

COURSES OF STUDIES
I.M.S.C.
BIO-INFORMATICS

Admission Batch - 2017-2022



Buxi Jagabandhu Bidyadhar (Autonomous) College

Bhubaneswar - 751014

Accredited at the 'A' Level by

National Assessment and Accreditation Council (NAAC)

College with Potential for Excellence (UGC)

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FIRST YEAR, SEMESTER – I

Paper Code	Title of the Paper	Term End Marks	Internal Marks	Full Marks
101	Communicative English	80	20	100
102	(Introduction to Biology & Bioinformatics)	60	15	75
103	Practical P I (Introduction to Biology & Bioinformatics)	25	0	25
104	Chemistry	60	15	75
105	Practical (Chemistry)	25	0	25
TOTAL			300	

FIRST YEAR, SEMESTER – II

Paper Code	Title of the Paper	Term End Marks	Internal Marks	Full Marks
201	Biochemistry & Molecular Biology	60	15	75
202	Practical (Biochemistry & Molecular Biology)	25	0	25
203	Chemistry	60	15	75
204	Practical (Chemistry)	25	0	25
205	Fundamentals of Bioinformatics-I	80	20	100
TOTAL			300	

SECOND YEAR, SEMESTER – III

Paper Code	Title of the Paper	Term End Marks	Internal Marks	Full Marks
301	Mathematical & Statistical Foundation	60	15	75
302	Practical (Mathematical & Statistical Foundation)	25	0	25
303	Chemistry	60	15	75
304	Practical (Chemistry)	25	0	25
305	Fundamentals of Bioinformatics-II	80	20	100
TOTAL			300	

SECOND YEAR, SEMESTER – IV

Paper Code	Title of the Paper	Term End Marks	Internal Marks	Full Marks
401	Microbiology & Immunology	60	15	75
402	Practical (Microbiology & Immunology)	25	0	25
403	Chemistry	60	15	75
404	Practical (Chemistry)	25	0	25
405	Environmental Studies	80	20	100
TOTAL			300	

THIRD YEAR, SEMESTER – V

Paper Code	Title of the Paper	Term End Marks	Internal Marks	Full Marks
501	Genetic Engineering, Gene Sequencing & RDT	60	15	75
502	Bioinformatics Algorithm & programming	60	15	75
503	Practical Genetic Engineering, Gene Sequencing & RDT	50	0	50
504	Computational Techniques	80	20	100
TOTAL			300	

THIRD YEAR, SEMESTER –VI

Paper Code	Title of the Paper	Term End Marks	Internal Marks	Full Marks
601	Data Analysis & Molecular Modeling	60	0	60
602	Biomedical & Drug Designing	60	0	60
603	Practical Bioinformatics Algorithm & programming	40	0	40
604	Project	30	0	30
605	Seminar	10	0	10
606	I.S.C	80	20	100
TOTAL			300	

FOURTH YEAR, SEMESTER –VII

Paper Code	Title of the Paper	Term End Marks	Internal Marks	Full Marks
701	Cell Biology & Genetics	80	20	100
702	Biochemistry of nucleic Acids & Proteins	80	20	100
703	Biophysics	80	20	100
704	Programming in C	80	20	100
705	Lab (Cell Biology, Biochemistry, C)	100	0	100
TOTAL			500	

FOURTH YEAR, SEMESTER –VIII

Paper Code	Title of the Paper	Term End Marks	Internal Marks	Full Marks
801	Molecular Biology & Genetic engineering	80	20	100
802	Comparative & Functional Genomics	80	20	100
803	Data Structure & Algorithms	80	20	100
804	Biological Database & Their Management	80	20	100
805	Practical-I on MB, GE, SMB, DSA	100	0	100
TOTAL			500	

FIFTH YEAR, SEMESTER –IX

Paper Code	Title of the Paper	Term End Marks	Internal Marks	Full Marks
901	Programming in PERL, C++ & Java	80	20	100
902	Computational Genomics,	80	20	100
903	Computational Proteomics	80	20	100
904	Molecular Evolution & Comparative Genomics	80	20	100
905	Lab on All Papers	100	0	100
TOTAL			500	

FIFTH YEAR, SEMESTER –X

Paper Code	Title of the Paper	Term End Marks	Internal Marks	Full Marks
1001	Advanced topics in Bioinformatics	80	20	100
1002	Neural Network and Genetic Algorithm	80	20	100
1003	Computer Aided Drug Design	80	20	100
1004	Project		0	100
1005	Presentation & Viva		0	100
TOTAL			500	

SEMESTER- I

COMMUNICATIVE ENGLISH (PAPER-101)

UNIT-I

Communication in language - its features. Writing skills - its features - how it differs from other language skills. How to put ideas together, writing paragraphs, identifying the logical development of ideas in piece writing.

UNIT-II

Report writing - How to present facts clearly and logically. Standard formats for writing Preparation of abstract Technical documents.

UNIT-III

Reading skills – Reading to get main ideas. Identifying the logical development of ideas in a piece writing, Reading to summarize, Reading to take and make notes. Communication: definition, types of communication and their process, Barriers to communication

UNIT-IV

Speaking –Group discussion based on current topics. Group dynamics Paralinguistic communication - gestures, actions, body language Linguistic tools for better communication. Elementary Phonetics: Speech Sounds, consonance, vowels, stress and intonation.

UNIT-V

Audio-visual aids for communication.

Communicative/functional Grammar –Communicative use of structures, collocations

TEXT BOOKS:

1. A Communicative Grammar of English By Geoffrey Leech and Jan Svartvik, Longman
2. A millennium Guide to Writing and Speaking English By J.D. Chand & B.C. Das
3. Oxford Guide to Writing and Speaking, OUP. By John Sealy

INTRODUCTION TO BIOLOGY & BIOINFORMATICS (PAPER – 102)

Unit- I

Classification, Characteristics and Distribution of different groups living Organisms. Introduction to genetics, Mendelian laws of inheritance, Sex determination, Chromosome – Structural and Numerical aberrations.

Unit- II

Linkage, Crossing Over, Chromosomal Maps, Mutations, Chromosome and inheritance factors, Extra Chromosomal inheritance.

Unit- III

Molecular Basis of life, Structure of DNA & RNA, Prokaryotic and Eukaryotic replications of DNA. Protein & Amino Acid.

Protein synthesis Transcription initiation complex, Mitochondrial and Chloroplast RNA, Polymerases, Initiation and Transcription, Regulation of RNA polymerase I, Role of mRNA and tRNA in protein synthesis, Codon, Anticodon Interaction.

Unit- IV

Ribosome structure, translation initiation in both Prokaryotes and Eukaryotes, Chain Elongation in Prokaryotes and Eukaryotes, Protein folding. Prokaryotic gene expression (lac, his, trip, catabolic repression), analysis and comparison between Prokaryotic and Eukaryotic 'Gene Expression'.

Unit- V

Introduction to the Bioinformatics and its application in Basic Biology. Its Scope and opportunities.

Genome analysis and sequencing, Mapping of Human Genome, Human Genome project, Future of Genome Research, its application and opportunities.

Reference Books:

1. Biology by Cambel
2. Biology by Roberts
3. Studies in Botany
4. Genetics by Gardner
5. Molecular Biology by Robert. F. Weaver – Mc Graw Hill International Edition
6. Text Book of Botany by A.C Dutta
7. Text Book of Zoology by Vidyarthi

PRACTICAL SYLLABUS FOR BIOLOGY (PAPER – 103)

1. To study / verify Monohybrid Mendelion ratio dy Chi-square analysis
2. To study / verify Dihybrid Mendelion ratio by Chi-square analysis
3. To study and identify different groups of human chromosomes by Karyotype analysis
4. Qualitative analysis of protein
5. Qualitative analysis of Amino acid.

CHEMISTRY (PAPER – 104)

Group-A PHYSICAL

Unit- I

kinetic Theory of Gases

- 1.1 Derivation of Kinetic equation, Deduction of gas laws, Avogrado's Hypothesis and law of diffusion of gasses, gas constants, behaviour of real gases, Van der Wall's equation of state.
- 1.2 **Colloids and Surface Chemistry** : Types of colloids, methods of preparation, Dialysis, optical and electrical properties of colloids, Coagulation, peptisation. Absorption, Langmuir and Gibb's adsorption isotherm.

Group-B INORGANIC

Unit- II

Atomic Structure

- 2.1 Bohr's model of atom, Somerfeld's modifications, wave nature of matter, de Broglie equation, Heisenberg's uncertainty principle, probability and orbital shapes, Quantum number, Aufbau's principle, Pauli's exclusion principle, Hund's rule, stability of half filled and fully filled orbitals.

Unit- III

Periodic Properties

- 3.1 Atomic size, Atomic, Ionic and covalent radii, ionisation potential, election affinity and electronegativity, definitions, trends in periodic table and applications in explaining chemical behaviour.

Unit- IV

Chemical Bonding

- 4.1 a) Ionic bond, Lattice energy, Born Harber Cycle, Fajan's rule, covalent bond, valence bond theory, it's limitations. VSEPR theory, Hybridisation and shapes of simple molecules.
- b) Molecular orbital theory of homonuclear diatomic molecules

Group-C ORGANIC

Unit- V

5.1 Distribution of Electrons in Organic compounds

- Inductive effect, resonance, hyper-conjugation and steric effect.
- Conditions of resonance, planarity uncharged atomic skeleton, presence of electron donating and withdrawing groups.
- Influence of these effect on acidity, basicity and dipolemoment.

Reaction Intermediates

- Carbocation structure and stability.
- Carbanion, structure and stability.
- Free radical.
- Carbenes
- Nucleophile, electrophile and their reaction.

CHEMISTRY PRACTICAL (PAPER – 105)

- Estimation of acetic acid in commercial vinegar using Na OH.
- Determination of alkali content in Antacid tablets using HCL.
- Estimation of Calcium content in chalk as calcium oxalate by permanganometry.
- Estimation of hardness of water by EDTA.
- Estimation of amount of Na_2CO_3 and Na OH in a solution.

SEMESTER II

BIOCHEMISTRY & MOLECULAR BIOLOGY (PAPER 201)

Unit – I

Carbohydrates and lipids, their importance in cells. Proteins: Amino acids and peptides; primary, secondary, tertiary and quaternary structures; protein – protein interactions; sequence homology, functional and evolutionary relationships of proteins.

Unit – II

Nucleic acids: Bases, nucleotides, RNA and DNA. Different Structural form of DNA, denaturation and renaturation of DNA, protein-nucleic acid interactions.

Unit – III

Enzymes: Units of activity, coenzymes and metal cofactors, temperature and pH effects, Michaelis-Menten kinetics, inhibitors and activators, active site and mechanism of enzyme action, isoenzymes, allosteric enzymes, regulation by covalent modification.

Organization of metabolic systems: enzyme chains, multienzyme complexes and multifunctional enzymes, regulatory enzymes and feedback control of metabolic pathways, energy charge.

Unit – IV

Carbohydrate metabolism: Glycolysis, gluconeogenesis, glycogenolysis, glycogenolysis and pentose phosphate pathway; hormonal control.

TCA cycle and oxidative phosphorylation.

Unit – V

B-oxidation and biosynthesis of fatty acids.

Transamination and deamination of amino acids, ketogenic and glycogenic and glycolytic amino acids, urea cycle. Purine and pyrimidine biosynthesis.

Reference Books :

1. Biochemistry – Lehninger
2. Biochemistry – Satya Narayan
3. Biochemistry - Stryer

PRACTICAL (BIOCHEMISTRY & MOLECULAR BIOLOGY) (PAPER 202)

1. Qualitative Biochemical tests for carbohydrates- monosaccharides and polysaccharides.
2. Qualitative tests for lipids.
3. Estimation of catalase and peroxidase.
4. Preparation of standard curve of BSA by Biuret method.
5. Separation of amino acid by paper chromatography.
6. Viva - Voce

CHEMISTRY (PAPER 203)

Group-A PHYSICAL

Unit- I

1.1 Homogeneous Equilibria

Law of mass action, Le Chatelier's principle, their application to following systems.

- a) Manufacture of NH_3 from N_2 and H_2
- b) Dissociation of N_2O_4
- c) Dissociation of PCl_5
- d) Hydrolysis of $\text{CH}_3\text{COOC}_2\text{H}_5$

1.2 Chemical Kinetics

Order and molecularity of reaction, rate of zero order reaction, 1st and 2nd order reactions, Half life period, General methods for determining the order of reaction. Effects of extraneous conditions on reaction rates (Activated Complex).

Group-B INORGANIC

Unit- II

2.1 P-Block elements - Comparative study including diagonal relationship

Group-C ORGANIC

Unit- III

- 3.1 Aliphatic substitution reaction. SN^1 and SN^2 and SN^i reaction: Kinetic, stereochemical, structural environmental (solvent) aspects, Neighboring group Participation reaction with simple examples.
- 3.2 SE, E¹, E² (full term explanation with examples)

Unit- IV

4.1 Stereo Chemistry

Conformational isomerism : Concept of confirmation in ethane, n-Butane, Sawhorse, Newman and Fisher projection formula of molecule containing single bond, conformation of cyclohexane – axial and equatorial bonds, boat and chair conformation and their energies.

Unit- V

Configurational Isomerism, Elements of symmetry, Chirality.

- 5.1 Optical isomerism, concept of mirror image with sample models and examples, conditions for optical models and examples, conditions for optical activity. Plane polarized light and optical rotation, specific rotation, optical isomers of lactic acid, enantiomers and dia-stereo-mers, racemic modifications, D,L notation, R,S notations of compounds containing chiral centre.
Geometrical isomerism of maleic and fumaric acids, E and Z notation of geometrical isomers.

CHEMISTRY PRACTICAL. P-II (CHEMISTRY) (PAPER 204)

- Mixture Analysis : Mixture Containing 4 radical (insoluble salts excluded) (Interfering radicals and Phosphate separation included)

Recommended for PASS I and II (1st & 2nd Semester)

- Physical Chemistry : S. Glastone
- Physical Chemistry : Puri, Sharma and Pathania
- Physical Chemistry : Atkins
- Physical Chemistry : Bhal & Tuli
- Physical Chemistry : J.D.Lee
- In-Organic Chemistry : Part-I – R.L.Dutta
- Organic Chemistry : R.K.Bansal
- Organic Chemistry : Mukherjee, Singh & Kapoor
- Organic Chemistry : Bhal & Bhal
- Inorganic Chemistry : Puri & Sharma

FUNDAMENTALS OF BIOINFORMATICS - I (Paper 205)**Unit –I**

Basics of Computers, Concept of Programming Language and its classification, Internet, World Wide Web, Browsers, Search Engines – Google, Yahoo, Life science Search engine (Entrez, SRS).

Unit II

Bioinformatics-Definition, History, Scope and Applications. Emerging areas of Bioinformatics, Opportunities in Bioinformatics. Web resources and its application in Bioinformatics

Unit III

Cell Structures and Cell Organelles. Introduction to Macromolecules like DNA, RNA and Proteins, Central Dogma of life.

Unit IV

Introduction to Molecular Biology and genetics. Central dogma of life: DNA – RNA - Protein. Role of Bioinformatics in Human Genome Project, Signal transduction, protein-protein interaction.

Unit –V

Introduction to Biological databases, Importance of databases, Nucleic acid sequence databases, Protein databases and Structure databases

References

- A Text Book of Bioinformatics – Singhal & Singhal. Pragati Prakashan
- Bioinformatics for Beginners – K.Mani and Vijayaraj (2002). Kalaikathir Achagam
- Fundamentals of Bioinformatics – Irfan Ali Khan, Atiya Khanum (2003). Ukaaz publications.
- Introduction to Bioinformatics –T.K Attwood and David Parry-Smith

SEMESTER III**MATHEMATICAL & STATISTICAL FOUNDATION (PAPER-301)**

Unit I**Calculus:**

1. Functions, different types of real functions, viz. (polynomials, exponential trigonometric function)
2. Differential Calculus: Concept of limit with simple problems. Derivatives of sum, product quotient of functions. Application of derivatives in finding tangents and normals of standard curves, elementary knowledge of partial derivatives.
3. Anti Derivatives : Definition of anti derivative, anti derivative of simple functions, integration as the reverse process of differentiation, integration by parts, simple problems of integration of solution of differential equation of type $dy/dx = kf(x)$ and $dy/dx = f(x)g(y)$

Unit II

1. Determinants : its evaluation matrices : Operation, transpose and inverse and rank of matrices, solution of linear equations.
2. Preliminaries of coordinate geometry, linear equation and their graphical solutions. Straight line, circle, parabola, ellipse, hyperbola with their graphs (equations in simple forms without derivativation) simple problem solving.

Unit III

Counting principles, permutation & combination, binomial theorem, probability independent events, concept of expectation.

Unit IV

Idea of population and sample, moments skewness and kurtosis, concepts of random variable, Univariate distributions : Binomial, Poisson and Normal distribution. Their means and variances. Area under Normal curves.

Bivariate distribution, scatter diagram correlation, correlation, coefficient, properties of correlation, regression coefficients, properties of regression coefficients, fitting of curves by least square principle, (Polynomial of 1st and 2nd degree)

Unit V

Test of Significance: Null and Alternative hypothesis, level of significance, Type-I error and Type-II error. Test of mean and variance of normal population. (large sample test) test of equality of two means and test of equality of two variances of two normal populations, tests based on chi-square, t and F statistics.

Reference Books

1. Topics in Mathematics by G.Das and others.
2. Theory of Matrices by B.S.Vatssa.
3. Statistical Methods and Concepts by M.N.Das (Wiley Eastern LTD.)
4. Statistical Methods by S.P.Gupta.

PRACTICAL (PAPER – 302)

1. Calculation of different measures of central tendency, dispersion, skewness and kurtosis.
 2. Calculation of first four moments from grouped and ungrouped data.
 3. Fitting of 1st, 2nd degree polynomials and exponential curves.
 4. Calculation of simple correlation and regression lines, rank correlation.
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CHEMISTRY (Paper-303)
GROUP-A
PHYSICAL

Unit I**Colligative Properties**

- 1.1 Osmotic pressure. Law of osmotic pressure, relative lowering of vapour pressure, lowering of freezing point and elevation of boiling point; Determination of molecular weight by these methods, Anomalous molecular weight of solutes due to dissociation and association.

Unit II**Thermodynamics**

- 1.1 Extensive and intensive properties of the system and surroundings, state of a system, work, heat and energy, first law of thermodynamics, enthalpy of chemical reaction and the thermal changes accompanying them.
- 1.2 Thermo Chemistry Laws simple calculation based on them, spontaneous and non-spontaneous processes. Second Law of thermodynamics : concept of free energy, entropy and thermodynamics criteria of equilibrium, effect of temperature and pressure on equilibrium, relation between equilibrium constant and free energy.

GROUP-B
INORGANIC

Unit III**Chemistry of elements of first transition series**

- 1.1 Characteristic properties of d-block elements, properties of elements of 1st row transition series, relative stability of their oxidation states, coordination number and geometry.
- 1.2 **Coordination Compounds** : Werner's coordination theory, nomenclature, isomerism in complexes.

Unit IV

- 4.1 Preparation properties and structure of diborane, boric acid, Borazenes, Silicones compounds.

GROUP-C
ORGANIC

Unit V**1.1 Organometallic Compounds**

Grignard's reagent, preparation from alkyl bromide (principle only), synthetic uses (as carbonion precursor).

1.2 Alicyclic Compounds

Nomenclature, preparation from dihalides, Dieckmann's reaction and stability Bayer's stain theory.

Reference Books:

1. Physical Chemistry : Bhal & Tuli
2. Physical Chemistry : J.D.Lee
3. In-Organic Chemistry : Part-I – R.L.Dutta
4. Organic Chemistry : R.K.Bansal

PRACTICAL (Paper-304)

1. Estimation of Ferrous and Ferric by dichromate method.
 2. Estimation of copper using thiosulphate.
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3. Estimation of Cu as Cu SCN. (Gravimetry)
4. Estimation of Ni as Ni (DMG)₂ (Gravimetry)
5. Determination of specific reaction rate of hydrolysis of ester by titration method.
6. To study the distribution of I₂ between Water and CCl₄ OR Benzoic acid and between Benzene and Water.

FUNDAMENTALS OF BIOINFORMATICS- II (PAPER 305)

Unit I

National Centre for Biotechnology Information and its resources like OMIM, OMIA, PUBMED, ENTREZ Domain identification tools. Protein structure prediction tool.

Unit II

Sequence analysis and Phylogeny – sequence search alignment- pair wise and multiple sequence. Similarity search tool, BLAST and its types, FASTA, Introduction to Phylogenetic Trees and their evolutionary relationships.

Unit III

Protein Secondary Structure prediction, Gene and Protein expression data. Protein interaction databases. Protein databank (PDB), Molecular Modeling Database (MMDB)

Unit IV

Genome and its databases, Gene: Introns, Exons and its identification tools, Open Reading Frame (ORFs), Genome databank, metabolic pathway databanks- KEGG and Meta Cyc.

Unit V

Homology Search, Phylogenetic tree construction (MEGA), Protein structure prediction (Secondary & Tertiary), RNA Structure prediction, function prediction (poteins), Protein-protein interaction, e-PCR, Detection of recombinant sequences.

SUGGESTED READING

1. Introduction to Bioinformatics - S.Sundararajan and Balaji
2. Instant notes – Bioinformatics – Westhead, Howard parish and Twyman. Viva books Pvt. Limited. Chennai
3. Bioinformatics basic methods and applications – S.C. Rastogi

SEMESTER IV

MICROBIOLOGY AND IMMUNOLOGY (PAPER-401)

Unit I

Viruses: Morphology, Architecture, Nomenclature, Classification and symmetry, Structure of a typical plant (TMV), Animal (polio) and Bacterial (T4) Viruses; Bacteriophages (Lytic & lysogenic cycles).

Unit II

Bacteria: General idea about Archebacteria, Eubacteria and Cyanobacteria, Structure of a typical bacterial cell, Bacterial recombination (transduction, transformation and conjugation), Nitrogen – fixing Bacteria, Economic importance of Bacteria.

Unit III

Role of microorganisms in biogeochemical cycles of Nitrogen and Carbon. Biological nitrogen fixation with special reference to Rhizobium. Industrial application of microorganisms: Organic acids, alcohol, food processing, milk products with special reference to Lactobacillus, antibiotics with reference to Streptomyces, biopesticides.

Methods in Microbiology – staining, sterilization method culture media, pure culture methods, methods for population estimation, growth determination.

Unit IV

Immunology: Immunity, Immune system in Human: Active and Passive Immunity, Antigens, Antibodies, Classes of Immunoglobulins, Antigen – Antibody reaction, B-cells and T-cells and their role in immunity to infection, Autoimmunity.

Unit V

Immunity to infectious agents; AIDS and other immunodeficiencies, Vaccines, Hybridoma Technology and Monoclonal antibodies, Gene Therapy.

Reference Books

1. Microbiology by Pelezer, Chan & Krieg – Tata McGraw Hill.
2. Textbook of Microbiology by D.R.Arora
3. Textbook of Microbiology by Ananthanarayanan & Paniker
4. Microbiology – 7th edition (Prescott, Harley, Klein) by Willey, Sherwood, Woolverton.
5. Essential of Immunology by Roit
6. Immunology by Nandini Shetty

PRACTICAL (PAPER – 402)

1. Sterilization and preparation of culture media.
2. Culture of bacteria from water and soil.
3. Identification and observation of bacteria by Gram staining.
4. Preparation of Alcohol by Fermentation.
5. Determination of bacteria sensitivity to antibiotics.
6. Determination of Blood groups.
7. Spotting
8. Viva.

CHEMISTRY (PAPER-403)

GROUP-A PHYSICAL

Unit I

Electro Chemistry

- 1.1 Specific, Equivalent and molar conductance Kohlrausch's law of independent mobility of ions, variation of conductance with concentration for strong and weak electrolytes, application of conductance measurement, determination of solubility product, degree of dissociation of weak electrolytes, degree of hydrolysis of salts, conductometric titrations, Acids and Bases, Bronsted – Lawry and Lewis concept of acids and bases, their relative strengths and effect of substituents and solvents on them. PH, theory of acids-base indicator, Buffer solution, Buffer capacity and Buffer range.

Unit II

Phase Rule

- 2.1 Water and Sulphur system, distribution Law.
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GROUP-B INORGANIC

Unit III

Nuclear Chemistry

- 1.1 Binding energy, mass defect, Nuclear reactions induced by ${}_1^1\text{H}$, ${}_0^1\text{n}$, ${}_1^2\text{D}$ and ${}_2^4\text{He}$ Nuclear fission, Bohr's liquid drop model, fusion reaction, chain reaction, Nuclear reactor.
- 1.2 **Zero group elements** : Chemical properties of noble gases. Chemistry of Xenon, Structure and bonding in Xenon compounds.

GROUP-C ORGANIC

Unit IV

- 4.1 **Esters containing active methylene group** Acetoacetic ester : Synthesis Claisen condensation) synthetic uses (alkane, ketone, acid, á, â unsaturated acid, structure of acetoacetic ester, keto-enol tautomerism.
- 4.2 Malonic ester : Preparation and synthetic uses (alkane, ketone, acid)

Unit V

- 5.1 **Aromatic Compounds**
Aromaticity and antiaromaticity, Huckel's Rule and its application, electrophilic substitution reaction in aromatic compounds (Nitration, sulphonation, halogenation, Friedel – Crafts alkylation and acylation).
- 5.2 Phenols : Synthesis, Physical properties, Acidic character of phenols, Chemical reaction (Kolbo's reaction, Reimer-Tiemann reaction).

CHEMISTRY PRACTICAL (Paper-404)

1. Organic compound Identification
 - (a) Element determination (N, S, Halogen)
 - (b) Functional groups of CHO and CHN groups
 - (c) MP / BP determination of the organic compound.
2. Systematic Identification of organic compound.

ENVIRONMENTAL STUDIES (PAPER – 405)

Unit I

Definition scope, importance of Environmental Economics. Natural Resources, Renewable and non-renewable resources. Forest resources – Deforestation, timber extraction and effects on tribal people. Mining effects on forests and tribal people. Effects on dams on forests and tribal people. Water resources-Diverse uses of water, water management, conflict over water, dams and benefits and problems. Mineral resources- effects of extracting and using. Food resources – World food problem, changes caused by agriculture and over – grazing, Agriculture practices in India. Effects of modern agriculture and industry on Environment.

Unit II

Ecosystem, Structure and function of an ecosystem. Food chain relationship, food web, Trophics levels, Ecological pyramids, Energy flow in an Ecosystem, Nutrient cycle, Ecological succession types of ecosystem – terrestrial, forest, grass land aquatic, pond as a fresh water ecosystem. Land resources Types of soil, effects of soil, effects of soil erosion land degradation, Role of individuals in Conservation, Equitable use of resources for sustainable life cycle.

Unit III

Bio-diversity and its conservation. Concept, importance of biodiversity, Biogeographical classification of India, Threats to biodiversity. Man and wild life conflict., Endangered and endemic species of India, Conservation of wild life in India, National parks.

Human population and environment Population growth, explosion- their causes and consequences, family welfare programmes. Environment and human health, community health. Pollution and health, Occupation and health, Radiation and health, stress and health, Food and health, Non-communicable diseases, cardioaocular disease, communicable diseases Malaria, Measles, Tuberculosi, Amoebiosis, filariasis.

Unit IV

Environmental pollution – its meaning, types of pollutants, causes and effects of environmental pollution, measures to control air, water, soil, marine, noise, thermal, nuclear pollution. Solid waste management, Industrial and urban waste management. Source, effect control measures. Role of individuals in preventing pollution, Disaster management, Flood, Earthquake, cyclone, land slides, climate changes, Acid rain, global warming ozone layer depletion, Nuclear Accidents, Waste land reclamation, consumerism and waste products.

Energy resources, sustainable and renewable sources of energy, Exhaustible and non- renewable sources of energy. Crisis of non-renewable resources. Alternate source of energy.

Unit V

Economic Development and Environment. From unsustainable to sustainable development, Problems related to urbanization, rain water harvesting and water shed management. Resettlement and Rehabilitation of people. Environmental education. Role of NGO's in environmental protection.

Bio-Statistics – Frequency Distribution – Measures of Central Tendency – AM, Median, Mode, Quartiles, Dispersion – Range Q.D, M.D, S.D and Coefficient of variation.

Reference Books

1. Environmental Biology and Toxicology –R.D.Sharma.
2. Fundamentals of Environmental Studies – S.N.Tripathy & S.Panda.
3. Environmental Economics – S.Sankaran.
4. Environmental Biology - Trivedi.
5. The Text Book of Environmental Studies – P.K Das, S.N.Gosh, D.K.Sarangi, S.P.Mohanty.
6. A Text book of Plant Ecology – R.S. Shukla, P.C.Chandel.
7. Environmental Studies – S.V.S.Rana.
8. Environmental Studies – Nayak, Mohapatra, Patra.

SEMESTER V**GENETIC ENGINEERING, GENE SEQUENCING & RDT (PAPER-501)****Unit I**

DNA as genetic material, Structure and Biological importance of DNA; Types of RNA and their structure; Replication of DNA.

Unit II

Genetic code, Central Dogma, Transcription, Translation, RNA editing, DNA repair.

Unit III

Introduction: Plasmids and bacteriophages: Cosmids, M13, Shuttle vectors and lamda of *E. coli*, Applications of genetic engineering in medicine, industry and agriculture.

Unit IV

Enzymes for RDT: polymerase, restriction endonucleases, ligases, Introduction of r-DNA into living cells – Transformation and Transfection, Identification of recombinants.

Unit V

Techniques in Genetic Engineering : PCR, Gene Sequencing – Maxam Gilbert method & Sanger method, Electrophoresis, Southern and northern blotting techniques.

Transgenic plants and animals, Gene therapy, Intellectual Property Rights, Bioethics.

Recommended Book

Molecular Biology, Genetic Engineering and Applications of Biotechnology (B.D.Singh, Kalyani Publishers)

Reference Books

1. Gene Cloning & DNA Analysis: An Introduction (T.A.Brown, Blackwell).
2. Principles of Gene Manipulation: An Introduction to Genetic Engineering (R.W.Old, & S.B. Primrose, Blackwell).

BIOINFORMATICS ALGORITHM & PROGRAMMING (PAPER-502)**Unit I Pairwise Sequence Alignment**

Similarity and Homology, Optimal Alignment, Global Alignment, Local Alignment, Similarity Search, Alignment Scoring Scheme, Quality of Sequence Alignment, Subsequences, Distance and Similarity, Hamming Distance, Unit Cost, Edit Operation, Similarity vs Distance, Gaps & Insertions, Gap Penalty, Gap Cost, Scoring Matrix, log odds Matrices, Substitution Matrices, Dot Plots, Identity Blocks, Dynamic Programming, The Needleman and Wunsch Algorithm, The Smith-Waterman Algorithm, Blossum Substitution Searching Matrix, PAM Matrices. [T1: Chapter 5]

Unit II Multiple Sequence Alignment

Local vs Global Multiple Alignment, Applications of Multiple Sequence Alignment, Mathematical Definition of Multiple Sequence Alignment, Multiple Sequence Alignment tools, Open Reading Frame (ORF), Gene Recognition, Machine Learning & Artificial Neural Networks, Hidden Markov Models.

[T1: Chapter 6, 9(9.6, 9.7)]

Unit III Phylogenetics

Categories of Data, Evolutionary Models, Homology, Gene Trees Versus Species Trees, How to read a phylogenetic Tree, Components of tree, Methods for Tree Building, Character Based Method, Distance Methods, Bootstrap Values. [T1: Chapter 7]

Unit IV Protein Structure

Nucleic Acids, DNA Structure, RNA Structure, Coding, Central Dogma, Protein Structure, Amino acid properties and Substitution, Levels of Protein Structure, Denaturation and Renaturation, Protein Secondary Structure Prediction Algorithms, Protein Database, Visualization Tools. [T1: Chapter 8]

Unit V PERL

Perl Programming, Comments, Functions and Statements, Numbers, Strings & Quotes, Lists, Arithmetic Operator, Assignment Operators, Relation Operator, Logical Operator, Variables, Scalar, Array of Scalar, Associative Array of Scalar (Hashes), Loops, Subroutines, File Test Operators, File Management, Introduction to Bioperl. [T1: Chapter 11]

Text Books

1. A Text Book of Bio-informatics - Singhal and Singhal (Pragati Prakashan)

Reference Books

Bioinformatics : Databases, Tools & Algorithms – Orpita Bosu and Simminder Kaur Thukral (Oxford Higher Education) Sequence analysis-David mount

PRACTICAL (PAPER – 503)

1. Pure culture of bacteria
2. Isolations of genomic DNA
3. Separation of Genomic DNA using electrophoresis
4. Local Alignment using SMITH WATERMANN Algorithm
5. Global Alignment using NEEDLEMANN WUNSCH Algorithm
6. Phylogenetic Tree Construction using UPGMA Method
7. Gene Prediction Tools

COMPUTATIONAL TECHNIQUES (PAPER-504)

Unit I INTRODUCTION TO COMPUTERS

Types of computers, anatomy of computers – CPU – Memory – Buses – Communication with peripherals- I/O devices-Network LAN, WAN Parallel computers-state of computing, Multiprocessors, Distributed computing – Introduction, Evolution, different models, definition. Internet concepts HTTP, WWW.FTP

Unit II OPERATING SYSTEM

Introduction to Operating system, DOS, Windows, UNIX/LINUX/IREX. Basic commands in DOS, WINDOWS and UNIX.

Unit III WEB LANGUAGES

Introduction to web based languages IITML-creating simple web pages, Tables, XML-parsers-linking servers with net-Java Script-introduction and basics.

Unit IV PROGRAMMING in C

Basic concepts and introduction to programming “C” Programming. Compiler, ASCII characters identifiers, program structure, Key words , Syntax, I/O statements ,Application of words (void, main, return, include, getch, delay etc)

Unit V PROGRAMMING in C

Operators: Assignment, arithmetic, logical, bitwise, Control Statements conditional, conditional statements: if, if else, nested if else, switch case, break, continue, go to, looping structure, functions, while, do while and for, Introduction to pointer, array and its structure

TEXT BOOKS

1. Peter Norton 2000 4th Edition Introduction to computers, Tata Mc. Graw Hill

Reference Books

1. Glenn Brookshear (2004) Computers – An overview Pearson Education Pvt. Ltd.
2. Alkelly Ira Pohl (2001) “O” by discussion : The Essentials of “C” Programming Pearson Education Pvt. Ltd.
3. Let us C : Yeshwant Kanetkar
4. Introduction to C: E. Balguruswamy

SEMESTER VI

DATA ANALYSIS & MOLECULAR MODELING (PAPER-601)

Unit I Databases

Sequence Databases : Nucleotide Sequence Databases, Secondary Nucleotide Sequence Databases, Protein Sequence Databases, Secondary & Specialized Protein Sequence Databases, Information Retrieval System: Entrez, Information Retrieval System: SRS.

Structure Databases : Structure File Formats, Protein Structure Database Collaboration, PDB, MMDB, CATH, FSSP, DALI, SCOP.[T1: Chapter 1, 2]

Unit II Tools

Data Submission Tools : Nucleotide Sequence Submission Tools, Protein Submission Tools, BLASTn, tBLASTn

Data Analysis Tools : Tools for Nucleotide Sequence Analysis, Tools for Protein Sequence Analysis.[T1: Chapter 4, 5]

Unit III

Prediction Tools : Phylogenetic Trees and Phylogenetic Analysis, Gene Prediction, Protein Structure & Function Prediction.

Modelling Tools : Tools for 2D Protein Modelling, Tools for 3D Protein Modelling. [T1: Chapter 6, 7]

Unit IV

Molecular Modeling, Quantum Mechanical and molecular orbital methods- Introduction to semi-empirical – Molecular mechanics and ab-initio techniques- Docking and Modeling substrate receptor Interactions.

Unit V

Software tools for modeling bio-molecules – Protein conformations- protein folding and mutational Analysis through comparative modeling.

Text Books

1. Bioinformatics : Databases, Tools & Algorithms – Orpita Bosu and Simminder Kaur Thukral (Oxford Higher Education)

Reference Books

A Text Book of Bio-informatics - Singhal and Singhal (Pragati Prakashan)

Molecular Modelling and drug Design (Leech)

Textbook of Drug Design and Discovery (Edited by Povl Krosgaard – Larsen, Tommy Liljefors and Ulf Madsen) Taylor Francis Publication.

Molecular Modeling for Beginners: Alan Hincliffe

BIOMEDICAL & DRUG DESIGNING (PAPER-602)

Unit I

Introduction to Drug Design; Strategies for Drug design and stages in drug development, Lead generation and lead optimization, Structure based Drug Design,

Unit II

Docking and different methodologies of Docking, Docking Softwares, Free Energy perturbation method.

Unit III

Principles of Drug Discovery system- Recent advances in drug design methodologies – Biomolecular structure- Structure Activity Relationships.

Unit IV

Analogue based drug Design: Alignment, Molecular Descriptors, Molecular field descriptors, Methods of regression, Genetic algorithm, Validation.

Unit V

Pharmacophore pattern – Pharmacokinetics- Structure based drug design- ADME properties- Quantitative Structure Activity relationships- QSAR Equations, CADD.

Recommended Books

1. Text Book of Drug Design and Discovery (Edited by Povl Krosgaard – Larsen, Tommy Liljefors and Ulf Madsen) Taylor and Francis Publication.
 2. Bioinformatics basic methods and applications – S.C. Rastogi
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PRACTICAL PAPER – 603**GROUP A**

1. Nucleotide Sequence Databases
(NCBI,EMBL/ENA,DDBJ)
2. Protein Sequence Databases
(UNIPROT, PROSITE, PDB, CATH, SCOP)

GROUP B

1. Implementation of Tools
 - (a) Use of CLUSTALW for Multiple Sequence Alignment tools
 - (b) Use of RASMOL Tool for Protein Prediction
3. Implementation of Protein Secondary Structure Prediction Algorithm

INDIAN SOCIETY AND CULTURE (PAPER-606)**Unit I**

Composition of Indian Society – Verna Order – Caste System-Castes and Tribes-Continuity and change of Caste in Indian Society.

Unit II

Change in Socio-Cultural Pattern-Sanskritisation-Secularisation, Modernisation, Westernization and Globalization

Unit III

1. Characteristics of Indian Culture-Features of Indian Culture-Underlying Fundamental Unity in Diversity.
2. Harappan Civilisation – Origin, Extent, Characteristics, Society, Religion, Economic Life and Causes of Decline.
3. Vedic Civilisation – Early Vedic period and Later Vedic period – Socio-economic Political and Religious Life of the people.

Unit IV

1. Socio – Religious life of the people of India in the 6th century B.C – Protestants Movements- Life and Teachings of Mahavir – Impact of Jainism – Life and Teaching of Buddha – Impact of Buddhism.
2. Contribution of Mauryas – War of Liberation, Political Unity by Imperialism, System of Administration, Benevolent Desposition, Ashoka's Dhamma and Missionary Activities, Development of Arts, Architecture, Sculpture and Literature.
3. Development of Indian culture during Gupta Age- Socio-economic and religious life during Gupta Age – Development of Arts and architecture-Literature and Science during Gupta Age.

Unit V

1. Hellenistic Impact on Indian Arts and architecture.
2. Impact of Islam on Indian Society and Culture.
3. Bhakti Movement – Causes and Impacts.
4. Socio-Religious Reform movement in the 19th Century-Raja Rammohan Roy and Bromho Samaj- Dayananda Saraswati and Arya Samaj-Vivekananda and Ramakrishna Mission.

Books Recommended

1. Evolution of Indian Culture- B.N.Luniya
 2. Cultural Heritage of India- Ramakrishna Mission
 3. The Wonder That was India – A.L.Basham
 4. Cultural History of India – A.L.Basham
-

5. Modernization of India Tradition – Y.Singh
6. Traditional India – Structure and Change- M.Singa
7. Marriage and Family in India – K.M.Kapadia

SEMESTER VII

CELL BIOLOGY & GENETICS (PAPER-701)

Unit I

Origin of Life and the cells, Cell Theory, Variability of Cell (Size, Shape, Complexity and Function), Eukaryotic and Prokaryotic cells, Cell Membrane and Bio-chemistry of Cell Membrane.

Unit II

Structure and Function of Chloroplast, Mitochondria, Ribosome, Golgi Bodies, Nucleus, Chromosome, Chromosome Models.

Unit III

Cell Cycle, Cell Division (Mitosis, Meiosis), Movement of Chromosome during cell division, cytoskeleton, biomolecules and cell mobility.

Unit IV

Mendel's Concept of inheritance, gene concept, DNA as a genetic material, Linkage, crossing over and chromosome mapping, structural changes in chromosome, role of polyploidy and haploidy, mutation as source of variation.

Unit V

Regulation of gene action, cell and tissue culture, protoplast isolation and fusion, Gene transfer, Gene tagging, Construction of genomic libraries, Dot blot hybridization.

Reference Books

1. Brown.T.A. (1999) Genomes. John Wiley & Sons (Asia) Pvt. Ltd. Singapore.
2. Callrw.J.A. Ford-Lloyd, B.V and Newbury HJ (1997). Biotechnology and Plant genetics resources CAB Interna.UK
3. Henry, R.J. (1997) Practical application of Plant Molecular Biology Command & Hall, London.
4. M.Samocok J, Fritger E.F. (2000), Molecular Cloning, Harbor Laboratory Press New York.
5. Old, R.W.Primrose (1997).

BIOCHEMISTRY OF NUCLEIC ACIDS AND PROTEINS (PAPER-702)

Unit I

Building Blocks of proteins: amino acids structure, classification, physical and chemical properties, acid-base titration of amino acids, determination of amino acid composition and amino acid sequence of peptide and polypeptides.

Unit II

Levels of protein architecture, Nature of peptide bonds; primary, secondary, tertiary and quaternary structure of protein; forces stabilizing the tertiary and quaternary structure of protein.

Unit III

Structural and functional diversity of proteins: globular proteins, lipoproteins, metalloproteins, glycoproteins and nucleoproteins; Proteins with catalytic activities- enzymes and their kinetics, catalysis, mechanism and regulation; antibodies and their diversity and function.

Unit IV

Building blocks of nucleic acids, nucleotides- composition, structure and properties; structure of RNA

and DNA, base composition and features of double helix; different three dimensional forms of nucleic acids; Nucleic acid chemistry, denaturation, hybridization, non-enzymatic transformation, methylation; determination of nucleotide sequence in nucleic acids.

Unit V

Nucleic Acid and protein synthesis: DNA replication, transcription, inhibitors of transcription, reverse transcription, post-transcriptional processing of RNA; Translation-genetic code, mechanism of translation (protein synthesis), post-translational modification of proteins, protein folding, protein targeting.

Recommended Books

1. L.Stryer: 2000, Biochemistry, 5th Edition, W.H.Freeman and Company, New York.
2. Zubay,G: 1993. Biochemistry, 3rd Edition, W C B Publisers, USA.
3. Cox and Nelson: 2000 Ed., Lelinger's Principle of Biochemistry.
4. Cohn and Stumpf 2000. 5th Edition. Outlines of Biochemistry, Wiley Eastern Pub.

BIOPHYSICS (PAPER-703)

UNIT I

Energetics of a living body, sources of heat limits to temperature (qualitative treatment), heat dissipation to conservation, laws of thermodynamics. Nature of chemical bonds, intra and intermolecular interaction in biological systems. Force field used in Molecular Dynamics Simulation

UNIT II

Absorption spectroscopy- Beer-Lambert's law, Colorimetry to Spectrophotometry(single and double beam spectrophotometer), primary biophysical events in photosynthesis.

UNIT III

Spectroscopic techniques to find out molecular structure (quantitative techniques), general spectroscopy (UV, Visible, Fluorescence, Atomic absorption, IR to Raman spectra).

UNIT IV

Physical methods of imaging, intact biological structures (X-ray, CT-Scan, ECG, EEG, NMR) and radioactive pollution- GM counter.

UNIT V

Structure of proteins – primary, secondary, tertiary and quaternary. X-ray crystallography Physical methods for determining size and shape of macromolecules – diffusion to sedimentation, reverse osmosis, ultracentrifugation, Ramachandran Plot Analysis.

Recommended Books:

- 1) Volkones, HV, General biophysics Vol I&II.
- 2) Pullman, B and M.Voino. Molecular biophysics.

FUNDAMENTALS OF COMPUTER AND PROGRAMMING IN C++ (PAPER-704)

Unit I

An overview of resolution in computers and communication. Applications software (Word processing, spreadsheets, database, financial, communicating etc.) Processors (microclips, CPU., Main memory, representation of data & programs, microcomputer system unit, future processing power), Input and output, storage, Interactivity, Multimedia.

Unit II

System Software, The use of online resources and the internet, Communications technology (hardware, channels & Networks), Software development (programming & languages).

Unit III

Introduction to programming in C++, C++ control structures (if, if/else, while, do/while, for, switch).

Unit IV

Functions (definition & prototypes, storage classes, Scope rules, Recursion, inline functions, references and reference parametrics, function overloading, function templates), Arrays (declaration, passing arrays to functions, sorting and searching arrays, multiple subscripted arrays).

Unit V

Pointers (declaration & initialization, pointer operators, calling functions by reference, pointer expression and pointer arithmetic, pointers & arrays, arrays of pointers, function pointers), Introduction to characters and string processing, classes(structures, class scope, access utility functions, constructors, destructors, use of data members and member functions).

Text Books

1. Using Information Technology – B.K.Williams, S.C.Sanyer & S.E.Hutchinson – Tata Mc Graw Hill – 2000, (chapters: 1-8, 11)
2. C++ How to Program – Deitel & Deitel, 3rd Edition (2001) – Pearson Education/Prentice Hall of India (chapters: 1, 6)

PRACTICAL (PAPER – 705)**Group A: Cell Biology & Biochemistry**

1. Study of Cell division – Mitosis and Meiosis
2. Carbohydrate, Protein and Lipids estimation.
3. Tissue Culture of any one cells/microbe/tissue
4. Prot param, Transeq, Rev Comp
5. Viva
6. Class Records

Group B: Computer Usage & C++ Programming

1. Working in a Linux system: Linux commands, using files and directories, using vi or Emacs editor, Transformations and filters, using printers, modem and multimedia, communicating with other computers (Internet, telnet, ftp, display from remote terminal, accessing devices as unix file system etc.)
2. Implementation of C++ programs developed in Units III, IV & V of Paper 704.
3. Viva
4. Record.

SEMESTER VIII**MOLECULAR BIOLOGY & GENETIC ENGINEERING (PAPER-801)****Unit I**

Introduction to genetic engineering, history, milestones and scope, recombinant DNA technology: enzymes used in DNA technology, various types of hosts and vectors used in DNA technology.

Unit II

C-DNA synthesis and cloning: DNA Primers, Linkers, Adapters and their chemical synthesis, genetic and physical maps, physical mapping and map based cloning, choice of mapping population, population, simple sequence repeat loci, Southern and in situ hybridization for genome analysis.

Unit III

Molecular markers in genome analysis, RFLP, RAPD and AFLP analysis, molecular markers to disease resistance genes. Application of RFLP in forensic and genetic counseling.

Unit IV

Gene regulation, DNA transfection, Northern blot, primer extraction, S1 mapping, reports assay, PCR technology, PCR types and application.

Unit V

Expression strategies: Vector engineering and Codon optimization, host engineering, expression in bacteria, expression in mammalian cells, transgenic and gene knockout technology.

Recommended Books

1. Practical biochemistry, Principles and techniques (fifth edition). Edited by Keith Wilson and John Walker. Cambridge University Press.
2. Lehninger Principles of Biochemistry. (3rd edition). David L.Nelson and Michael M.Cox.
3. Concepts in Molecular Biology- Sharma and Tandon.
4. Molecular Biology of the Gene. Watson etal. (Benjamin Cumings)
5. Notes on Molecular Biology. T.A. Twywan.
6. Genes VII – Lenin, Oxford University Press.
7. The Genomes-T.A. Brown Wiley Less

COMPARATIVE AND FUNCTIONAL GENOMICS (PAPER-802)**UNIT I**

Introduction to Bioinformatics, Biological Databases (primary & secondary); Nucleotide & protein sequence databases:- Data display format, submission & retrieval of data; Nucleic acid & protein structure databases; Pathway databases, Micro array databases, Specialized sequence databases; NCBI resources; EXPASY resources ; EBI resources.

UNIT II

Introduction to Comparative Genomics; Large scale genome sequencing strategies:- Genome isolation; Restriction Endo nucleases ; Polymerase chain reaction; Chain termination and chemical degradation method of DNA sequencing; Contig sequence & whole genome assembly; Human genome project; Comparative genomics tools

UNIT III

Introduction to proteomics; Protein isolation, purification & sequencing strategies; 2D gel electrophoresis; chromatography & sequencing by Edman degradation & mass spectrometry; Endopeptidases; SAGE (serial analysis of genomic expression); Mechanism of Gene Prediction & Gene Prediction Tools; Protein-protein interaction database & tools.

UNIT IV

Disease gene identification (OMIM); Literature database (PUBMED); Introduction to System Biology, Molecular Modeling, Drug designing and Pharmacogenomics.

UNIT V

Protein structure classification databases: SCOP and CATH, Human genome and diseases database – OMIM, NCBI Genomic Resources, GBFF, Swiss Prot, Blast n / Blast p, Gene Prediction Tool, Suggested Readings

Azuaje F & Dopazo J. 2005. *Data Analysis and Visualization in Genomics and Proteomics*. John Wiley & Sons.

Jollès P & Jörnvall H. 2000. *Proteomics in Functional Genomics: Protein Structure Analysis*. Birkhäuser.

DATA STRUCTURE & ALGORITHMS (PAPER-803)**Unit I**

Basic concepts of data representation; Introduction to algorithms, their specification and performance analysis, randomized algorithms, array, linked lists, stacks, queues, tree implementation.

Unit II

Binary-Tree binary search tree, heap tree and algorithm; Tree: definition- binary trees, inorder, preorder and post order traversal algorithms, height balanced tree, B-tree, AVL tree.

Unit III

Divide-and-conquer: Binary search, Finding maximum and minimum, merge sort, Quicksort, selection.

Unit IV

The Greedy Method:- Knapsack problem, Minimum Spanning Tree(Prim's & Kruskal's algorithm), Single source shortest path algorithm.(Dijkstra's algorithm)Branch-and-Bound(Assignment problem), Backtracking(n-queens problem)

Unit V

Dynamic Programming-Multistage Graph, All-pairs shortest paths, optimal binary search tree, The travelling sales person algorithm. P, NP and NP-Complete problem, Approximation algorithm for Travelling salesperson.

Books Recommended:**Texts:**

1. E. Horowitz, S. Sahani, S. Rajasekaran-Fundamentals of computer Algorithm-Galgotia, 2002 [chapters 1, 2, 3 (3.1-3.6), 4(4.1, 4.2, 4.5), 5(5.1-5.3), 6(6.1, 6.2)].
2. A.Levitin- Introduction to the Design & Analysis of Algorithms [chapters 9(9.3), 10(10.3), 11(11.1 – 11.3)].

Reference Books

2. T.H.Coremen, C.E.Leiserson, R.L.Rivest, C.Stein – Introduction to Algorithms – PHI.
3. Robert Kruse, C.L.Tondo, B.Loung – Data Structure & Program Design in C.

BIOLOGICAL DATA BASES AND THEIR MANAGEMENT (PAPER- 804)**UNIT-1**

Introduction to database management,the relational model introduction, QBE, The relational algebra, SQL (Database creation and retrieval, Compound conditions, compute fields, Sorting, built-in-function, nesting queries, Grouping, joining tables, union, updating tables), views, indexes, security, integrity, integrity rules changing the structure of a rational data base, integrity in SQL, [T1:chapters1,2,3,4]

UNIT-2

Database-Normalisation(first,second& third normal form,Multivalued dependencies & fourth normal form) Design methodology, functions of a database management system (data storage-retrieval & update, catalog, backup & recovery, security, integrity, data independence, replication, utilities) [T1:chapters:5,6,7]

UNIT-3

The NCBI data model ,the genbank sequence data base,submitting DNA sequences to the data base,structure data base,genomic mapping and mapping data bases, information retrieval from biological data bases [T2 : CHAPTERS 2, 3, 4, 5, 6, 7]

UNIT-4

DNA vs protein searches,scoring matrices,(PAM 250,BLOSUM 62),FASTA sequence data base similarityn search, basic local allingment search tool(BLAST),theory of BLAST, data base searches with smith-waterman method S SEARCH, searching sequence data bases with a position specific scoring matrix or sequence profile. [t3: chapter7, t4: chapter 9, t2: chapter-8, t5: chapter 1, 2, 3]

UNIT-5

Creation and analysis of protein multiple sequence alignments, predictive method using DNA and protein sequence, expressed sequence tags. sequence assembly and finishing methods. [t2: 9, 10, 11, 12, 13. t5cs-5, 6]

Books recommended

1. P.J. Pratt, J.J. Adamski-concepts of database management-Thomason learning vikash, 3rd edition, 2000
2. A.D. Barevanis, B.F.F. Ouellette-Bio-informatics, a practical guide to the analysis of genes and proteins – Wiley Interscience, 2nd edition, 2001
3. David W. Mount-Bioinformatics-sequence and Genome Analysis-CBS Publishers-2001
4. W.J. Ewens, G.R. Grant-statistical Methods in bioinformatics-springer Verlag-(Indian Reprint)-2004
5. H.P. Bal-Bioinformatics-principles & applications-TMH-2005.

REFERENCES

1. J. PEVSNER-bioinformatics & functional genomics-wiley-LISS, 2003
2. S.C. Rastogi, N. Mendiratta, P. Rastogi-Bioinformatics methods and Applications-PHI, 2005

PRACTICAL (PAPER – 805)**Group A: Molecular Biology**

1. Isolation of genomic DNA
2. Separation of DNA in agarose gel
3. e PCR
4. Codon usage
5. ORF Finder
6. Vecscreen

Group B: Data Structure and Algorithms

Implementation of algorithms studied in units 1, 2, 3 & 4 of Paper 803.

Group C: Biological Databases & their Management

1. Searching the database of nucleotides & Proteins using BLAST and interpretation of the results.
2. Construction of specific Oligonucleotide Probes for PCR & RAPD analysis.

SEMESTER IX**PROGRAMMING IN PERL, C++ & JAVA (PAPER-901)****Unit I (Programming in Perl-I)**

Getting started in PERL, Sequences and string, files, arrays, scalar and list context, Conditional statements, Loops-Finding motifs, Regular expressions-counting nucleotides, Exploding strings into arrays, Operating on Strings, writing to files. [T1 : chapters – 2, 4, 5]

Unit II (Programming in Perl-II)

Subroutines, Scoping, Command-line arguments and arrays, passing data to subroutines, Fixing bugs, Mutations and randomization, Genetic codes, Use of regular expression for finding restriction sites. [T1 : chapters – 6, 7, 8, 9]

Unit III (Programming in C++)

Classes, Operators, Overloading, Inheritance, Virtual functions and Polymorphisms, C++ Stream input / output, Templates, files processing, Class String & String Stream Processing.

[T2 : chapters – 7, 8, 9, 10, 11, 12, 14, 19]

Unit IV (Programming in JAVA - I)

Overview of JAVA Language, Constants, Variables and datatypes, operators and expressions, Decision making with branching & looping, classes, object and methods, arrays, strings & vectors.

[T3 : chapters – 3, 4, 5, 6, 7, 8, 9]

Unit V (Programming in JAVA - II)

Packages, Applet Programming, Graphics programming, Managing input / output files in JAVA.

[T3: chapters – 11, 14, 15, 16]

Text Books:

1. J.Tisdall – Beginning Perl for Bioinformatics – O’Reilly,2001.
2. H.M.Deitel, T.J.Deitel – C++ How to Program, Person Education / Prentice Hall of India, 2001.
3. E. Balguruswamy – Programming with JAVA – Tata McGraw Hill – 1999.

Reference Books

L.Wall, T.Christiansen, Orwan – Programming Perl – O’Reilly.

COMPUTATIONAL GENOMICS (PAPER-902)**Unit I (Physical Mapping of DNA)**

The biological problem, Modeling the number of restriction sites in DNA, Restriction fragment length distribution, Algorithm for the double-digest Problem, Experimental approximations to restriction mapping , Building contigs from cloned genome fragments, Minimal tiling clone clone sets and fingerprinting. [T3: chapters: 3(3.1, 3.2, 3.5), 4]

Unit II (Pariwise Sequence Alignment)

The importance of sequence comparison in molecular biology, the edit distance between two strings, Dynamic Programming calculation of edit distance, weighted edit distances, String similarity, local alignment-finding substrings of high similarity, Gaps - use of gaps in cDNA matching, choices for gap weights, arbitrary and affine gap weights. [T1: chapters 10 & 11]

Unit III (Multiple Sequence Comparison)

Why multiple string Comparison, Biological uses for multiple string comparison, Family and super family representation, Multiple sequence comparison for structural inference, Computing multiple string alignment, Multiple alignment with sum of pairs and consensus objective functions. [T1: chapters-14(14.1 – 14.7)]

Unit IV (HMM for sequence alignment)

Pair wise alignment using Hidden Markov models (HMM) (Pair HMMs, forward calculation of pair HMMs, Backward Calculation of pair HMMs), profile HMMs for sequence families(Adding insert and delete states to obtain profile HMMs, Deriving profile HMMs from multiple alignments, Searching with Profile HMMs, Optimal model construction), Progressive alignment approach to multiple sequence alignment (Feng-Doolite, CLUSTALW, iterative refinement) [T2: chapters-4(4.1, 4.2, 4.4), 5(5.1-5.4, 5.7),6(6.4)]

Unit V

The biological problem, search strategies, Looking for regions of similarity using FASTA, BLAST, Scoring matrices for Protein sequences, Tests of alignment methods. DNA sequence assembly (reading DNA, the three steps method, High-throughput genome sequencing). [T3: chapters-7, 8, T2: chapter-15]

Recommended Books**Texts:**

- T1. Dan Gusfield-Algorithms on Strings, Trees and Sequence:- Computer Science and Computational Biology – Cambridge University Press, 1997.
- T2. R..Durbin, S.Eddy, A.Krogh, G.Mitehison-Biological Sequence Analysis;- Probabilistic models of Proteins and Nucleic acids- Computational Genome Analysis: an Introduction- Cambridge University Press.
- T3 R.C.Doeniier, Simon Tavare, M.S.Waterman- Computational Genome Analysis: An Introduction- Springer-2005

Reference Books

David W. Mount- Bioinformatics : Sequence and Genome Analysis- CBS Publishers-2003.

COMPUTATIONAL PROTEOMICS (PAPER- 903)

UNIT-I

Proteomics (Technology platforms in proteomics, case studies), Function Prediction from Protein sequence, Protein structure classification, From protein structure to function, Global approaches for studying protein-protein interaction, predicting the structure of protein –biomolecular interaction. [t1:ch-5,7,10,13,16]

UNIT-II

Protein structure-protein stability and folding, applications of hydrophobicity, superposition of structures and structural alignment, DALI. evolution and classification of protein structures, alignment of protein structure to Genomes, prediction of protein function drug discovery and development. [t2:ch5, excluding section on protein structure ,prediction and modeling]

UNIT-III

Protein structure prediction and modeling (secondary structure prediction, homology modeling, fold recognition, conformational energy calculation and molecular dynamics, ROSE TTA, LINUS), amino acid pair potentials, Lattice models of proteins. [t2:ch-5 [relevant section] t3:ch-6(6.3,6.4)]

UNIT-IV

Algorithms for protein –Hart and Istrail's approximation algorithm, constraint-based structure prediction, protein threading. [t3:ch6(6.5,6.6)]

UNIT-V

Protein sequencing and identification-sequencing by hybridization (SBH), SBH as Hamiltonian and Eulerian problem. the peptide sequencing problem, spectrum graphs , protein identification via database search, spectral convolution, spectral alignment [t4:ch8(8.6,8.7,8.8,8.10,8.15)]

Books Recommended

Text

1. C.A. Orengo, D.T. Jones & J.M. Thornton - Bioinformatics: -Genes, Proteins and Computers - BIOS Scientific Publishers limited, 2003
2. A.M. Lesk - Introduction to bioinformatics - Oxford university press (Indian Edition) - 2003
3. P. Clote and Backofen - Computational Molecular Biology: an introduction – John Wiley & Sons - 2000
4. N.C. Jones and P.A. Pevzner - An introduction to Bioinformatics Algorithm MIT Press - 2004

Reference

1. D.W. Mount - Bioinformatics: Sequence and Genome Analysis - CBS publishers - 2003
2. S.R. Pennington, M.J. Dunn - Proteomics: from protein sequence of function – viva Books - 2004

MOLECULAR EVOLUTION AND COMPARATIVE GENOMICS (PAPER-904)

UNIT-I

Introduction, molecular evolution and population genetics (evolution sequence variation within and between species, genealogical trees and coalescence, the spread of new mutations , neutral evolution and adaptation)

Models of nucleic acid and sequence evolution (the Jukes-Cantor and other models), the PAM model of protein sequence evolution, Log odds scoring matrices for amino acids. [t1:ch-1,3,4]

UNIT-II

Phylogenetic methods, phylogenetic trees, choice of sequences, Distance matrices and clustering methods, Bootstrapping, tree optimization criteria and tree search methods , the maximum likelihood criterion, The parsimony Criterion, other methods related to maximum likelihood [T1:ch-8, Text-2:ch-12]

UNIT-III

RNA structure and evolution, fitting evolutionary models to sequence data, Application of molecular phylogenetics, Genome Evolution (Prokaryotic genomes, Organellar genomes). [T1:ch11,12]

UNIT-IV

Genome Rearrangement-The biological problem,Modeling conserved syntery,Rearrangement of cirenlar genomes,revivals,breakpoints,Estimating reversal distance by cycle decomposition,estimating reversal distances between two permutations ,analyzing genomis with reversal of oriented ,conserved segments ,application to comp-lete genomes (synteny blocks,representing genome arrangement,comparision of human and mouse genomic).[t2:ch-5]

UNIT-V

Comparitive genomic-compositional measures, tranposable elements ,sequence organization within chromosomes,gene content,predicted proteome.[t2:ch-14]

Books Recommended**Texts**

1. P.G.Higgs & T.K. Attwood-Bioinformatics and Molecular Evolution-Blavkwell publishing-2005.
2. R.C.Deonier, S.Tavare, M.S.Waterman-computational genome analysis-springer-2005.

Reference

1. R.Durbin, S.Eddy,A.Krugh,G.Mitchinor-Biological srquence analysis-CUP-1998.
2. David Mount-Bioinformatics:sequence and genome analysis-CBS publishers-2003

PRACTICAL (PAPER – 905)**Group A: Programming in Perl and JAVA**

- (i) Implementation of Perl programs of paper 901.
- (ii) Implementation of C++ and Java programs in UNIT (III, IV, V) paper 901

Group B: Online Bioinformatics Databases and Tools

- (i) Pairwise Sequence alignment Tools (BLAST, PSI-BLAST, FASTA, LALIGN)
- (ii) Multiple Sequence Alignment (Clustal W, T Coffee)
- (iii) Searching for motifs and patterns (Gibbs Sampler, Pralt, SPIDY, eMOTIF,3D Jigsaw)
- (iv) Editing and Analyzing Multiple Sequence Alignment (Jalview, Bioedit)
- (v) Prediction of Protein 3D-Structure (Phyre 2, Swiss PDB, Geno 3D)
- (vi) Building Phylogenetic Trees (PHYLIP)

References:

1. J.M.Claverie, C.Notredame – Bioinformatics: a beginner's guide Wiley-dreamtech,2003
2. A.D.Baxevanis, B.F.Francis Ouellette – Bioinformatics: a Practical guide to the analysis of genes and Proteins – Wiley Interscience,2001
3. R.A.Dwyer – Genomic Perl: From Bioinformatics to working code- Cambridge University Press-2003
4. Beginning with Perl for Bioinformatics: James Tisdall

SEMESTER X**ADVANCED TOPICS IN BIOINFORMATICS (PAPER-1001)****Unit I**

Regulatory motifs in DNA sequences, Profiles, The motif finding problem, Search Trees, Finding Motifs and Median strings. Greedy approach to motif finding.

Protein Motifs and PROSITE (Patterns in PROSITE and Perl, Suffix trees, suffix trees for PROSITE Searching) [Text 1 : chapter 4(4.1 – 4.9), 5.5,; Text 2 : chapter 12]

Unit II

Gene Prediction, Statistical and Similarity based approaches to gene prediction, Spliced alignment, Coding sequence Prediction with dicodons (Trigram & hexagram models, Predicting all genes, Gene finding in Perl) [Text 1 : chapter 6(6.11 – 6.14); Text 2 : chapter 14]

Unit III

Artificial Intelligence techniques to bioinformatics problems: Nearest Neighbour and clustering approaches, Decision Trees approach (method, gain criterion overfitting and Pruning, application guidelines, bioinformatics applications) [Text 3 : chapter 5 & 6]

Unit IV

Functional annotation and Protein families (ProtoNet-tracing Protein families, ProtoNet based tools for structural genomics, PNDORA-integration of annotations, PANDOR-based tools for functional genomics., Discovering Protein-Protein interaction-Experimental detection of Protein interaction, Computational Prediction of Protein interaction (structure, sequence and genome based Prediction) [Text 4 : chapter 12, 13]

Unit V

Computational methods for pathways and systems Biology, Drug Discovery (Introduction, technology and strategies, computer aided design) [Text 5 : chapter 13, 14, 15, 16]

Books Recommended:

1. N.C.Jones, P.A.Pevzner – An Introduction to Bioinformatics Algorithm, MIT Press, 2004
2. R.A.Dwyer – Genomic Perl: from Bioinformatics basics to working code – Cambridge University Press, 2003
3. E.Keedwell, Ajit Narayanan – Intelligent Bioinformatics, John WILEY & Sons, 2005
4. L.Wong – The Practical Bioinformatician – World Scientific Publishing, 2004
5. S.C.Rastogi, N.Mendiralta, P.Rastogi – Bioinformatics Methods and applications – Genomics, Proteomics and Drug Discovery – Prentice Hall of India – 2004

NEURAL NETWORKS AND GENETIC ALGORITHM (PAPER- 1002)**Unit-I**

Fundamentals of Neural Network-Basic concepts Neural networks architectures and characteristics Learning methods, Early neural network architectures. Backpropagation network(BPN). The Perception model, single and multiplayer network, Backpropagation learning, effect of tuning parameters and BPN, Selection of various parameters. [Text-1:ch-2,3(excluding 3.4,3.7,3.8)Text-2: ch-7]

Unit-II

Application of Artificial Neural Network(ANN) in Bioinformatics-classification and dimensionality reduction of gene expression data, Identifying protein sub cellular location, Techniques for recognition.[Text-2:ch-7,Text-3:ch4 &5]

Unit-III

Application of ANN in Bioinformatics: Neural Statistical model of TATA BOX motifs in eukaryotes, Tuning the Dergon promoter finder system for human promoter recognition.[Text-3:ch-6,7,8]

Unit-IV

Genetic Algorithms- Genetic modeling, single and multi objective genetic algorithms, bioinformatics applications (Reverse engineering of regulatory networks, multiple Sequence alignment) [Text-1: ch-9(9.1-9.8),Text-w ch-8]

Unit-V

Genetic programming (The method, application guidelines, bioinformatics, applications)(data mining for drug discovery, functional genomics for yeast data 0 hybrid method(Neural-genetic algorithms for

analyzing gene expression data, Genetic Algorithm and nearest neighbor hybrid for biochemistry solution, Genetic programming neural networks for determining gene-gene interaction in epidemiology)[Text-2: ch-9 & 11]

Books Recommend :

1. S.Rajeseckeran & G.A. Vijoylaxshmi pai Neural network, Fuzzy logic and Genetic Algorithms. PHI-2003.
2. E. Keedorell & A.Neroyenen- Intelligent Bioinformatics-John Wiley-2005.
3. L.Worg- The practical Bioinformaticien-world Scientific Publishing-2004.

COMPUTER AIDED DRUG DESIGN (PAPER- 1003)**UNIT-I**

Concepts of Molecular Modeling, Molecular Structure and internal energy, Energy minimization of small molecules, Local and global energy minima.

UNIT-II

Homology Modelling , Threading , Abinitio, Simulation methods for protein tertiary structure prediction.

UNIT-III

Steps in Drug Design, Design of Ligands , Drug receptor interactions , ClassicalSAR/QSAR , Docking of Molecules

UNIT-IV

Role of computers in chemical research: structure representation, SMILES, Chemical Databases, 2D and 3D structures, Search techniques, similarity searches, Chemoinformatics tools for drug discovery.

Practical

- i) Modelling Tools: MODELLER, Geno3D
- ii) Docking Tools: Autodock Tools, Hex

Suggesting Readings

Bunin BA. 2006. *Chemoinformatics: Theory, Practice and Products*. Springer
Gasteiger J & Engel T. 2003. *Chemoinformatics: A Textbook*. Wiley-VCH.
HinchliffeA. 2003. *Molecular Modelling for Beginners*. John Wiley & Sons.
Leach AR. 1996. *Molecular Modelling: Principles and Applications*. Longman.
