6. Test of Significance**

Problem solution of all types of tests of significance.

**7. Matrix Algebra**

Problem solution on matrix addition, subtraction, multiplication, transpose and inverse.

**8. Vector Algebra & calculus**

Problem solution on vector addition , subtraction, dot, cross, scalar triple product, divergence, curl of a vector, equation of normal

**Section B- Basics of Computers**

1.Introduction to number system- Problem solving on conversion of number systems.From Decimal to Binary, octal , hexadecimal & vice-versa and all other combinations of conversions.

2.Hands-On experience and regular usage: Tutorials (Typing, Windows OS introduction, Linux OS introduction,Internet etc.), applications.

3. Internet: Introduction to Browsers, utilizing current browsers (Internet Explorer, Mozilla, Chrome etc.) , surfing the Internet, Search Engines,using E-Mail/Web mail.

4. Downloading and installing software/plugin-ins on Windows 98/XP, Linux (Acrobat Reader, Post Scripts Viewer, etc.).

5. Word Processing (Microsoft Word): Creating, Saving & Opening a document, Editing, Inserting, Deleting, Formatting, Moving & Copying Text, Find & Replace, Spell Checker & Grammar Checker (Thesaurus), Document Enhancement (Borders, Shading, Header, Footer), Printing document (page layout, Margins), Introduction to the use of Wizards & Templates, Working with Graphics (Word Art).

6. Working with Tables & Charts, Inserting Files (pictures, Databases, Spreadsheets)

7. Microsoft Excel: Worksheet Basics (Entering information in a worksheet, Saving & Opening a worksheet, Editing, Copying & Moving data, Inserting, Deleting & Moving Columns & Rows, Clearing Cells & Formatting cells), Working with workbooks, Working with formulae and functions, Printing worksheets.

8. Introduction to the use of advanced spreadsheet concepts and applications, Database "Management (Sorting records, Finding records, Adding & Deleting records, Filtering records in a worksheet), Working with Macros, Creating and using multiple worksheets

9. Database Applications (Microsoft Access): Fields, Records, Files, Organization of Files, Access Modes. Database, Relational Database; Primary and Secondary Key, Working with databases & tables, Creating a Database, Appending, Updating Records Querying, Reports, Forms and sub forms, Sorting, Filters. An introduction to use of Macros, Modules, Wizards with database applications

10. Creation of Computer Presentations with graphics (Microsoft Power Point): Creation of slides, Rapid Presentation design using wizards, Inserting graphs & charts Action buttons, Transitions, Build and Animation effects Introduction to Multimedia Tools & Devices Searches on Medline, bibliographic databases, etc.

## **LC-III Fundamentals of biology & Cell Biology**

### **Section A- Fundamentals of Biology-I**

1. Cell organelles study with permanent slides

2. Meiosis

3. Mitosis

4. Study of Osmosis

5. Microtomy

6. TC of stem, pollen grain, stigma, leaves, root7. Xylem, Phloem

7. Detection of normal and abnormal constituents of urine – sugar, albumen  
bile and blood cells.

8. Demonstration of salivary amylase.

9.Effect of temperature and pH on amylase

### **Section B- Cell Biology**

1.Visualization of Chromosomes in mitotic/ meiotic stages in onion root tips / buds.

2.Isolation and confirmation of mitochondria from plant / animal cells.

3.Lipid solubility of membrane

4.Study of osmosis in blood cells

5.Isolation of Chloroplasts from Spinach leaves

6.Study of hill reaction using isolated chloroplast

7.The effect of detergents on the erythrocyte membrane

8.Effect of lipid composition on membrane permeability.

## **Semester-II**

| <b>Semester- II</b> |  |                     |                        |              |
|---------------------|--|---------------------|------------------------|--------------|
| <b>Paper No</b>     | <b>Subject Name</b>  | <b>Theory Marks</b> | <b>Practical Marks</b> | <b>Total</b> |
| Paper- VII          | Basic Biophysics-II  | 50                  | 00                     | 50           |
| PaperVIII-          | Fundamentals of Biology-II                                     | 50                  | 00                     | 50           |
| Paper-IX-           | Basic Chemistry-II   | 50                  | 00                     | 50           |
| Paper-X-            | Basic Mathematics & Statistics-II                              | 50                  | 00                     | 50           |
| Paper-XI-           | Programming in C   | 50                  | 00                     | 50           |
| Paper-XII-          | Introduction to Genetics                                       | 50                  | 00                     | 50           |
| LC-IV               | Fundamentals of Biology-II & Basic Mathematics & statistics-II | 00                  | 50                     | 50           |
| LC-V                | Basic Chemistry-II & Introduction to Genetics                  | 00                  | 50                     | 50           |
| LC-VI               | Programming in C   | 00                  | 50                     | 50           |

**Paper -VII – Basic Biophysics-II      Theory Marks 50      Total Hrs-40**

**UNIT 1: Waves & Laws of Thermodynamics**

Types of waves; Wavelength and frequency; Speed of traveling waves; Energy and power of waves; wave equation; Principle of superposition of waves; Sound waves, speed;      Temperature; Definition and applications of Zeroth law, 1<sup>st</sup> law and 2<sup>nd</sup> law of      thermodynamics; Applications

**UNIT 2: Electricity**

Electric Charge; Columb's law; Electric field, due to a point charges, due to dipole; due to      line of charge; point charge in electric field; Gauss's law;

**UNIT 3: Magnetism**

Magnetic field, Definition; cyclotrons & synchrotrons; magnetic field in a current carrying wire; Ampere's Law; Solenoids; Energy stored in magnetic fields;

**UNIT 4: Electromagnetic waves**

Electromagnetic waves; Energy; Polarization; reflection & refraction; total internal      reflection;

**UNIT 5: Optics & Light**

Light as a wave; Diffraction, Young's Interference, double-slit experiment; wave theory of light;



Diffraction grating; X-ray Diffraction

### Reference Books:

1. David Friefelder: physical biochemistry- w. h. freeman and company
2. Wilson and walker
3. Nath & Upadyay: Biophysical chemistry –himalaya
4. Gudep and Chatwal :Instrumental methods of chemical -himalaya

## Paper -VIII – Fundamentals of Biology-II

Theory Marks 50

Total Hrs-40

### UNIT 1: Overview

Introduction & History of Microbiology - Biogenesis and abiogenesis Contributions of Redi, Spallanzani, Needham, Pasteur, Tyndal, Joseph Lister, Koch [Germ Theory], Edward Jenner and Flemming [Penicillin], Scope of Microbiology. Classification of Microbes - Systems of classification, Numerical taxonomy, Identifying characters for classification, General properties and principles of classification of microorganisms Systematics of bacteria, Nutritional types [Definition and examples]. Classification on the basis of oxygen requirement.

### UNIT 2: Concept of Sterilization

Definition of sterilization, dry and moist heat, pasteurization, tyndalization; radiation, ultrasonication, filtration. Physical and Chemical methods of sterilization; disinfection sanitization, antiseptics sterilants and fumigation. Determination of phenol coefficient of disinfectant.

### UNIT 3: Stains and staining techniques

Definition of auxochrome, chromophores, dyes, Classification of stains, Theories of staining, Mechanism of gram staining, acid fast staining, negative staining, capsule staining, flagella staining, endospore staining.

### UNIT 4: Microbes in Extreme Environment

Nature, special features of the thermophilic, methanogenic and halophilic; Archaea; photosynthetic bacteria, Cyanobacteria some Archaea who live in extreme conditions like cold, and space. Pathogenic Microorganisms – List of common bacterial, fungal and viral diseases of human beings [Name of the disease, causative pathogen, parts affected]

#### **UNIT 5: Basic concepts of Virology**

General characteristics of viruses, differences between bacteria and viruses. Classification of viruses Physical and chemical Structures of different Viruses.

#### **Reference Books:**

1. Brock Biology of Microorganisms - Madigan et al, 9th ed.
2. Biology by Raven and Johnson
3. Biology by Campbell and Reece
4. Molecular Biology of the Cell – Bruce Alberts
5. Exploring creation with Biology – Wile and Durnell
6. Prescott's Microbiology Joanne Willey , Linda Sherwood , Chris Woolverton
7. Microbiology, Robert bauman

### **Paper No-IX Basic Chemistry-II      Theory Marks 50      Total Hrs-40**

#### **UNIT 1: Stereochemistry**

Classification of stereoisomers, isomer number, enantiomerism, diastereomerism, chiral center, absolute configuration, R & S, conformations in Cycloalkanes and cyclohexanes, geometrical isomerism: E & Z, resolution, stereoselecting and stereospecific reactions

**UNIT 2: Basis of Organic Reactions Mechanism:** Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution,

#### **UNIT 3: Hydrocarbons**

Alkanes, Alkenes, Alkynes: definition, general formula, IUPAC nomenclature, general preparation methods and physical and chemical properties; Cycloalkanes, Aromatic compounds: definitions, general formulae, IUPAC nomenclature, general preparation methods and physical and chemical properties

#### **UNIT 4: Alcohols, Phenols, Aldehydes, Ketones, Carboxylic Acids in Biology**

Definition, general formula, IUPAC nomenclature, general preparation methods and bio-physico-chemical properties.

#### **UNIT 5: Heterocyclic & Polymer Chemistry**

Hetero-cyclic systems, 5-membered rings: structures of pyrrols, furenes and thiophenes, electrophilic substitutions;

6-membered rings: structures of pyridines; sources, reactions of pyridines, basicity of pyridines.  
Introduction, preparation and physical and chemical properties of poly-ethylene, PVC, Nylon-6, Nylon-6-6, Polyester, Styrene, Natural rubber,

**Reference:**

1. N. N. Greenwood, A. Earnshaw: Chemistry of the Elements
2. D. F. Shriver, P. W. Atkins, C.H. Langford: Inorganic Chemistry
3. A. G. Sharpe: Inorganic Chemistry
4. J. March: Advanced Organic Chemistry
5. I. L. Finar: Organic Chemistry (Vol. I)
6. D. A. Mcquarrie and J. D. Simon: Physical Chemistry – A Molecular Approach
7. I. N. Levine: Physical Chemistry
8. G. W. Castellan: Physical Chemistry
9. P. W. Atkins: Physical Chemistry
10. Organic Chemistry, R. T. Morrison & R. N. Boyd, 6th Edition, Publishers: Pearson Education.
11. Organic Chemistry, Arun Bahl & B. S. Bahl, Publishers: S. Chand

**Paper No-X-Basic Statistics & Mathematics- II**

**Theory Marks 50**

**Total Hrs-40**

**Unit I: Introduction to Probability**

Introduction to probability- definition& types of probability. Probability distribution – binomial, Poisson , normal, Baye’s theorem, concept of Random variable, types of Random variable

**Unit II: ANOVA & MANOVA**

ANOVA, one-way and two-way ANOVA, applications of ANOVA in biological problems, Multivariate ANOVA

**Unit III: Limit & Continuity**

Functions, types of functions ,Limits, standard formulae, limits of logarithmic, exponential, trigonometric ,implicit and explicit functions.

Continuity, definition, continuity of functions.

#### **Unit IV: Derivatives**

Derivatives: laws of derivatives of functions, differentials of all types of functions functions- logarithmic, exponential, trigonometric ,implicit and explicit functions.

#### **Unit V: Integration**

Concept of Integration, applications, types: Definite and Indefinite(Nondefinite), basic rules and properties of Integration.

Definite Integrals, definite integrals of functions- logarithmic, exponential, trigonometric ,implicit and explicit functions.

Non-definite Integrals, definite integrals of functions- logarithmic, exponential, trigonometric ,implicit and explicit functions

#### **References:**

1. Introductory Biostatistics: Chap T Le, Wiley interscience publication
2. Jenny Olive – Maths :- a self study Guide – Cambridge Low prices edition
3. R.G. Bartle and D.R. Sherbert (2nd edition)-1992, JohnWiley, New York
4. E.D. Rainville and P.E. Bedient (1989), Elementary
5. Campbell R.C.–Statistics for Biologist, Cambridge University Press, Cambridge
6. Ward Law A.C. (1985)–Practical Statistics for Experimental Biologists
7. Daily N.T.J.–Statistical Methods in Biology, English University Press
8. P.S.S. Sunderrao & J. Richard–An Introduction to Biostatistics, Prenticed hall Pvt. Ltd. India

**Paper No-XI-Programming in C/C++      Theory Marks 50**  
**Total Hrs-40**

**UNIT 1: Introduction to C/C++(CPP):**

Importance of C/CPP, Basic structure of C/CPP program, creating a simple CPP program, executing a CPP program, header files, Data types, Operators and Expressions: Character set, keywords and identifiers, constants and variables, data types, declaration of variables, defining symbolic constants. Operators: relational operators, logical operators, assignment operators, increment and decrement operators, conditional operator, library functions, arithmetic expressions evolution of expression, precedence of arithmetic operators, operator precedence and associatively.

**UNIT 2: Loops & Control Statements**

Data Input Output, Branching and Loops:Reading a character, writing a character, formatted input and formatted output. Decision making and if... else statement, nesting of if... else statement, the switch statement, the? : operator, the goto statement, The while statement, the do statement, the for statement.

**UNIT 3: Arrays**

Arrays and Functions: One dimensional arrays, two dimensional arrays, sorting algorithm bubble sort and insertion sort.

**UNIT 4: Functions**

Defining a function, function prototype, return type, passing arguments, call by value, call by reference, recursive function, passing array to function, scope rule. String manipulation functions.

**UNIT 5: Introduction to OOPs & Standard Template Library (STL)**

Introduction to concept of Object Oriented Programming, characteristics of OOP's ( Encapsulation, Abstraction, Inheritance,Polymorphism ), classes and objects , Bytecode ,Using STL's (Streams, fstreams, numeric, vectors).

**References**

1. The C Programming Language, Brian W. Kernighan, Dennis M. Ritchie, ISBN:9788120305960, PHI Learning
2. How to Solve it by Computer, R.G. Dromey, ISBN:9788131705629, Pearson Education
3. A Structured Programming Approach Using C, Behrouz A. Forouzan, Richard F. Gilberg ISBN:9788131500941, Cengage Learning India
4. Using The GNU Compiler Collection, Richard M. Stallman; The GCC Developer Community Pothi.com

5. Mastering C by Venugopal, Prasad – TMH
6. Complete reference with C Tata McGraw Hill
7. C – programming E.Balagurusamy Tata McGraw Hill
8. Schaums outline of Theory and Problems of programming with C : Gottfried
9. The C programming language : Kernighan and Ritchie
10. An introduction to data structures with applications, Jean-Paul Trembly and Paul Sorenson, (2<sup>nd</sup> edition), 1984.

## **Paper No-XII-Introduction to Genetics Theory Marks 50**

**Total Hrs-40**

### **UNIT 1: Mendel's Principles of Heredity**

The Basic Principles of Inheritance, Mendel's experiments, Monohybrid Crosses: The Principles of Dominance and Segregation, Dihybrid Crosses: The Principle of Independent Assortment, Applications of Mendel's Principles, Mendelian inheritance in Humans, Mendelian Principles in Human Genetics, Pedigrees, Mendelian Segregation in Human Families

### **UNIT 2: Extensions to Mendel's laws**

Extensions of Mendelism, Allelic Variation and Gene Function, Incomplete Dominance and Codominance, Multiple Alleles, Allelic Series,

### **UNIT 3: Chromosome Theory of Inheritance**

Inborn Errors of Metabolism, Pleiotropy, The Chromosomal Basis of Mendelism, Sex, Chromosomes, Genes, Sex Chromosomes, The Chromosome Theory of Heredity, Experimental Evidence Linking the Inheritance of Genes to Chromosomes

### **UNIT 4: Linkage, Recombination and the mapping of Genes on Chromosomes**

Linkage, Recombination, and Crossing Over, Exceptions to the Mendelian Principle of Independent Assortment, Frequency of Recombination as a Measure of Linkage Intensity, Crossing Over as the Physical Basis of Recombination, Evidence that Crossing Over Causes Recombination, Chiasmata and the Time of Crossing Over, Chromosome Mapping, Crossing Over as a Measure of Genetic Distance, Recombination Mapping with a Two-Point Testcross, Recombination Mapping with a Three-Point Testcross, Recombination Frequency and Genetic Map Distance, Chiasma Frequency and Genetic Map Distance, Cytogenetic Mapping, Localizing Genes Using Deletions and Duplications, Genetic Distance and Physical Distance, Linkage Analysis in Humans, Detecting Linked Loci by Pedigree Analysis, Somatic-Cell Techniques for Assigning Genes to Chromosomes, Recombination and Evolution, Evolutionary Significance of Recombination, Suppression of

Recombination by Inversions, Genetic Control of Recombination, Focus on Evolutionary Divergence of the Human X and Y Chromosomes

**UNIT 5: Quantitative Genetics and Alterations of Chromosomes**

Polygenic inheritance, heritability and its measurements, QTL Mapping. Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

**Reference Books:**

1. Genetics a conceptual approach – Benjamin Pierce
2. Principles of Genetics – Tamarin
3. Genetics: Strickberger, M. W. (Macmillan)
4. Principle of Genetics (2001) 8thEd. -Gardener et al.
5. Concept of Genetics 7thEd. (2003) -Klug& Cummings.

**LC-IV -Basic Biophysics-II & Basic Mathematics & statistics-II**

**Section A- Fundamentals of Biology-II**

1. Simple staining/Monochrome staining
2. Negative staining
3. Differential staining –Grams staining and Acid Fast staining
4. Cell wall staining
5. Capsule staining
6. Flagella staining
7. Spore staining
8. Nucleic acid staining

9. Media construction, minimal and complex medium

10. Selective medium for Salmonella

11.. Growth curve for E. coli strain and LB medium

12. Testing efficiency of sterilization

### **Section B- Basic Mathematics & statistics-II**

**1.Introduction to Probability:** Introduction to probability, definition & problem solving on types of probability, Probability distribution – binomial, Poisson, normal, Baye's theorem in with statistical and biological problems.

**2.ANOVA & MANOVA: Biological problem solving on ANOVA,** one-way and two-way ANOVA, Multivariate ANOVA

**3.Limit & Continuity: Problem solving on** Functions, types of functions, Limits, standard formulae, limits of logarithmic, exponential, trigonometric, implicit and explicit functions.

Continuity, definition, continuity of functions.

**4.Derivatives :Problems solving on** Derivatives: laws of derivatives of functions, differentials of all types of functions functions- logarithmic, exponential, trigonometric, implicit and explicit functions.

**5. Integration: Problem solving on** Definite and Indefinite (Nondefinite) Integrals, Definite Integrals, definite integrals of functions- logarithmic, exponential, trigonometric, implicit and explicit functions. Non-definite Integrals, definite integrals of functions- logarithmic, exponential, trigonometric, implicit and explicit functions



## LC-V-Basic Chemistry-II & Introduction to Genetics

### Section A- Basic Chemistry-II

1. Systematic qualitative analysis of organic compounds (Single compound:
  - i. Benzoic Acid
  - ii. Phthalic acid
  - iii. Cinnamic acid
  - iv. 2-naphthol
  - vi. *p*-nitroaniline
  - vii. Acetanilide
  - viii. Naphthalene)for nature, functional group, elements, derivatives and physical constant.
2. Purification of organic compound by crystallization–Benzoic acid
3. Purification of organic compound by sublimation– Naphthalene.
4. Purification of organic compound by distillation.

### Section B- Introduction to Genetics

1. Determination of mutation rate
2. Fluctuation analysis
3. Spontaneous mutation –drug resistance phenotype
4. Mutations by UV rays
5. Mutations by chemical agents such as; base analogue, intercalating agents or Alkylating agents.
6. Bacterial transformation
7. Bacterial conjugation
8. Bacterial transduction
9. UV survival curve and Photo and/or Dark repair.

## LC-VI-Programming in C

1. Introduction to C and C++
2. Working with Operators in C and C++
3. Working with loop and control statements C and C++
4. Using Functions Binding data and functions C and C++

5.Pointers and Arrays C and C++

6. Function and Operator Overloading in C++

7. Reusing classes in C++

8. Object-oriented programming  
in C++

9.Standard Template Library (STL) & its uses in C++

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| Semester-III                                    | Semester- IV  |
|---|---|
| Paper-XIII- Biomolecules                        | Paper-XIX Metabolism                                |
| Paper-XIV-Database Management System            | Paper-XX Introduction to Data Structure & Algorithm |
| Paper-XV-Molecular structures & Enzyme Kinetics | Paper-XXI- Central Dogma                            |
| Paper-XVI- Basic Techniques in Biology          | Paper-XXII- Advanced JAVA                           |
| Paper-XVII- OOPs using JAVA                     | Paper-XXIII- Introduction to chemoinformatics       |
| Paper-XVIII- Introduction to Bioinformatics     | Paper-XXIV-Genomics & Proteomics                    |
| LC-VII-Biomolecules & Biotechniques             | LC-X- OOPs using JAVA                               |
| LC-VIII-PL/SQL                                  | LC-XI-Techniques in Bioinformatics                  |
| LC-IX- Basic Bioinformatics                     | LC-XII-Structural Bioinformatics                    |

## Semester III

### Paper No. XIII - Biomolecules

#### UNIT I – Carbohydrates

Functions of carbohydrates, Types, Structures and Properties of – Monosaccharides, Disaccharides, Polysaccharides, glycoconjugates - Proteoglycans, Glycoproteins, and Glycolipids.

#### UNIT II – Lipids

Definition, Alcohols and fatty acids, simple lipids, compound lipids, derived lipids, properties of fats and oils.

#### UNIT III – Vitamins

Structure and Properties of - Fat soluble vitamins (A, D, E, K), Water soluble vitamins (B<sub>1</sub>, B<sub>2</sub>, B<sub>3</sub>, B<sub>5</sub>, B<sub>6</sub>, B<sub>7</sub>, B<sub>9</sub>, B<sub>12</sub>, C)

#### UNIT IV – Hormones

Structure, Function and role of - Animal hormones (Thyroid, Parathyroid, Gonadal, Adrenal, and pancreatic), Plant hormones (Auxin, Gibberelin, Cytokinins, Abscisic acid, Ethylene)

#### UNIT V – Molecular fuels

Structure, Function and role of – ATP, NADH<sub>2</sub>, NADPH<sub>2</sub>, FADH<sub>2</sub>.

#### Reference Books:

1. Biochemistry by Stryer 5th Edition WH Freeman 2001
2. Cohn & Stump, Outline of Biochemistry Wiley Eastern Ltd.2.
3. Harpers Review of biochemistry Prentice Hall
4. Cregnton Protein Structure & Molecular Properties
5. A.L. Lehninger, D. L. Nelson & M M Cox Principles of Biochemistry.

## **Paper No-XIV- Database Management System**

### **Unit-I**

Introduction of DBMS, Overview, File system Vs DBMS, Describing & storing data (Data models (relational, hierarchical, network)), Levels of abstraction, data independence, Queries in DBMS (SQL: DDL, DML, DCL, TCL), Structure of DBMS, Advantages of DBMS.

### **Unit-II**

File Organization- Physical / logical files, Special characters in files, fields & record organization (fixed, variable length) types of file organization (heap, sorted, indexed, hashed), choosing a file organization.

### **Unit-III**

Indexed File Organization- Overview of indexes, types of indexes (dense, sparse, clustered, primary, secondary, tree (multilevel indexes, B+ tree).

### **Unit-IV**

Conceptual Design (E-R model). Overview of DB design, ER data model (entities, Attributes, entity sets, relations, relationship sets) , Additional constraints ( key constraints, participation constraints, weak entities, aggregation / generalization, conceptual design using ER ( entities VS attributes, Entity Vs relationship, binary Vs ternary, constraints beyond ER).

### **Unit-V**

Relational data model –Relations: concepts, Conversion of ER to Relational model, integrity constraints (key, referential integrity, general constraints).  
Relational algebra-Preliminaries, Relational algebra (selection, projection, set operations, renaming, joins, division).

### **References**

1. Database System Concepts, Henry F. Korth, Abraham Silberschatz, S. Sudarshan, ISBN:9780071289597, Tata McGraw-Hill Education.
2. Database Management Systems ,Raghu Ramakrishnan,ISBN:9780071254342, Mcgraw-hill higher Education.
3. Database Management Systems,Raghu Ramakrishnan and Johannes Gehrke, McGraw-Hill Science/Engineering/Math; 3 edition, ISBN: 9780072465631
4. Database Systems, Shamkant B. Navathe, Ramez Elmasri, ISBN:9780132144988, PEARSON HIGHER EDUCATION
5. Beginning Databases with PostgreSQL: From Novice to Professional, Richard Stones, Neil Matthew.

## **Paper No-XV-Molecular Structures & Enzyme Kinetics**

### **UNIT I- DNA**

Nature of genetic material; evidence that DNA is the genetic material, generalized structural plan of nucleic acid, forms of DNA, features of DNA double helix; role of DNA as genetic material.

### **UNIT II – RNA**

RNA – structure and types of RNA, mRNA, tRNA, rRNA.

### **UNIT III – Proteins – Basic concepts**

Amino acids: Classification, Properties, reactions. Protein classification: Reactions, functions, properties and Solid phase synthesis.

### **UNIT IV – Structural levels of proteins**

Primary Structure: Peptide bond, importance of primary structure. Secondary structure: X ray diffraction, alpha-helix,  $\beta$  - structure,  $\beta$ -helix, super secondary structure. Tertiary Structure: Forces stabilizing, Prediction of tertiary Structure. Quaternary structure – Haemoglobin, Myoglobin, Actin, Torsion angle, Ramachandran plot.

### **UNIT V – Enzymes**

Basic concept, Classification, Nature of enzymes catalysed reaction, active site of enzymes, Michaelis-Menton equation, effect of temp, pH, Enzyme concentration and time of incubation. Role of co-enzymes, prosthetic groups, activator and inhibitors in enzyme catalysed reaction.

### **Reference Books:**

1. Biochemistry by Stryer 5th Edition WH Freeman 2001
2. Cohn & Stump, Outline of Biochemistry Wiley Eastern Ltd.2.
3. Harpers Review of biochemistry Prentice Hall
4. Cregnton Protein Structure & Molecular Properties
5. A.L. Lehninger, D. L. Nelson & M M Cox Principles of Biochemistry.
6. David Friefieder Essentials of Molecular Biology, Jones & Barlett publications
7. J.D.Watson, N.H.Hopkins, J.W Roberts, et al Molecular Biology of the Gene, Benjamin Cummings publ.co.inc., California
8. Zubay Biochemistry 4<sup>th</sup> edition

### **Paper No-XVI-Basic Techniques in Biology**

#### **UNIT I**

Isolation, purification and criteria of purity of proteins and enzymes, Centrifugation-Analytical and Differential.

#### **UNIT II**

UV and visible Spectrophotometry.

#### **UNIT III**

**Membrane filtration and dialysis:** Nitrocellulose, Polycarbonate filters, dialysis and Concentration, freeze drying and lyophilization.

#### **UNIT IV**

**Chromatography techniques:** Partition and adsorption Chromatography- GLC, gel filtration, Molecular exclusion, HPLC.

#### **UNIT V**

**Electrophoretic techniques:** Types of electrophoresis: (paper, cellulose-acetate electrophoresis, gel Electrophoresis (starch gel, native PAGE, disc PAGE, gradient PAGE, SDS-PAGE, agarose gel electrophoresis, Isoelectric focusing, 2D gel electrophoresis).

#### **Reference Books:**

1. Physical Biochemistry: Application to Biochemistry and Molecular Biology –Freilider.
2. Biochemical Technique : Theory and Practice, -Roby & White
3. Principle of Instrumental Analysis –Skoog & West
4. Principle & Technique –Practical Biochemistry 5thEd. (2000) -Walker J. & Wilson K.
5. Biochemical Techniques Theory and Practice: J.R. Roby and B.J. White. 1990
6. Principle of Instrumental Analysis–Skoog et al., 7<sup>th</sup> edition

## **Paper No-XVII- Object Oriented Programming using JAVA**

### **Unit-I**

Fundamentals of Object Oriented programming: Object Oriented paradigm - Basic concepts of Object Oriented Programming - Benefits of OOP - Applications of OOP. Java Evolution: Java Features - How Java differs from C and C++. - Java and Internet - Java and World Wide Web - Web Browsers - Hardware and Software Requirements - Java Environment.

### **Unit-II**

Overview of Java Language: Simple Java Program - Java Program Structure - Java Tokens- Java Statements - Implementing a Java Program - Java Virtual Machine - Command Line Arguments. Constants, Variables and Data types: Constants - Variables - Data types - Declaration of Variables-Giving Values to variables- Scope of Variables-Symbolic Constants-Type Casting.

### **Unit-III**

Operators and Expressions, Decision Making and Branching: Decision Making with If statement - Simple If Statement-If else Statement-Nesting If Else Statement- the ElseIf Ladder-The switch Statement - The?: operator. Decision Making and Looping: The while statement - The do statement - The for statement - Jumps in Loops, Class , Objects and Methods: Defining a Class - Fields Declaration - Methods Declaration - Creating Objects - Accessing class members - Constructors .

### **Unit-IV**

Methods Overloading - Static Members - Nesting of Methods - Inheritance - Overriding Methods - Final Variables and Methods - Final Classes - Abstract Methods and Classes - Visibility Control.

### **Unit-V**

Arrays, Strings and Vectors: One-dimensional Arrays-creating an Array - Two dimensional Arrays - Strings - Vectors - Wrapper Classes - Enumerated Types  
Interfaces: Multiple Inheritance: Defining Interfaces - Extending Interfaces - Implementing Interfaces - Accessing Interface Variables.

### **References**

- 1.Programming with Java A Primer, E. Balaguruswamy Tata McGrawHill Companies.
- 2.Java Programming John P. Flynt Thomson 2nd.
- 3.Java Programming Language Ken Arnold Pearson.
- 4.The complete reference JAVA2, Hervert schildt. TMH.
- 5.BigJava, Cay Horstmann 2ndedition, Wiley India Edition.
- 6.Core Java, Dietel and Dietel.
- 7.Java–Balaguruswamy.



### **Paper No-XVIII-Introduction to Bioinformatics**

#### **Unit I**

Introduction to Bioinformatics, History of Bioinformatics, Scope and applications of Bioinformatics. Data generation-Generation of large scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction, and microarray).

#### **Unit II**

Nature of biological data, Overview of Bioinformatics resources on the web-NCBI/EBI/SIB etc, Introduction to biological databases, Nucleic acid sequence database-GENBANK/EMBL/DDBJ, Protein sequence database- PIR, UniprotKB, Structural database-PDB and other derived databases, Biological information search engine-Concept and Applications.

#### **Unit III**

Overview of sequence analysis, Concept of pairwise sequence alignment, Local and Global sequence alignment method, Matrices-PAM & BLOSUM, Significance of pairwise alignment, Sequence similarity search tools- BLAST, FASTA.

#### **Unit IV**

Multiple sequence alignment, Its types and significance, CLUSTAL-W, Phylogenetic analysis- Phylogenetic data, substitution models, Tree Building methods, Tree Evaluation Method- Bootstrap, MEGA, PHYLIP.

#### **Unit V**

Protein structure, Secondary structure prediction-Chou-Fasman, GOR method with algorithm, 3D structure prediction, Molecular modelling methods-Homology, Threading (fold recognition) and Ab initio.

#### **References**

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins -By: Andreas D. Baxevanis (Ed), B. F. Francis Ouellette (Ed) Publisher: Wiley, John & Sons, Incorporated ISBN: 0471478784
2. Introduction to Bioinformatics- By: Arthur M. Lesk Publisher: Oxford University Press, ISBN: 0199251967
3. Introduction to Bioinformatics, (Atwood, T. K. and Parry-Smith, D. J).
4. David W Mount Bioinformatics - sequence and genome analysis 2nd edition
5. Bioinformatics and functional genomics by Pevzner J, 2<sup>nd</sup> edition, Wiley

## **Semester IV**

### **Paper No-XIX-Metabolism**

**(Treat it as base of Metabolomics and not as Biochemistry)**

#### **UNIT I – Basic concepts**

Definition, Anabolism, Catabolism, Amphibolism, Intermediary metabolism, Metabolic pathways, Anaplerotic pathways, Regulation of metabolic pathways, Bioenergetics.

#### **UNIT II – Carbohydrate metabolism**

Glycolysis, Gluconeogenesis, Glycogen synthesis, glycogenolysis, TCA cycle, Glyoxylate bypass, HMP pathway,.

#### **UNIT III – Carbohydrate metabolism**

Calvin cycle, ETC, oxidative phosphorylation, substrate level phosphorylation.

#### **UNIT IV – Lipid metabolism (Oxidation)**

Activation of fatty acid and transport in mitochondria,  
Oxidation of fatty acids (Even, odd,  $\alpha$ ,  $\beta$ ,  $\omega$ )

#### **UNIT V – Metabolomes**

KEGG, BRENDA, ENZYME, ECOCYC and METACYC databases.

#### **Reference Books:**

1. Biochemistry by Stryer 5th Edition WH Freeman 2001
2. Cohn & Stump, Outline of Biochemistry Wiley Eastern Ltd.2.
3. Harpers Review of biochemistry Prentice Hall
4. Cregnton Protein Structure & Molecular Properties
5. A.L. Lehninger, D. L. Nelson & M M Cox Principles of Biochemistry.
6. Lippincott's Biochemistry 4<sup>th</sup> edition
7. Basic Medical Biochemistry: A Clinical Approach, 3<sup>rd</sup> edition,by Lieberman and Marks

**Paper No-XX-Introduction to Data structure & Algorithm**

**Unit-I**

Basic concept of data structure, Stacks, Queues, Linked Lists, Double-ended Queues, Abstract Data Type (ADT), The List ADT, Simple Array Implementation of Lists, Linked Lists, Programming Details, Common Errors.

**Unit-II**

Doubly Linked Lists, Circularly Linked Lists, Examples, Cursor Implementation of Linked Lists, The Stack ADT, Implementation of Stacks, Applications, The Queue ADT, Array Implementation of Queues, Applications of Queues.

**Unit-III**

Tree, Implementation of Trees, Tree Traversals with an Application, Binary Trees, Expression Trees, the Search Tree ADT-Binary Search Trees, AVL Trees, Single Rotation, Double Rotation, Red-Black Trees, External searching in B-Trees, Tree Traversals, B-Trees.

**Unit-IV**

Insertion Sort, Shell sort, Heap sort, Quick sort, Bucket Sort, Merge Sort and radix Sort, and A Lower Bound on comparison-based Sorting and radix Sort, the complexity of some sorting algorithms, comparison of Sorting Algorithms, The Set ADT and union / file Structures.

**Unit-V**

Graphs-The graph Abstract Data Type, Data Structures for Graphs, Graph Traversals, Directed Graphs, Weighted Graphs, Shortest Paths, and Minimum spanning Trees. Applications of DFS and BFS, Shortest-Path Algorithms, Dijkstra's Algorithm, Graphs with Negative Edge Costs, Acyclic Graphs, Network Flow Problems, Minimum Spanning Tree.

**References:**

1. Data structure and Algorithm:Adamson Iain
2. Data structure and Algorithm; Aho Alfred
3. Elliot Koffman, Paul Wolfgang, Objects, Abstraction, Data Structures and Design Using C++, Wiley, 2005.
4. M. A. Weiss, Data Structures and Algorithm Analysis in C++, Addison Wesley, 2006.
5. Cormen, Leiserson, Rivest, Introduction to Algorithms, MIT Press, 2001.
6. Sahni, Data Structures, Algorithms and Applications in C++, McGraw-Hill, 1998.
7. Horowitz, Sahni, Rajasekaran, Computer Algorithms, Computer Science Press, 1998.

## **Paper No-XXI-Central Dogma**

### **(Overview in the perspective to make use in Computational Biology)**

#### **UNIT I – Replication of DNA**

Possible modes of replication, Meselson Stahl experiment, origin of replication in *E. coli*, major proteins and enzymes involved in replication process: DNA replication in nut shell, rolling circle model of replication.

#### **UNIT II – DNA mutations**

Definition, Characteristics of mutation, types of mutations- base pair substitutions and frame shift mutations, Point mutations - missense, nonsense, silent, null, lethal mutations, Physical and chemical mutagenic agents. Suppression of mutations.

#### **UNIT III – Repair and Recombination**

Excision, Mismatch, SOS, Photoreactivation, Recombination repair, Eukaryotic repair Mechanisms, Recombination between heteroduplex, Holiday intermediate, Proteins involved in Recombination.

#### **UNIT IV – Transcription**

Mechanism of transcription, DNA dependent RNA polymerase(s), recognition, binding and initiation sites, TATA/Pribnow box, chain termination and the role of the protein, split genes and post transcriptional processing of RNA in eukaryotes, inhibitors of transcription

#### **UNIT V – Genetic code & Translation**

Discovery, Characteristics of genetic code, Deciphering the code, Woobler hypothesis, codon bias. Mechanism of Translation: Ribosome structures, A and P sites, Charged tRNA, f-met tRNA, initiator codon, Shine-Dalgarno consensus sequence, formation of 70S initiation complex, role of EF-Tu, EF-Ts, EF-G and GTP, Non-sense codons and release factors, RF1 and RF2. Post translational modifications (general treatment), inhibitors of protein synthesis.

#### **Reference Books:**

1. Benjamin Lewin -Gene VI, Gene VII, Gene IX, Gene X Oxford University press
2. David Friefieder Essentials of Molecular Biology, Jones & Bartlett publications
3. J. Kendrew Encyclopedia of Molecular Biology Blackwell Scientific publications.
4. Weaver Molecular Biology
5. J.D. Watson, N.H. Hopkins, J.W. Roberts, et al Molecular Biology of the Gene, Benjamin Cummings publ.co.inc., California
6. J. Darnell, et al molecular biology of the cell (2nd edition) Garland Publishing Inc.
7. Meyers R.A (ed) ., Molecular biology and biotechnology. VCH publishers NY Inc.
8. Alberts B et al Molecular biology of the cell. Garland Publishing Inc.
9. Watson J.D ., Recombinant DNA.
10. Malacinski; Essentials of Molecular Biology.
11. Stansfield; Molecular and cell biology.
12. Walker Molecular biology and Biotechnology.

## **Paper No-XXII-Advanced JAVA**

### **Unit-I**

Packages: Java API Packages - Using system Packages - Naming Conventions - Creating Packages - Accessing a Package - Using a Package - Adding a Class to a Package - Hiding Classes - Static Import

### **Unit-II**

Multithreaded Programming: Creating Threads - Extending the Thread Class - Stopping and Blocking a Thread - Life Cycle of a Thread - Using Thread Methods - Thread Exceptions - Thread Priority -- Synchronization,

### **Unit-III**

Managing Errors and Exceptions: Types of Errors - Exceptions - Syntax of Exception Handling Code - Multiple Catch Statements - Using Finally Statement - Throwing our own Exceptions - Using Exceptions for debugging.

### **Unit-IV**

What is an applet, applet lifecycle, applet class, applet context class, passing parameters to applet , use of java .awt graphics class and its various methods in an applet ,Java Swing Working with JFrame, JApplet, JPanel, JTextfield, JPasswordField, Jbutton, Jcheckbox, Jradiobutton, Jlist, Jscrollpane, Jcombobox, Jmenu, Jmenubar, JMenuitem, JpopupMenu, JTree, JTable

### **Unit-V**

Introduction to Servlets: Need for Servlets, Introduction to Servlets , The javax.servlet Package, Life Cycle of a Servlet, Accessing a Servlet using an HTML page.

### **References:**

- 1.Programming with Java A Primer, E. Balaguruswamy Tata McGrawHill Companies.
- 2.Java Programming John P. Flynt Thomson 2nd.
- 3.Java Programming Language Ken Arnold Pearson.
- 4.The complete reference JAVA2, Hervert schildt. TMH.
- 5.BigJava, Cay Horstmann 2ndedition, Wiley India Edition.

### **Paper No-XXIII-Introduction to Chemoinformatics**

#### **Unit -I**

Introduction to chemoinformatics-History and Evolution of chemoinformatics, application of chemoinformatics in pharmaceutical research, Molecular Modeling and Structure Elucidation, chemical databases.

#### **Unit -II**

Introduction to medicinal chemistry, lead compounds, natural resources of lead compounds, physical and chemical properties of lead molecules, insilico drug discovery pipeline, pharmacokinetics, pharmacodynamics, biological concept about drug metabolism & elimination.

#### **Unit -III**

Representation of Molecules and Chemical Reactions-Nomenclature, Different types of Notations, SMILES coding; InChi notation, Structure of Molfiles and Sdf files, Libraries and toolkits, Different electronic effects, Reaction classification.

#### **Unit -IV**

Searching Chemical Structure-Full structure search, sub structure search, basic ideas, similarity search, Three dimensional search methods, Basics of Computation of Physical and Chemical Data and structure descriptors, Chemical data visualization.

#### **Unit-V**

Computer Assisted Virtual screening design- Structure Based Virtual Screening- Protein Ligand Docking, Scoring Functions for Protein Ligand docking, Practical aspects of structure based Virtual Screening, Prediction of ADMET Properties, 2 D and 3D data searching.

#### **References**

1. An Introduction to Chemoinformatics-Andrew R. Leach, Valerie J. Gillet
2. Chemoinformatics in Drug Discovery (Methods and Principles in Medicinal Chemistry)-byMannhold, Raimund, Wiley-VCH Verlag publication
3. Chemoinformatics: A Textbook-by Johann Gasteiger, Thomas Engel
4. Basic Cheminformatics: A Textbook-By Mercato Inglese
5. Cheminformatics: Theory, Practice & Products (2009) Barry A. Bunin , Brian Siesel, Guillermo Morales Jürgen Bajorath, Springer
6. Pharmaceutical Data Mining: Approaches and Applications for Drug Discovery (2009) Konstantin V. Balakin Sean Ekins (Series Editor) , Wiley
7. Cheminformatics: An Approach to Virtual Screening (2008), Alexandre Varnek Alexander Tropsha (Editor) , Royal Society of Chemistry
8. Cheminformatics: Concepts, Methods, and Tools for Drug Discovery (Methods in Molecular Biology), (2004) J. bajorath (ed.) Humana Press

**Paper No-XXIV-Genomics & Proteomics**

**(Technical / Analytical – Introductory level)**

**UNIT I**

Introduction of genomics, Organization of genomes: main features of bacterial and eukaryotic genome organization. Need of genome sequencing, Genome sequencing strategies-Chain termination method, automated sequencing, Clone contig and shotgun approaches. pyro-sequencing.

**UNIT II**

Introduction to Next Generation Sequencing Platforms, sample preparation and analysis, applications of NGS. Locating the genes: ORF scanning, homology searches. Tools for genome analysis-RFLP, DNA fingerprinting, RAPD,PCR, Linkage and Pedigree analysis-physical and genetic mapping.

**UNIT III**

Introduction to Proteomics, protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectric focusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.

**Unit IV**

Pharmacogenetics High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development.

**Unit V**

Functional genomics and proteomics, analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays; Structural proteomics, comparative genomics and proteomics.

**References:**

1. Genomes-3-By Brown T.A.
2. Discovering Genomics, Proteomics and Bioinformatics: By Campbell
3. Introduction to Bioinformatics, (Atwood, T. K. and Parry-Smith, D. J).
4. An introduction to Computational Biochemistry. (C. Stain Tsai, A. John Wiley and Sons, Inc., publications).
5. Bioinformatics; Methods and applications; Genomics, Proteomics and Drug Discovery; (Rastogi, S. C. and Mendiratta and Rastogi, P.
6. Bioinformatics; A practical guide to the analysis of genes and proteins.; Edited by, Andreas D. Baxevanis and Francis Oulelette

### **LC VII – Biomolecules and Biotechniques**

- Estimation of carbohydrates by qualitative methods
- Estimation of carbohydrates by quantitative method ( DNSA / Anthrone / GODPOD)
- Purification of polysaccharides
- Acid values Iodine number& Saponification values of fats (commercial samples)
- Isolation and purification of lipids from microbes and eukaryotes
- Simple assays for vitamins and hormones
- Preparation / isolation of biomolecules from natural resource (Starch, glycogen, Lecithin, Cytochrome)
- Paper Chromatography of amino acids- Ascending and Descending methods.
- Separation of sugars by chromatography.
- TLC of lipids and sugars.
- Column chromatography for proteins, pigments using sephadex G-50
- Paper electrophoresis.
- Agarose electrophoresis-separation of bromophenol blue and xylenecyanol.
- Determination of molecular weight by PAGE- native and SDS
- Immunoelectrophoresis- serum proteins



### LC VIII – PL/SQL

- Create a table Student-master with the following fields client\_no,name, address, city, state,pincode,remarks,bal\_due with suitable data types.
  - a) Create another table supplier\_table from client\_master. Select all the fields and rename client\_no with supplier\_no and name with supplier\_name.
  - b) Insert data into client\_master
  - c) Insert data into supplier\_master from client\_master.
  - d) Delete the selected row in the client\_master.
  
- Create a table sales\_order with s\_order\_no and product\_no as primary key. Set other fields to store client number, delivery address, delivery date,order status.
  - a) Add a new column for storing salesman number using ALTER Command.
  - b) Set the s\_order\_no as foreign key as column constraints.
  - c) Set the s\_order\_no as foreign key as table constraints.
  - d) Enforce the integrity rules using CHECK.
  
- Create a table student\_master with the following fields name, regno, dept and year with suitable data types. Use Select command to do the following.
  - a) Select the student's name column.
  - b) Eliminate the duplicate entry in table.
  - c) Sort the table in alphabetical order.
  - d) Select all the Students of a particular department.
  
- Create a table sales\_order\_details with the s\_order\_no as primary key and with the following fields: product\_no, description, qty\_ordered, qty\_disp,product\_rate, profit\_percent, sell\_price, supplier\_name.
  - a) Select each row and compute sell\_price\*.50 and sell\_price\*1.50 for each row selected.
  - b) Select product\_no, profit\_percent, Sell\_price where profit\_per is not between 10 and 20 both inclusive.
  - c) Select product\_no, description, profit\_percent, sell\_price where profit\_percent is not between 20 and 30.
  - d) Select the suppliername and product\_no where suppliername has 'r' or 'h'as second character.
  
- Create a table master\_book to contain the information of magazine code, magazine name, publisher. Weekly/biweekly/monthly, price. Write PL/SQL block to perform insert, update, delete operations on the above table.
- Create a table to contain phone number, user name, address of the phone user. Write a function to search for a address using phone numbers.
  
- Create a table stock to contain the itemcode, itemname, current stock, date of last purchase. Write a stored procedure to seek for an item using itemcode and delete it, if the date of last purchase is before 1 year from the current date. If not, update the current stock.

### **LC IX - Basic Bioinformatics**

- Exploring and accessing of resources-NCBI/EBI/SIB.
- Exploring of biological search engine-Entrez & SRS
- Exploring and accessing of biological information of given sequence entry from GenBank database.
- Exploring and accessing of biological information of given sequence entry from DDBJ database.
- Exploring and querying the Swissprot/TrEMBL database.
- Exploring and querying the PIR database
- Exploring and using the derived databases: PRO SITE, PRINTS, BLOCKS, Pfam and Prodom for pattern searching.

### **LC X – OOPs using JAVA**

- Programs based on basic arithmetic operations.
- Programs using constructor and destructor.
- Creation of classes and use of different types of functions.
- Write programs on interfaces.
- Write programs on packages.
- Write programs using function overloading.
- Programs using inheritance
- Programs using IO streams.
- Programs using files.
- Write a program using exception handling mechanism.
- Programs using AWT
- Programs on swing.
- Count the number of objects created for a class using static member function.

### **LC XI - Technique's in Bioinformatics**

- Pairwise sequence alignment & sequence analysis with BLAST, FASTA and study of various BLAST programs and assignments.
- Multiple sequence alignment and analysis with CLUSTAL X and CLUSTAL W
- Phylogenetic analysisPhylogenetic analysis with PHYLIP, MEGA software using different phylogenetic methods.
- Structure visualization softwares RasMol,RasTop , Cn3D, SpdbViewer etc.
- Molecular Docking using online server Swissdock and other molecular docking tools.

### **LC – XII Structural Bioinformatics**

- Exploring the PDB & NDB: Database searches, understanding entry contents and file formats
- Visualization of tertiary structures, quaternary structures, architectures and topologies of proteins and DNA using molecular visualization software such as RasMol, Cn3D, SPDBViewer.
- Prediction of secondary structures of proteins using at least 5 different methods with analysis and interpretation of the results. Comparison of the performance of the different methods for various classes of proteins.
- Prediction of tertiary structures of proteins using Homology Modeling approach: SWISSMODEL, Geno3D, 3D JIGSAW.
- Prediction of tertiary structures of proteins using at least 3 methods for fold recognition along with analysis and interpretation of results.

**B.Sc. Bioinformatics V<sup>th</sup> & VI<sup>th</sup> Semester Syllabus**

| Semester-V  | Semester-VI                               |
|---|---|
| Paper-XXV-Molecular Cell Biology                      | Paper-XXV-Introduction to PERL            |
| Paper-XXVI-Immunology                                 | Paper-XXVI-Metabolomics                   |
| Paper-XXVII-Bioinformatics Method                     | Paper-XXVII- Advanced Molecular Genetics  |
| Paper-XXVIII-Phylogenetics and Molecular evolution    | Paper-XXVIII-Molecular Phylogeny          |
| Paper-XXIX -Virology                                  | Paper-XXIX-RDT                            |
| Paper-XXX - Molecular Modeling and Drug Designing     | Paper-XXX-Drug Regulatory Affairs and IPR |
| LC-XIII- Chemical databases & Analysis                | LC-XIII- Introduction to PERL             |
| LC-XIV- Seminar's on emerging areas in Bioinformatics | LC-XIV-Phylogeny                          |
| LC-XV-Minor Project                                   | LC-XV-Major Project                       |

**Semester V**

| Paper No.    | Subject Name                                  | Theory Marks | Practical Marks | Total      |
|--------------|---|--------------|-----------------|------------|
| Paper-XXV    | Molecular Cell Biology                        | 50           | 00              | 50         |
| Paper-XXVI   | Immunology                                    | 50           | 00              | 50         |
| Paper-XXVII  | Bioinformatics Method                         | 50           | 00              | 50         |
| Paper-XXVIII | Phylogenetics and Molecular evolution         | 50           | 00              | 50         |
| Paper-XXIX   | Virology                                      | 50           | 00              | 50         |
| Paper-XXX    | Molecular Modeling and Drug Designing         | 50           | 00              | 50         |
| LC-XIII      | Chemical databases & Analysis                 | 00           | 50              | 50         |
| LC-XIV       | Seminar's on emerging areas in Bioinformatics | 00           | 50              | 50         |
| LC-XV        | Minor Project                                 | 00           | 50              | 50         |
| <b>Total</b> |   |              |                 | <b>450</b> |

**Semester VI**

| Paper No.    | Subject Name                    | Theory Marks | Practical Marks | Total      |
|--------------|---------------------------------|--------------|-----------------|------------|
| Paper-XXV    | Introduction to PERL            | 50           | 00              | 50         |
| Paper-XXVI   | Metabolomics                    | 50           | 00              | 50         |
| Paper-XXVII  | Advanced Molecular Genetics     | 50           | 00              | 50         |
| Paper-XXVIII | Molecular Phylogeny             | 50           | 00              | 50         |
| Paper-XXIX   | RDT                             | 50           | 00              | 50         |
| Paper-XXX    | Drug Regulatory Affairs and IPR | 50           | 00              | 50         |
| LC-XIII      | Introduction to PERL            | 00           | 50              | 50         |
| LC-XIV       | Phylogeny                       | 00           | 50              | 50         |
| LC-XV        | Major Project                   | 00           | 50              | 50         |
| <b>Total</b> |                                 |              |                 | <b>450</b> |



**D R. BABASAHEB AMBEDKAR  
MARATHWADA UNIVERSITY,  
AURANGABAD**



**Revised Syllabus of  
*B.Sc. Third Year Bioinformatics*  
Semester- V to VI**

**Three Year Degree Course**

*(Effective from 2016-2017)*

**B.Sc. Bioinformatics T.Y. (V & VI semester) syllabus**

| <b>Semester-V</b>   | <b>Semester- VI</b>   |
|---|---|
| <b>Paper-XXV- RDT &amp; Molecular Genetics</b>  | <b>Paper-XXXI - Introduction to Python &amp; R</b>          |
| <b>Paper-XXVI-Immunology</b>  | <b>Paper-XXXII- Genomes to drug and vaccine</b>             |
| <b>Paper-XXVII- Gene Expression &amp; Flow processing</b>   | <b>Paper-XXXIII- Algorithms for bioinformatics</b>          |
| <b>Paper-XXVIII- Bioinformatics methods</b>   | <b>Paper-XXXIV- Structural bioinformatics</b>               |
| <b>Paper-XXIX- Introduction to LINUX</b>  | <b>Paper-XXXV- Object oriented and relational databases</b> |
| <b>Paper-XXX- Introduction to PERL &amp; Julia</b>  | <b>LC-XVI- Programming in Python &amp; R</b>                |
| <b>LC-XIII-LINUX</b>  | <b>LC-XVII- Seminar on emerging area of bioinformatics</b>  |
| <b>LC-XIV-Programming in PERL and Julia</b>   | <b>LC-XVIII- Major Project</b>                              |
| <b>LC-XV-Project based on wet lab techniques (Microbial, Biotechnological, Molecular, Cell Biology, Genomics)</b> |   |



## **Semester V**

### **Paper-XXV- RDT & Molecular Genetics**

#### **Unit I**

History of molecular biotechnology, Recombinant DNA technology, Manipulation of gene expression in prokaryotes, Recombinant protein production in eukaryotic cells.

#### **Unit II**

Production of therapeutic agents, vaccines, commercial products by recombinant microorganisms, Bioremediation, Microbial insecticides.

#### **Unit III**

Methodology and applications of genetic engineering of plants, Transgenic animals, Human molecular genetics, gene therapy, Legal and patent issues in RDT.

#### **Unit IV**

Early concepts of inheritance, Sex determination, Linkage, recombination and genetic mapping in eukaryotes, Somatic cell genetics, Structural and numerical changes in chromosomes, recombination in bacteria, fungi and viruses, tetrad analysis.

#### **Unit V**

Inheritance of quantitative traits, Concepts in population genetics, Genes and behaviour, Genetics and evolution, An overview of some recent discoveries in the field of genetics.

#### **References:**

1. Genetic Engineering, 200 by Nicholl.
2. Principals of Gene Manipulations, 1994 by Old and Primrose, Blackwell Scientific Publications.
3. Klug WS & Cummings MR. 2003 Concepts of Genetics. Peterson Education.
4. Lewin B. 2008. Genes IX. Jones & Bartlett Publication.

## **Paper-XXVI-Immunology**

### **Unit I**

Innate and adaptive immunity in vertebrates, Antigen processing and presentation, Contemporary challenges to the immune system, Infectious diseases, Autoimmune diseases, Categories of vaccines, Immunoglobulin classes and subclasses, CDR and LDR regions and sequence numbering.

### **Unit II**

Immunogenetics & immunogenomics, Hybridoma technology: applications, Humanization of antibodies by design, BCR,TCR,MHC, MHC polymorphism its causes and supertype, concept of epitope, Affinity Maturation, Recognition of Antigen by B cells, Neutralizing Antibody.

### **Unit III**

Reverse vaccinology, Rational Vaccine design, Evolution and escape due to variations, Immunoinformatics databases & tools: IMGT & IEDB, BciPep, Epiteome, CED, AgAbDb.

### **Unit IV**

Specificity, characterization, Ag-Ab: Sequential and conformational epitopes, MHC- peptide, HLA: nomenclature, HLA-peptide interactions & matrices.

### **Unit V**

B-cell epitope predictions using sequence-based approaches, B-cell epitope predictions using structure-based approaches, T-cell epitope prediction methods, Vaccine design: Pipeline & workflows, Prediction of immunogenicity.

## **References:**

1. Flower Darren R. Bioinformatics for Vaccinology Publisher: UK, John Wiley & Son Inc. 2008. ISBN: 9780470027110.
2. Flower Darren R. Immunoinformatics: Predicting Immunogenicity In Silico Publisher: New Jersey, Humana Press. 2007. ISBN: 9781603271189.
3. Kindt, Thomas J., Osborne Barbara A. Goldsby Richard A. Kuby Immunology 6<sup>th</sup> Edition. Publisher: New York, W. H. Freeman. 2007. ISBN: 9780716785903.
4. Lund Ole , Nielsen Morten , Lundegaard Claus, Kesmir Can, Brunak SÅ, ren. Immunological Bioinformatics. Publishesr: London, MIT PRes 2005 ISBN: 0262122804.
5. Foundation Novartis. Immunoinformatics: Bioinformatic Strategies for Better Understanding of Immune Function. Publisher: Chichester, John Wiley & Sons Inc. 2003. ISBN: 0470853565.

## **Paper-XXVII- Gene Expression & Flow processing**

### **Unit I**

Prokaryotic gene expression, operons -positive & negative regulation, sigma factors Initiation, elongation and termination of transcription -template & enzyme properties.

### **Unit II**

Eukaryotic RNA polymerase I, II & III transcribed genes, promoter & regulatory sequences, transcription factors.

### **Unit III**

Techniques -foot printing, Reporter genes, Organization of globin, immunoglobulin, HLA, rRNA and 5 sRNA genes.

### **Unit IV**

Processing of RNA and Proteins -Transport and Stability, Stress & hormones regulated gene expression.

### **Unit V**

Organization of human genome. RFLP, Fingerprinting, RAPDs, Micro arrays, ESTs.

### **References:**

1. Gene VII; Benjamin Lewin
2. Recombinant DNA technology; Watson
3. Molecular Biology; Watson
4. General Biochemistry; Lehninger, Nicolson and Cox

## **Paper-XXVIII- Bioinformatics methods**

### **Unit I**

Nature of pairwise sequence alignment and database searching, Optimum sequence alignments methods, Principles, algorithms and methods of pairwise sequence alignment, statistical significance of pairwise sequence alignments.

### **Unit II**

Introduction to multiple sequence alignments and its importance, MSA methods and its significance, CLUSTALW2, MUSCLE, Concepts of phylogeny, homology, analogy, orthology and paralogy, phylogenetic data analysis , tree building methods , tree evaluation & interpretation methods, PHYLIP.

### **Unit III**

Concept of molecular modeling, in silico methods of molecular modelling, software for homology modeling , computer and graphic representation of simple molecules and peptides , use of structural databases in molecular modelling.

### **Unit IV**

Concepts of geometry optimization and energy minimization , introduction of molecular dynamic simulation and monte carlo simulation, concepts and applications of macromolecular docking.

### **Unit V**

Motif searching, protein-protein interactions, cis-element predictions.

### **References:**

1. Andreas D. Bazavanis and B.F. Francis (Eds.) Bioinformatics: A Practical Guide to Analysis of Genes and Proteins, Wiley Interscience Publishers.
2. Thomas Lengauer (Eds.) Bioinformatics – Genomes to Drugs, Vol. I: Basic Technologies, Wiley-WCH publishers.
3. Jay A. Glasel and Murray P. Deutscher (Eds.) Introduction to Biophysical Methods for Protein and Nucleic Acid Research, Academic Press.
4. T.K. Attwood and DJ Parry Smith Introduction to Bioinformatics, Pearson education, Asia.

## **Paper-XXIX- Introduction to LINUX**

### **Unit I**

Basics of LINUX, need of LINUX, History, Difference Between Linux and Windows, Difference Between Linux and Unix, GNU , Usage, Career Options, Interesting Facts about Linux, Why Linux is Virus proof, Various Linux Distributions, Pros and Cons.

### **Unit-II**

GNU/LINUX OS Installation, Basic System configuration and Administration, OS Installation, Root in LINUX, Who/why/what is root, Basic commands: mkdir, touch, ls, pwd, cd, chmod, df, du, dd, adduser, sort, passwd, rm/rmdir, date, tar, gzip, top .

### **Unit-III**

Editors, Vi Editor, Understanding Files and Directories in Linux, File Structure and hierarchy, File Permissions, LVM overview, Schedulers: cron, at, User Administration, Software Installation In Linux: RPM, make.

### **Unit -IV**

Linux Boot process:Boot Loaders (LILO and GRUB), System Initialization, inittab, rc.sysinit, rc, LVM (Logical Volume Manager), TCP/IP Network Management: route, ifconfig, ping, netstat, Driver/Module Installation and Removal: modprobe, rmmod, insmod ,lsmmod, modinfo.

### **Unit -V**

Log Monitoring and rotating, OpenSSH - The GNU/Linux Secure Shell, sudo and su - Giving users SuperUser Privileges, Various Linux Administrations, Linux Hardening, Linux Scripting using bash: awk, sed, grep, while, for, echo, variables, functions, Information over open source projects: lynis(Unix-based auditing tool, rootkit hunter).

### **References:**

1. Moving from Windows to Linux, Second Edition by Chuck Easttom.
2. Linux in a Nutshell, O' Reilly Publication.
3. Linux Administration Handbook by Evi Nemeth.
4. An introduction to Linux for bioinformatics 2016 by Paul Thothard

## **Paper-XXX- Introduction to PERL & Julia**

### **Unit I**

History of Perl, Perl in Bioinformatics: Basic concepts, Scalar data, Arrays and list data, Control structures, Hashes. Regular expressions: Concepts about regular expressions, simple uses of regular expressions, patterns, matching operator, substitutions, the split and join functions.

### **Unit II**

Subroutines: System and user functions, the local operator, variable-length parameter lists, lexical variables, Filehandles and file tests: Opening and closing a filehandle, using pathnames and filenames, die, using Filehandles.

### **Unit III**

Other data transformation: Finding a substring, extracting and replacing a substring. Formatting data: Sorting, Transliteration CGI programming: The CGI.pm Module, CGI program in context, simple CGI programs, passing parameters via CGI, Perl and the Web.

### **Unit IV BioPerl and Julia**

Bioperl: Introduction, Installation procedures, Architecture, Uses of Bioperl and other tutorials on Bioperl

Julia::Getting started some introductory words, installation, paths, and various bits of magic, The REPL-Using the REPL; Julia as a calculator; getting help, Arrays and tuples, Types-Storing data – Arrays and tuples; the core of Julia and scientific programming, Controlling the flow Functions- a quick introduction to types, the way to organize your code and the secret to making your programs fast, loops and decisions; ifs and elses, functions and methods; multiple dispatch Dictionaries and sets-storing data in dictionaries and sets, Strings and characters working with strings,

### **Unit V**

Julia:: Working with text file-reading data from text files; elementary file processing, Working with dates and times- working with date and time functions, Plotting -Plotting; an introduction to some of the plotting packages, Metaprogramming-metaprogramming, expressions and macros , Modules and packages-how Julia code is organized, and should be developed, DataFrames-data frames; organizing data in tables

## **References:**

1. Harshawardhan P Bal, "Perl Programming for Bioinformatics", Tata McGraw Hill, 2003.
2. James Tisdall, "Mastering Perl for Bioinformatics", O'Reilly, 2010.
3. James Lee, "Beginning Perl", Apress, 2004.
4. Curtis Jamison D., "Perl Programming for Bioinformatics & Biologists", John Wiley & Sons, INC., 2004.
5. Michael Moorhouse, Paul Barry, "Bioinformatics Biocomputing and Perl", Wiley, 2004.
6. Getting started with Julia Programming by Ivo Balbaert
7. Mastering Julia by Malcolm Sherrington

## **LC-XIII-LINUX**

1. Study of Basic commands of Linux.
2. Study of Advance commands of Linux.
3. Study of current directory according to the following arguments:
  - a. Suffix to be replaced
  - b. Replacement suffix
4. Shell scripting using general-purpose utilities.
5. Shell programming using filters (including grep, egrep, fgrep).
6. Write a shell script to validate the entered date. (eg. Date format is : dd-mm-yyyy)
7. Write a shell script to check entered string is palindrome or not.

## **C-XIV-Programming in PERL, Bioperl and Julia**

1. Basic arithmetic operations using loop, array and decision making statement.
2. chop, chomp based simple Perl program
3. Program based on control structures- dowhile, foreach and with control flow statements-redo, next, goto etc.
4. Subroutines
5. Retrieving sequence file and searching for a pattern
6. Comparing files. Combining and extracting data from different files using modules
7. MSA using Perl and conserved domain identification and hast table creation
8. Blast usingBioperl

9. CGI- Perl Programs for developing MSA.

10. Number with Julia, String, Types, Function, Methods ,Control flow

11. Arrays, 2-D Arrays, Dictionaries

**LC-XV-Project based on wet lab techniques**

Project will be based on any one of the techniques mentioned below

- Microbial
- Biotechnological
- Molecular
- Cell Biology
- Genomics



## **Semester VI**

### **Paper-XXXI - Introduction to Python & R**

#### **Unit I**

Python program structure- builtin types- basic statements, Functions basics- scope rules- argument passing- Odds and Ends- Function Gotchas.

#### **Unit II**

Basics- Module files- import model- reloading- modules Gotchas- classes- Exceptions OOLS Built-in Tools- Common Tasks in Python.

#### **Unit III**

An Automated Complaint System- Interfacing with COM- Cheap Public Relations- A Tkinter-Based GUI Editor for Managing Form Data- Design Considerations- JPython- The Felicitous Union of Python and Java

#### **Unit IV**

Introduction and preliminaries of R, Simple manipulations; numbers and vectors, Objects, their modes and attributes, Ordered and unordered factors, Arrays and matrices, Lists and data frames, Reading data from files, Probability distributions.

#### **Unit V**

Grouping, loops and conditional execution, Writing your own functions, Statistical models in R, Graphical procedures, Packages, OS facilities, Applications of R in molecular biology data analysis.

#### **References:**

1. Cynthia Gibas, Per Jambeck, Developing Bioinformatics Computer Skills, O'Reilly, 2001.
2. Harvey M. Deitel, Python: How to Program, Prentice Hall, 2002.
3. Patrick O'Brien, Beginning Python for Bioinformatics, O'Reilly, 2002.
4. Alex Martelli, Python in a Nutshell, O'Reilly, 2006.
5. A Little Book of R for Bioinformatics by Avril Coghlan, 2014.
6. Learn R in a Day by Steven Murray.

## **Paper-XXXII- Genomes to drug and vaccine**

### **Unit I**

Genome Assembly, Genome Databases and related data resources (EST, STS, GSS, HSS etc.), Nature and types of data, Organization of data in databases, Genome Data , Tools for Genomic Data Mining.

### **Unit II**

Basic Aspects of Genome Annotation, Database Search Engines: Special tools for searching genomic data, Prediction of ORFs and Genes, Identification of Disease Genes in the context of Human Genetics and Genetics of Model Animals.

### **Unit III**

Identification of Drug Targets, Pharmacogenetics, The genetics of drug metabolism, the genetics of therapeutic targets; Interactions of small molecules and gene-based drug targets.

### **Unit IV**

Protein Sequence Analysis and Prediction of epitomes on Genomic scale Interactions of epitomes with Antibodies, MHC molecules and TCR.

### **Unit V**

Approaches for designing vaccines, Peptide/DNA vaccines, Polytope vaccines, Recombinant vaccines.

### **References:**

Bio informatics from Genome to drugs (ed.) Vol., I &II ;Thomas Lengauere  
Microcomputer in physiology : a practical approach ;P.J. Frasre

## **Paper-XXXIII- Algorithms for bioinformatics**

### **Unit I**

Introduction to Algorithms, Dynamic Programming, Sequence Alignment: Edit distance, LCS. PAM and BLOSUM Scoring Matrices. Global alignments: Needleman Wunsch Algorithm, Local Alignments: Smith Waterman Algorithm, Gap Penalties.

### **Unit II**

Graph Algorithms, SBH and Eulerian Paths, De-novo Peptide Sequencing: Longest Paths and Space Efficient Alignment Algorithms. Fast LCS using Table Lookup.

### **Unit III**

Exact Pattern Matching: KMP Algorithm, Keyword Trees, Aho-Corasick Algorithm. Clustering Basics: Hierarchical Clustering, Multiple Sequence Alignment: CLUSTAL, Center-based Clustering, Clustering via Cliques.

### **Unit IV**

Evolutionary Trees and Ultrametrics, Additive distance trees, Perfect Phylogeny Problem, Small Parsimony Problem, Nearest Neighbor Interchange.

### **Unit V**

Hidden Markov Models: Basics, Forward and Backward (Viterbi) Algorithms, Randomized algorithms and their applications.

### **References:**

1. Neil C. Jones and Pavel A. Pevzner, "An Introduction to Bioinformatics Algorithms", MIT Press, 2005.
2. Gusfields D, "Algorithms on strings, trees and sequences: Computer Science and Computational Biology", Cambridge University Press, 1997.
3. Steffen Schulze-Kremer, "Molecular Bioinformatics: Algorithms and Applications", Walter de Gruyter, 1996.
4. Gary Benson, Roderic Page (Eds.), "Algorithms in Bioinformatics", Springer International Edition, 2004.
5. Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison. "Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acid", Cambridge University Press, 1999.

## **Paper-XXXIV- Structural bioinformatics**

### **Unit I**

Define Bioinformatics and structural bioinformatics, fundamentals of protein structure, fundamentals of DNA & RNA structure, computational aspects of high throughput Crystallographic macromolecular structure determination, Macromolecular structure determination by NMR Spectroscopy, Electron Microscopy, Molecular visualization.

### **Unit II**

PDB, NDB database, Comparative features-protein structure evolution and the SCOP databases, the CATH domain structure databases, structural quality assurance all-atom contacts; a new approach to structure validation, structure comparison and alignment.

### **Unit III**

Secondary structure assignments, identifying structural domains in proteins, Inferring protein function from structure. Prediction of protein-protein interaction from evolutionary information, electrostatic interactions.

### **Unit IV**

Principles and methods of docking and ligand design, structural bioinformatics in drug discovery, CASP and CAFASP experiments and their finding.

### **Unit V**

Protein secondary structure prediction methods: Chau Fasman, GOR, 3D structure Prediction methods: homology, threading and ab initio.

## **References:**

Structural Bioinformatics by Phillip E. Brune & Helge Weissig, A John Wiley & Sons Publications.

## **Paper-XXXV- Object oriented and relational databases**

### **Unit I**

Introduction, Database System Concepts and Architecture, Entity-Relationship Model. EER and Object Modeling.

### **Unit II**

Relational Model, Algebra, Calculus, ER- and EER-to-Relational Mapping, Relational languages SQL and QBE, RDBMS Systems: SQL server and MS Access.

### **Unit III**

Object-oriented concepts, Object Modeling, Object-Oriented Databases, Object Database Languages, Object Database Design, Object-Relational and Extended Relational Database Systems.

### **Unit IV**

Functional Dependencies, Normalization, Design Algorithms and Further Dependencies.

### **Unit V**

Query Processing and Optimization, Transaction Processing, Concurrency Control, Recovery Security and Authorization.

### **References:**

1. Database Management and Design by G. W. Hansen and J. V. Hansen, Prentice-Hall of India, Eastern Economy Edition, Latest Edition.
2. Database System Concepts by A. Silberschatz, H.F. Korth and S. Sudarshan, 3rd edition, McGraw-Hill, Latest International Edition.

## **LC-XVI- Introduction to Python & R**

### **Python**

1. String methods
2. Operators
3. Using a class from a module
4. Fetch a PDB entry from the RCSB Web server
5. Extracting the complete CDS from a GenBank entry
6. Import from Bio.Clustalw
7. Using a class from a module
8. Fetching enzymes referenced in a SwissProt entry and display related proteins

### **Introduction to R**

1. Construct and execute basic programs in R using elementary programming techniques, e.g. import/export of data from file or Internet, assign and manipulate data structures, create user-defined functions, loops, condition statements and debugging.
2. Use R for statistical calculations
3. Implement and describe Monte Carlo techniques as well as perform simulation studies with analysis and evaluation of result
4. Graphically visualise data and results of statistical calculations
5. Use external R-packages in statistics and data mining

### **LC-XVII- Seminar on emerging area of bioinformatics**

**Students have to perform one project and one seminar in the semester any one of the following:**

- Seminars on Applications of Bioinformatics in Biotechnology
- Seminars on Applications of Bioinformatics in Drug Designing
- Seminars on Applications of Bioinformatics in Agriculture
- Seminars on Applications of Bioinformatics in Human Health
- Seminars on Applications of Bioinformatics in Plant Breeding
- Seminars on Applications of Bioinformatics in Veterinary science
- Seminars on Applications of Bioinformatics in any recent field of science.

### **LC-XVIII- Major Project**

#### **Project should be based on the following topics**

- Parasite bioinformatics
- Biodiversity informatics
- Microbial informatics
- Immunology bioinformatics
- Plant bioinformatics
- Molecular modelling
- Any recent advanced topic in the field of life sciences.