Proposed Semester Syllabus for

B.Sc (Honours) BIOCHEMISTRY

FOR COLLEGES AFFLIATED TO

UNIVERSITY OF DELHI

2010

GENERAL GUIDELINES/ PREAMBLE

B.Sc. (Hons) Biochemistry

Three year Full Time Programme

The three years programme for B.Sc. (Hons) Biochemistry is prescribed according to the semester system of University of Delhi for the undergraduate courses beginning 2010 and is divided into six semesters. The programme has 24 papers in total, 4 in each semester.

The programme endeavors to provide students a broad based training in biochemistry with a solid background of basic concepts as well as exposing them to the exciting advancements in the field. In addition to theoretical knowledge, significant emphasis has been given to provide a hands on experience to the students in the forefront areas of experimental biochemistry. A multidisciplinary approach has been employed to provide the best leverage to students to enable them to move into frontier areas of Biological research in the future. Hence, apart from the papers in biochemistry, two papers of chemistry, one paper of mathematics, one paper on applications of computers and one paper of biophysics have also been included in the course.

Semester- I

COURSE CODE	COURSE TITLE
BIOCHEM- 101	Biomolecules
BIOCHEM- 102	Biophysics
BIOCHEM- 103	Chemistry I
BIOCHEM- 104	English

Semester- II

COURSE CODE	COURSE TITLE
BIOCHEM - 201	Computer Applications
BIOCHEM – 202	Biochemical Techniques
BIOCHEM – 203	Chemistry II
BIOCHEM – 204	Mathematics & Statistics

Semester- III

COURSE CODE	COURSE TITLE
BIOCHEM – 301	Proteins & Enzymes
BIOCHEM – 302	Metabolism of Carbohydrates & Lipids
BIOCHEM – 303	Cell Biology I
BIOCHEM – 304	Molecular Biology I

Semester- IV

COURSE CODE	COURSE TITLE
BIOCHEM – 401	Bioenergetics
BIOCHEM – 402	Metabolism of Amino acids & Nucleotides
BIOCHEM – 403	Cell Biology II
BIOCHEM – 404	Molecular Biology II

Semester- V

COURSE CODE	COURSE TITLE
BIOCHEM – 501	Membrane Biology
BIOCHEM – 502	Hormone Biochemistry
BIOCHEM – 503	Immunology I
BIOCHEM – 504	Genetics and Genomics-I

Semester- VI

COURSE CODE	COURSE TITLE
BIOCHEM – 601	Molecular Physiology
BIOCHEM – 602	Recombinant DNA Technology
BIOCHEM – 603	Immunology II
BIOCHEM – 604	Genetics and Genomics -II

BIOCHEM 101: BIOMOLECULES

1. **Biomolecules**: Structure, function, diversity and distribution. General introduction of composition of living matter, Cell wall structure with reference to gram positive and gram negative bacteria.

2. **Carbohydrate:** Monosaccharides and their inter relationship, structure of sugar, Stereoisomerism and optical isomerism of sugars. Ring structure and tautomeric forms, mutarotation. Important derivatives of Monosaccharides, Disaccharides and Trisaccharides (Glucose, fructose, maltose, lactose, cellobiose, gentiobiose, Melibiose, Turanose, Sucrose, Trehalose, Mannotriose, Rabinose, Rhamnose, Raffinose, Gentionose, Melizitose.) Structure, occurance and biological importance of structural polysaccharides e.g. Cellulose, chitin, agar, algenic acids,pectins, glycoproteins, proteoglycans, sialic acids, blood group polysaccharides, bacterial cell wall polysaccharides.

3. **Lipids:** Building block of lipids - fatty acids, glycerol, sphingosine Definition and classification of lipids. Classification of fatty acids, physio-chemical properties of fatty acids, separation of fatty acids, distribution of fatty acids in nature and characterization of fatty acids, saponification and iodine number. Properties of glycerol, fats and oils. Systematic nomenclature and classes of glycerides, MAG, DAG, TG, phospholipids, PA, PG, PE, PS, LPC, PI and plasmalogens, sphingolipids - sphingosine, ceramide, sphingomyelin, glycolipids cerebrosides, gangliosides and sialic acids. Properties and function of phospholipids and Prostaglandins. Isoprenoids- types and structures, structure of sterols, Bile acids, steroid hormones, plant sterol, ergosterol, stigma sterol, cholesterol, glucocorticoid, mineralocorticoids. Lipoproteins - classification, composition and their importance, Role of Lipids in cellular architecture and functions.

4. **Amino acids:**Classification and formulae, Proteinaceous and non-proteinaceous, Essential and Non-Essential amino acids. Physical, chemical and optical properties of amino acids. Introduction to biologically active peptides e.g. Glutathione, Oxytocin, Insulin.

5. **Nucleic acids:** Importance of nucleic acids in living system, general composition of nucleic acids, the purine and pyrimidine bases, Tautomeric forms of bases. Reactions of purines and pyrimidines, structure of nucleosides and nucleotide, deoxynucleotides, cyclic nucleotides and polynucleotides. Watson and crick model for DNA. Different types of DNA and RNA.

6. **Vitamins:** Structure of fat soluble vitamins A, D, E & K. Water soluble vitamins, their co- enzyme forms and deficiency disorders, Thiamine, riboflavin, pantothenic acid, niacin, pyridoxine, biotin, cobalamine, folic acid and ascorbic acid.

Suggested Textbooks

1. Nelson, D.L. and Cox, M.M.(2009). Lehninger`s Principles of Biochemistry, W.H. Freeman and Company, New York.

Practicals

1. Preparation of normal, molar and percent solutions.
2. Titration curve of Glycine.
3. Buffer preparation..
4. Qualitative tests for Carbohydrates, Lipids, Amino acids, Proteins, Nucleic acids
5. Preparation of casein from milk and determination of its isoelectric point.
6. Titrimetric analysis of Vitamin C.

BIOCHEM 102: BIOPHYSICS

1. **Origin and Evolution of Life.** Introduction. Prebiotic earth. Theories of Origin and Evolution of life.

2. **Biophysics of Water.** Molecular structure of water, hydrogen bonds and physical properties of water.

3. **Electrochemistry.**Ionization; theories of electrolytic dissociation; classification of electrolytes; Electrolysis;Conductance; solubility product; common ion effect; Ostwald's dilution law; Dielectric Constant.

4. **Photophysics.** Nature and measurement of light; Light sources , Optical components and their calibration Radiometry; Actinometry; UV radiation dosimetry with poly sulphonification; Molecular structure and excited states; Physical properties of excited molecules; PhotoPhysical processes; Fluorescence; Photophosphorescence;Internal conversion; Intersystem crossing; Photophysical spectra; Atomic spectra; Optical activity; Photophysical kinetics of biomolecular processes.

5. **Spectroscopic Techniques.** Principle, Instrument design, methods and application of UV spectroscopy; circular Dichroism and optical rotatory dispersion(ORD); Flurescence spectroscopy; Infrared spectroscopy; NMR and ESR spectroscopy.

6. **Hydrodynamic Techniques.**Principle , Instrument design, methods and application of Centrifugation; Ultracentrifugation ; Viscometry; Osmosis; Diffusion and Surface tension.

7. **Optical Techniques.**Principle, Instrument design, methods and application of Bright field; Dark field; Phase Contrast; Fluorescence; Polarising; Scanning and Transmission Electron Microscopy. Flowcytometry and Cytophotometry.

8. **Diffraction Techniques.**Crystals, Molecular crystal symmetry, X ray diffraction by crystals, Bragg's Law, von Laue conditions and rotation methods. Calculating electron density and Patterson maps (Fourier transform and structure factors, convolutions), phase model building and evaluation, Newton diffraction, Application to Biology.

9. **Radioactivity and measurement.** Radioactivity, Radioactive decay, Isotopes, Biological application of radioisotopes, Detection and measurement of radioactivity, Instruments used for measurement of radiation intensities, Biological effects of radiation and radiation hazards.

Suggested Textbooks

1. Pattabhi. V. and Gautham.N. (2002) Biophysics. Narosa Publishing House, India.

2. Roy, R.N. (2005) A Textbook of Biophysics. New Central Book Agency(P) Ltd., Calcutta, India.

Practicals.

1. Verification of Beer- Lambert's Law
2. λ max of $CoCl_2$, PNP
3. Determination of ε of PNP,DCPIP
4. Determination of Pka of Bromophenol blue.
5. Mutarotation of sugars.

BIOCHEM 103: CHEMISTRY-1

Section A: Inorganic Chemistry

1. Atomic Structure: *Recapitulation of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Need of a new approach to Atomic structure.*

What is Quantum mechanics? Time independent Schrodinger equation ($H\Psi = E\Psi$) and meaning of various terms in it. Significance of Ψ and Ψ^2, Schrodinger equation for hydrogen atom in Cartesian coordinates (x,y,z). Need of polar coordinates, transformation of Cartesian coordinates (x,y,z) into polar coordinates (r,θ,ϕ). Radial and angular parts of the hydogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals. (Only graphical representation), Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distances with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers m_r and m_s. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

2. Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and salvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Lande equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent bonding: *VB Approach* Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of, linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures.

Section B: Physical Chemistry

3. Chemical Thermodynamics

What is thermodynamics? State of a system, state variables, intensive and extensive variab les, concept of heat and work, thermodynamic equilibrium, thermodynamic properties, var ious types of systems and processes. First Law of thermodynamics. Calculation of work (*w*), heat (*q*), changes in internal energy (ΔU) and enthalpy (Δ*H*) for expansion or compress ion of ideal gases under isothermal and adiabatic conditions for both reversible and irreversible processes. Calculation of *w*, *q*, ΔU and Δ*H* for processes involving changes in physical states.

Important principles and definitions of thermochemistry. Concept of standard state and sta ndard enthalpies of formations, integral and differential enthalpies of solution and dilution.

Calculation of bond energy, bond dissociation energy and resonance energy from thermoc hemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation. Various statements of Second Law of thermodynamics, Carnot cycle, concept of entropy, Gibbs free energy and Helmholtz energy, Calculations of entropy change and free energy change for reversible and irreversible processes under isothermal and adiabatic conditions. Criteria of spontaneity. Gibbs - Helmholtz equation. Maxwell's relations. Statement of Third Law of thermodynamics and calculation of absolute entropies of substa nces.

4. Ionic Equilibria

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of io nization, ionizationconstant and ionic product of water. Ionization of weak acids and base, pH scale, common ion effect, Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts.Buffer solutions.
Solubility and solubility product of sparingly soluble salts applications of solubility product principle.
Qualitative treatment of acid base titration curves (calculation of pH at various stages of H Cl –NaOH titration only). Theory of acid – base indicators.

Suggested Textbooks

1. Barrow, G. M. (2007) Physical Chemistry Tata McGraw-Hill, India.
2. Castellan, G. W.(2004) Physical Chemistry 4th Ed. Narosa, India.
3. Kotz, J. C., Treichel, P. M. & Townsend, J. R. (2009)General Chemistry Cengage Le arning India Pvt. Ltd.: New Delhi
4. Mahan, B. H. (1998)University Chemistry 3rd Ed. Narosa, India.
5. J. D. Lee, A new Concise Inorganic Chemistry, E L. B. S.

6. F. A. Cotton & G. Wilkinson. Basic Inorganic Chemistry, John Wiley.

7. Douglas, McDaniel and Alexader : Concepts and Models in Inorganic Chemistry, John Wiley.

8. James E. Huheey, *Ellen Keiter and Richard Keiter : Inorganic Chemistry: Principles of Structure and Reactivity,* Pearson Publication.

Practicals

Section A: Inorganic Chemistry

Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.

2. Estimation of oxalic acid by titrating it with $KMnO_4$.

3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.

4. Estimation of Fe(II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.

5. Estimation of Cu(II) ions iodometrically using $Na_2S_2O_3$.

Section B: Physical Chemistry

(I) **Surface tension measurement** (use of organic solvents excluded) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.

(II) **Viscosity measurement** (use of organic solvents excluded) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.

(III) **Kinetic studies** Study of the kinetics of the following reaction by integrated rate method: Acid hydrolysis of methyl acetate with hydrochloric acid volumetrically

BIOCHEM 104

TECHNICAL WRITING AND COMMUNICATION IN ENGLISH

Unit 1
Communication: Language and communication, differences between speech and writing, distinct features of speech, distinct features of writing.

Unit 2
Writing Skills; Selection of topic, thesis statement, developing the thesis; introductory, developmental, transitional and concluding paragraphs, linguistic unity, coherence and cohesion, descriptive, narrative, expository and argumentative writing.

Unit 3
Technical Writing: Scientific and technical subjects; formal and informal writings; formal writings/reports, handbooks, manuals, letters, memorandum, notices, agenda, minutes; common errors to be avoided.

SUGGESTED READINGS

1. M. Frank. Writing as thinking: *A guided process approach, Englewood Cliffs,* Prentice Hall Reagents.
2. L. Hamp-Lyons and B. Heasely: Study Writing; *A course in written English.* For academic and professional purposes, Cambridge Univ. Press.
3. R. Quirk, S. Greenbaum, G. Leech and J. Svartik: *A comprehensive grammar of the English language*, Longman, London.
4. Daniel G. Riordan & Steven A. Panley: *"Technical Report Writing Today"* - Biztaantra.

Additional Reference Books

5. Daniel G. Riordan, Steven E. Pauley, Biztantra: *Technical Report Writing Today*, 8th Edition (2004).
6. *Contemporary Business Communication*, Scot Ober, Biztantra, 5th Edition (2004).

BIOCHEM 201: APPLICATIONS OF COMPUTERS IN BIOCHEMISTRY

Theory

Computer basics: PC hardware, operating systems, data storage and backup, networks, information technology, Basic operations using windows.

Computer programming: Constants, variables, bites, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions. Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

Practicals

Word processing: Incorporating chemical structures into word processing documents, presentation graphics, on-line publication (www/html), multimedia animations etc.

Handling numeric data: spreadsheet software (Excel), simple calculations, statistical analysis, plotting graphs using a spreadsheet (radial distribution curves for hydrogenic orbitals, gas kinetic theory, spectral data), graphical solution of equations, solving equations numerically (e.g. pH of a weak acid ignoring/not ignoring the ionization of water, volume of a van der Waals gas, equilibrium constant expressions).

Numeric modelling, numerical curve fitting, numerical differentiation (e.g. handling data from potentiometric titrations), integration (e.g. entropy/enthalpy change from heat capacity data). Numerical solution of differential equations (e.g. kinetics).

BASIC programs for numerical differentiation and integration, finding roots (quadratic formula, iterative, Newton-Raphson method), numerical solution of differential equations.

Computational chemistry: Visualization of 3D structures, calculation of molecular structures and properties (e.g. conformational energies of butane, rotation of 1,3-butadiene, distribution of isomers, energies of orbitals and total energy as a function of bond angle for H_2O, Diels-Alder reaction).

Chemical information on the web. Chemical abstracts. Structures and properties.

*Note:*1. Software: Microsoft Office, ChemOffice.

2. References: Internet, documentation of software.

These are representative projects. The students must be encouraged to explore other projects and prepare a presentation based on their project. Internal assessment may be based on the project.

Suggested Textbooks

1. Noggle, J. H. (1985) Physical Chemistry on a microcomputer. Little Brown & Co.

2. Venit, S. M. (1996) Programming in Basic: Problem solving with structure and style. Jaico Publishing House: Delhi .

BIOCHEM 202: Biochemical Techniques

1. **Separation Techniques.** Different methods of protein precipitation: Precipitation using inorganic salts (salting out) and organic solvents, isoelectric precipitation,Dialysis, Ultrafilteration, Lyophilization

2. **Chromatography.** Basic principles of chromatography: Partition coefficient, concept of theoretical plates, various modes of chromatography (paper, thin layer, column), preparative and analytical applications, LPLC and HPLC. Different types of chromatography: Paper Chromatography, Thin Layer Chromatography. Molecular Sieve Chromatography, Ion Exchange Chromatography, Affinity Chromatography, Gas Liquid Chromatography

3. **Electrophoresis.** Basic Principle of electrophoresis, Paper electrophoresis, Gel electrophoresis, discontinuous gel electrophoresis, PAGE, SDS-PAGE, Native gels, denaturing gels, agarose gel electrophoresis, buffer systems in electrophoresis, electrophoresis of proteins and nucleic acids, protein and nucleic acid blotting, detection and identification (staining procedures), molecular weight determination, Isoelectric Focusing of proteins.

4. **Centrifugation.** Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient, various types of centrifuges, different types of rotors, differential centrifugation, density gradient centrifugation (Rate zonal and Isopycnic)

5. **Spectrophotometry.** Principle of UV-Visible absorption spectrophotometry, instrumentation and applications

6. **Flourimetry.** Phenomena of fluorescence, intrinsic and extrinsic fluorescence, instrumentation and applications

Suggested Textbooks

1. Freifelder, D. (1982) Physical Biochemistry 2nd edition, W.H. Freeman and Co., N.Y. USA.

2. Cooper, T.G. (1977) The Tools of Biochemistry John Wiley and Sons, N.Y. USA.

Practicals

1. Estimation of Proteins by Biuret, Lowry and Bradford.
2. Separation and identification of amino acids by paper chromatography.
3. Separation and identification of Sugars/lipids by TLC.
4. Separation of Amino acids by Ion- Exchange Chromatography.
5. Gel Filtration Chromatography.
6. SDS-PAGE analysis of proteins.

BIOCHEM 203: CHEMISTRY-2

Section A: Basic Organic Chemistry **(30 Periods)**

1. Fundamentals of Organic Chemistry

Concept of hybridization of carbon. Cleavage of a covalent bond: homolysis and heterolysis. Electronic effects and their applications (inductive, electromeric, hyperconjugation and resonance). Structure and stability of reactive intermediates (carbocations, carbanions and free radicals). Relative strength of carboxylic acids (aliphatic, aromatic and halo-substituted aliphatic), alcohols, phenols and nitro-phenols. Relative basic strength of amines (aliphatic and aromatic) Intermolecular and intramolecular forces: types of intermolecular forces and their characteristics (ion-dipole, dipole-dipole, dipole-induced dipole and dispersion forces). Intermolecular and intramolecular hydrogen bonding. Effect of intermolecular and intramolecular forces on properties such as solubility, vapour pressure, melting and boiling points of organic compounds.

2. Stereochemistry

Conformations w.r.t. ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newman, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds) . Threo and erythro; D and L; *cis* - *trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

Section B: Chemistry of Biomolecules

3. Carbohydrates

Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disacharrides (sucrose, cellobiose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

4. Amino Acids, Peptides and Proteins

Preparation of Amino Acids: Strecker synthesis, using Gabriel's phthalimide synthesis. Zwitter ion, Isoelectric point and Electrophoresis. *Reactions of Amino acids*: ester of –COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test.

Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins. Determination of Primary structure of Peptides by degradation Edmann degradation (N-terminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis.

Suggested Textbooks

1. T. W. Graham Solomons : *Organic Chemistry, John Wiley and Sons*.
2. Arun Bahl and B. S. Bahl : *Advanced Organic Chemistry*, S. Chand.
3. E. L. Eliel : *Stereochemistry of Carbon Compounds*, Tata McGraw Hill.
4. I. L. Finar : *Organic Chemistry* (Vol. I & II), E. L. B. S.
5. R. T. Morrison & R. N. Boyd : *Organic Chemistry*, Prentice Hall.

Practicals

Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, 1^{o} amines) and preparation of one derivative.

BIOCHEM 204: MATHEMATICS AND STATISTICS

1. **Calculus** Sets. Functions and their graphs : polynomial, sine, cosine, exponential and logarithmic functions. Motivation and illustration for these functions through projectile motion, simple pendulum, biological rhythms, cell division, muscular fibres etc. Simple observations about these functions like increasing, decreasing and, periodicity. Sequences to be introduced through the examples arising in Science beginning with finite sequences, followed by concepts of recursion and difference equations. For instance, the Fibonacci sequence arising from branching habit of trees and breeding habit of rabbits. Intuitive idea of algebraic relationships and convergence. Infinite Geometric Series. Series formulas for ex, log (1+x), sin x, cos x. Step function. Intuitive idea of discontinuity, continuity and limits.

   Differentiation. Conception to be motivated through simple concrete examples as given above from Biological and Physical Sciences. Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions. Integration as reverse process of differentiation. Integrals of the functions introduced above.

2. **Sequences and Multivariate Calculus** Points in plane and space and coordinate form. Examples of matrices inducing Dilation, Rotation, Reflection and System of linear equations. Examples of matrices arising in Physical, Biological Sciences and Biological networks. Sum and Produce of matrices upto order 3.

   Functions of two variables. Partial differentiation upto second order. Modeling and verification of solutions of differential equations arising in population growth, administration of medicine and diffusion equation arising from diffusion of Potassium ions in Cells.

3. **Statistics** Measures of central tendency. Measures of dispersion; skewness, kurtosis. Elementary Probability and basic laws. Discrete and Continuous Random variable, Mathematical Expectation, Mean and Variance of Binomial, Poisson and Normal distribution. Sample mean and Sampling variance. Hypothesis testing using standard normal variate. Curve Fitting. Correlation and Regression. Emphasis on examples from Biological Sciences.

Suggested Textbooks

1. Bear, H.S. (2003) Understanding Calculus, 2nd Edition. John Wiley and Sons.

2. Batschelet, E. (1971) Introduction to Mathematics for Life Scientists. Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi.

3. Edmondson, A. and Druce, A. (1996) Advanced Biology Statistics. Oxford University Press;

4. Danial, W. (2004) Biostatistics : A foundation for Analysis in Health Sciences. John Wiley and Sons Inc.

Note: It is desirable that softwares should be used for demonstrating visual, graphical and application oriented approaches.

BIOCHEM 301: Proteins and Enzymes

1. **Proteins and Enzymes**- Monomeric and multimeric proteins, Conjugated proteins. Purification and characterization. Physiochemical properties and criteria of purity. Functional diversity of proteins –enzymes, transporters, metalloprotein, nucleoprotein, lipoprotein, glycoprotein, membrane proteins, regulatory proteins.

2. **Hierarchy of protein structure-** Primary, Secondary, Tertiary and Quaternary structure.

3. **Primary structure analysis-** Amino acid composition, Subunit Determination, N-Terminal and C-Terminal analysis, Edman Sequencing methods Endopeptidases, assembly of structure using overlaps, 2D peptide mapping, solid phase synthesis.

4. **Secondary structure-** *N*ature of peptide bond , ϕ and Ψ angles, Ramachandran plot, helices and pleats, structure of keratin, collagen, silk fibroin, supersecondary structure motifs, domains(DNA binding motifs, nucleotide binding motifs)

5. **Tertiary and Quartenary structure** – structure of Myoglobin (Mb), determination of protein structure- X- ray, NMR and Theoretical modeling Quaternary structure – structure of Haemoglobin (Hb), structure function relationship using Mb & Hb, molecular physiology of Hb & Mb, Bohr Effect, Hill coefficient, allosteric models-concerted & sequential model, molecular diseases- sickle cell anemia Protein stability, Forces stabilizing the protein structure, Denaturation and Renaturation Protein folding, folding pathways assisted folding, chaperones-GroEL /ES system, misfolding, folding diseases.

6. **Introduction to enzymes**, proteinaceous nature, coenzymes, isozymes and ribozyme. Classification. Enzyme assays- fixed time and continuous. Activity units- IU and Katals.

7. **Features of enzyme catalysis**- concept of active site, specificity, higher reaction rates, capacity for regulation.

8. **Enzyme kinetics**- Lowering of activation energy - release of binding energy, distorsion of substrate , binding to transition state, proximity and steering effects.

Rate equations for unisubstrate reactions. Progress curve for enzyme reactions. Typical Michaelis Menten hyperbolic curve for enzymes, V_o vs [S], V_{max}. Derivation of Michaelis -Menten equation applying steady state hypothesis. K_{cat} (turnover number) and K_m and their significance. K_{cat}/K_m ratios for determining catalytic efficiency. Graphical methods of determining Km and Vmax. Lineweaver- Burke, Eadie-Hofstee and Dixon plots. Reversible inhibitions- competitive, uncompetitive and noncompetitive. Diagnostic kinetic plots for the same (Lineweaver-Burke). Bisubstrate reactions- nomenclature, single and double displacement reactions, identifying the same based on kinetics and isotope exchange studies.

9. **Mechanism of action of selected enzymes**- chymotrypsin, lysozyme and carboxypeptidase.

10. **Coenzymes and their mechanisms**- TPP, FAD/FMN, NAD/NADPH, pyridoxal phosphate, coenzyme-A, biotin, cobalamin, tetrahydrofolate, lipoic acid.

11. **Regulation of enzyme activity**- allosteric enzymes, ATCase as an example, reversible covalent modification- glycogen phosphorylase and glutamine synthase. Zymogen activation.

12. **Irreversible inhibitors**- mechanism based eg. Fluoroacetate (aconitase), DFMO (ornithine decarboxylase). Antibiotic inhibitors of enzymes- penicillin, sulfa drugs, methotrexate etc.

Suggested Textbooks

1. Nelson, D. L. and Cox, M.M.(2008**).** Lehninger , Principles of Biochemistry, 5th Edition, W.H.Freeman and Company, N.Y., USA.

2. Voet, D. and Voet, J.G.(2004). Biochemistry, 3rd Edition, John Wiley & Sons, Inc. USA.

3. Price, N.C. and Stevens, L.(1996). Fundamentals of Enzymology, Oxford University Press Inc. N.Y.,

Practicals

1. Assay of acid phosphatase activity, specific activity from germinating mungbean seeds.
2. Linearity curve of enzyme.
3. Effect of substrate concentration on acid phosphatase activity and determination of its Km, Vmax and Ki (with respect to inorganic phosphate).
4. Effect of pH and temperature on enzyme activity.
5. Purification of enzyme.

BIOCHEM 302: Metabolism of Carbohydrates and Lipids

Carbohydrate Metabolism

1. **Introduction to Intermediary metabolism**: Auxotrophs , Heterotrophs, Anabolism and Catabolism.

2. **Glucose: central role in metabolism** of plants, Animals and microorganism .

3. **Glycolysis**, reactions of glycolysis . Fermentation: anaerobic fate of pyruvate, control of metabolic flux. Regulation of glycolytic pathway. Entry of Galactose , Mannose and fructose into glycolytic pathway .Substrate cycle and their physiological importance.

4. **TCA cycle**: Overveiw of TCA, Metabolic sources of Acetyl-Coenzyme A. Amphibolic nature, anaplerotic reactions. TCA Cycle inhibitors . Regulation, pyruvate dehydrogenase complex enzyme.

5. **Other pathways of carbohydrate metabolism** :Gluconeogenesis and its Regulation, Glyoxalate Cycle reactions,Pentose phosphate Pathway, Calvin Cycle, photorespiration,

6. **Carbohydrate synthesis**, Synthesis of starch, cellulose and peptidoglycan.

7. **Glycogen metabolism**, Synthesis and breakdown, glycogen synthetase and phosphoryllase and their regulation, Glycogen Storage diseases.

Lipid Metabolism

8. **Lipid digestion**, absorption and transport.

9. **Fatty acids Oxidation**, oxidation of saturated, unsaturated fattys in mitochondria , transport of fatty acids to mitochondria. α ώ .β Oxidation. Peroxisomal and glyoxisomal pathways of Fatty acids oxidations.

10. **Ketone Bodies** synthesis and degradation.

11. **Biosynthesis of lipids,** fatty acid synthesis in plants and animals and its regulation, Biosynthesis of triacylglycerols, Phospholipids, Cardiolipids, Glycolipids and sphingolipids.

12. **Arachidonate metabolism,** Prostaglandins, Prosta cyclins,Thrombaxanes and leukotrienes

13. **Starve Feed Cycle**

14. **Cholesterol metabolism in animals,** synthesis of cholesterol and steroid hormones; degradation to bile acids

Suggested Textbooks

1. Nelson, D.L. and Cox, M.M. (2005); Lehninger Principles of Biochemistry, 4th edition, W.H.Freeman and company, N.Y. USA.

2. Garret, R.H. and Grisham, C.M. (2005) Biochemistry, 3rd Edition. Thomson Learning INC.

3. Voet, D and Voet, J.G, (2009) Biochemistry, John Wiley and Sons, N.Y. USA.

Practicals

1. Estimation of blood glucose .
2. .Estimation of cholesterol
3. Sugar Fermentation in Microorganisms.
4. Isolation of Lecithin and its estimation.
5. Assay of salivary amylase.
6. Estimation of Glucose 6- P.

BIOCHEM 303: CELL BIOLOGY-I

THEORY

Unit 1. An Overview of Cells (Ch 1 Cooper *et al.*/ Ch 1 Karp)

Overview of prokaryotic and eukaryotic cells, cell size and shape, Phages, Viriods, Mycoplasma and *Escherichia coli*.

Unit 2. Tools and techniques of Cell Biology (Ch 1 Cooper *et al.*/ Ch 18 Karp/ Ch 3 De Robertis)

Microscopic-Principles of Light microscopy; Phase contrast microscopy; Confocal microscopy;Electron microscopy (EM)- scanning EM and scanning transmission EM (STEM); Fluorescence microscopy;

Analytical-Flow cytometry- flurochromes, fluorescent probe and working principle; Spectrophotometry; Mass spectrometry; X-ray diffraction analysis.

Separation-Sub-cellular fractionation- differential and density gradient centrifugation; Chromatography- paper, thin-layer, gel-filtration, ion-exchange, affinity and High-Performance Liquid Chromatography (HPLC).

Unit 3. Composition of Cells (Ch 2 Cooper *et al.*)

Molecules of cell, cell membranes and cell Proteins.

Unit 4. The Nucleus (Ch 9 Cooper *et al.*)

Nuclear Envelope- structure of nuclear pore complex, nuclear lamina, Transport across Nuclear Envelope, Chromatin: molecular organization, Nucleolus and rRNA Processing.

Unit 5. Protein Sorting and Transport (Ch 10 Cooper *et al.*)

The Endoplasmic reticulum, The Golgi Apparatus, Mechanism of Vesicular Transport, Lysosomes.

Unit 6. Mitochondria, Chloroplasts and Peroxisomes (Ch 11 Cooper *et al.*)

Structural organization, Function, Marker enzymes,Mitochondrial biogenesis, Protein import in mitochondria, Semiautonomous nature of mitochondria and chloroplast, chloroplast DNA, Peroxisomes'assembly

Unit 7. Cytoskelton and Cell Movement (Ch 12 Cooper *et al.*)

Structure and organization of actin filaments; actin, myosin and cell movement; intermediate filaments; microtubules.

PRACTICALS

1. Separation of nucleic acid bases by paper chromatography.
2. Microscopy- Theoretical knowledge of Light and Electron microscope.
3. Study of the following techniques through electron / photo micrographs: Fluorescence microscopy, autoradiography, positive staining, negative staining, freeze fracture, freeze etching, shadow casting.
4. Study of structure of cell organelles through electron micrographs.

Permanent slide preparation:

5. Cytochemical staining of DNA-Feulgen.
6. Cytochemical staining of DNA and RNA- Methyl Green Pyronin (MGP).
7. Cytochemical staining of Polysaccharides-Periodic Acid Schiff's (PAS).
8. Cytochemical staining of Total proteins- Bromophenol blue.
9. Cytochemical staining of Histones -Fast Green.

SUGGESTED BOOKS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

BIOCHEM 304: MOLECULAR BIOLOGY-I

THEORY

Unit 1. Nucleic Acids convey Genetic Information (Ch 2 Watson)

DNA as the carrier of genetic information, Key experiments establishing-The Central Dogma, DNA Double helix, Genetic code, Direction of Protein Synthesis, Genomics.

Unit 2. The Structures of DNA and RNA / Genetic Material \ (Ch 6 Watson/ Ch 18 Becker)

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves.

DNA topology - linking number, topoisomerases; Organization of DNA- Prokaryotes, Viruses, Eukaryotes.

RNA Structure

Organelle DNA -- mitochondria and chloroplast DNA.

Unit 3. Genome Structure, Chromatin and the Nucleosome (Ch 7 Watson/ Ch 18 Becker)

Genome Sequence and Chromosome Diversity, Chromosome Duplication and Segregation,

The Nucleosome

Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

Regulation of Chromatin Structure and Nucleosome Assembly.

Organization of Chromosomes

Unit 4. The Replication of DNA (Prokaryotes and Eukaryotes) (Ch 8 Watson/ Ch 19 Becker)

Chemistry of DNA synthesis, general principles - bidirectional replication, Semi-conservative, Semi discontinuous,RNA priming, Various models of DNA replication including rolling circle, D-loop (mitochondrial), Θ (theta) mode of replication, replication of linear ds-DNA, replicating the 5'end of linear chromosome. Enzyme involved in DNA replication – DNA polymerases, DNA ligase, Primase, Telomerase and other accessory proteins

Unit 5. The Mutability and Repair of DNA (Ch 9 Watson)

Replication Errors, DNA Damage and their repair.

PRACTICALS

1. Preparation of Polytene chromosome from *Chironomous* larva/*Drosophila* larva
2. Demonstration of mammalian sex chromatin.
3. Preparations of temporary mount and study the different stages of Mitosis (Onion root tip).
4. Perform Southern Blot Hybridization (Restrict DNA for Southern Blot electrophoresis, perform electrophoresis of restricted DNA, perform southern transfer, hybridization and detection of gene of interest)
5. Demonstration of Northern Blotting.
6. Demonstration of Western Blotting.
7. Perform DNA amplification by PCR.
8. Study of semiconservative replication of DNA through micrographs/schematic representations.

SUGGESTED BOOKS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

BIOCHEM 401: Bioenergetics

1. **Principles of chemical thermodynamics:**Free energy, enthalpy and entropy. Equilibrium steady ribution and role in cellular metabolism, ATP cycle. Energy charge of the cell, phosphorylation potential, proton motive force, concept of high energy bond. Chemical basis of high standard free energy of hydrolysis of ATP and other phosphorylated compounds and Thioesters. Secondary functions of proton gradient: Thermo genesis and trans hydrogenation of NAD and NADP

2. **Biological oxidation and reduction:** Redox reactions, reduction potentials standard reduction potentials. Nernst equation. Universal electron carriers (NAD^+, $NADP^+$ and FAD, flavoproteins).

3. **Mitochondria and Oxidative phosphorylation:**Structure and organization, mitochondrial electron carriers: Ubiquinone, cytochromes and iron sulfur proteins, determination of sequences of electron carriers. position and function of the four complexes of ETC, glycerophosphate shuttle, Redox loops, Q-cycle, proton motive force, the electrochemical potential gradient, thermodynamics of phosphorylation, inhibitors. Mitchells chemiosmotic hypothesis and experimental evidences. Generation of ROS and antioxidant mechanism. Metabolite transporters in mitochondria: ADP-ATP translocase, malate aspartate shuttle and phosphate carrier. ATP Synthase: Subunit structure, F0-F1 rotor stator model, Binding change mechanism of ATP synthesis. Uncouplers, Thermogenesis. Regulation of oxidative phosphorylation, Respiratory control (P/O ratio).

4. **Photophosphorylation:**General features of photophosphorylation, historical background, Hills reaction Hills reagents, photosynthetic pigments, light absorption by various photosynthetic pigments. Light harvesting systems of plants and microbes, Oxygenic and non-oxygenic photosynthesis.**Bacterial photophosphorylation**: Structure and function of bacterial photochemical reaction centers (purple bacteria and green-sulfur bacteria, Halobacterium salinarum).**Photophosphorylation in plants**: Structure of chloroplast, Molecular architecture of Photosystem I and Photosystem II, Z-scheme of photosynthetic electron flow, oxygen evolving complex. Action of Herbicides. ATP synthesis by photophosphorylation, chloroplast, ATP Synthase. Cyclic photophosphorylation and its significance. Thermodynamics and quatum yield of cyclic and non-cyclic photophosphorylation Regulation of photo-phosphorylation. Evolution of mitochondria and chloroplast.

5. **Bioluminescence**. Phenomenon and its biological significance. Applications of Bioluminescence: ATP estimation, GFP as marker protein or gene, biolighting.

Suggested Textbooks

1. Nelson, D.L. and Cox, M.M. (2005); Lehninger Principles of Biochemistry, fourth edition, W.H.Freeman and company, N.Y. USA.

2. Voet, D and Voet, J.G, (2009) Biochemistry, John Wiley and Sons, N.Y. USA.

3. Garret, R.H. and Grisham, C.M. (2005) Biochemistry 3rd edition, Thomson Learning INC.

Practicals

1. Isolation of Mitochondria from rat liver.
2. Effect of inhibitors and uncouplers on ATP synthesis.
3. Isolation of chloroplasts from spinach leaves.
4. Evolution of oxygen by isolated chloroplast.
5. Separation of photosynthetic pigments
6. Activity of PS I and PS II.

BIOCHEM 402: Metabolism of Aminoacids and nucleotides

1. **Nitrogen Cycle:** Overview; assimilation of inorganic nitrogen in biomolecules.

2. **Nitrogen Balance:** Positive and negative nitrogen balance, protein quality: complete and incomplete proteins, criteria to assess protein quality, protein calorie malnutrition, Kwashiorkor and Marasmus.

3. **Outlines of Amino Acids metabolism:** Digestion, absorption and uptake of Amino Acids including γ-glutamyl cycle; Transamination, role of PLP, oxidative and non-oxidative deamination, glucose-alanine cycle, urea cycle and inherited defects of urea cycle, Krebs's bicycle

4. **Degradation of the carbon skeleton:** Glucogenic and ketogenic amino acids, catabolic pathways for the 20 standard amino acids; Metabolism of one-carbon units

5. **Biosynthesis of Amino Acids:** Biosynthesis of non-essential amino acids; biosynthesis of Essential amino acids (Only overview-in plants) and their regulation.

6. **Disorders of amino acid metabolism:** Phenylketonuria, Alkaptonuria, Maple syrup urine disease, Methylmalonic aciduria, Parkinson's disease, Homocystinuria, and Hartnup's disease

7. **Precursor function of Amino acids:** Biosynthesis of Creatine, Creatine phosphate and creatinine; Creatine- Creatine phosphate energy shuttle; polyamines (putresine, spermine, spermidine,); catecholamines (dopamine, epinephrine, nor-epinephrine); and neurotransmitters such as serotonin, GABA; porphyrin biosynthesis and disorders of porphyrin metabolism.

8. **Biosynthesis of purine nucleotides:** Biosynthesis of IMP; pathways from IMP to AMP and GMP; conversion to triphosphates; regulation of purine nucleotide biosynthesis, salvage pathways; synthesis of coenzymes (NAD^+, FMN, FAD, HSCoA)

9. **Biosynthesis of pyrimidine nucleotides:** Biosynthesis of UMP, conversion of triphosphate and regulation of Biosynthesis of pyrimidine nucleotide synthesis;

10. **Deoxy ribonucleotides and synthesis of dTTP**; inhibitors of nucleotide metabolism and their use as anti bacterial / anticancer drugs

11. **Degradation of purine and pyrimidine nucleotides**.

12. **Disorders of nucleotide metabolism**: Lesch Nyhan syndrome, Gout, SCID, Adenosine deaminase deficiency

Suggested Textbooks

1. Cox, M.M. and Nelson, D.L.(2008). Lehninger Principles of Biochemistry, W.H. Freeman and Company, New York, USA

2. Voet, D. and Voet, J.G.(2004). Biochemistry, John Wiley and Sons. INC.

3. Devlin, T.M.(2002)Textbook of Biochemistry with clinical correlations, John Wiley and sons, INC.

4. Bowsher, C, Steer, M. and Tobin, A (2008). Plant Biochemistry, Garland science, Taylor and Francis Group, LLC.

Practicals

1. Assay of serum transaminases.

2. Aminoacid metabolism in Bacteria

3. Estimation of Urea.

4. Estimation of Uric acid.

5. Estimation of Creatinine.

BIOCHEM 403: CELL BIOLOGY-II

1. THEORY

Unit 1. The Plasma Membrane (Ch 13 Cooper *et al.*)

Structure; Transport of small molecules, Endocytosis

Unit 2. Cell Wall, the Extracellular Matrix and Cell Interactions (Ch 14 Cooper *et al.*)

Bacterial and Eukaryotic Cell Wall; the extracellular matrix and cell matrix interactions; cell-cell interactions.

Unit 3. Cell Signaling (Ch 15 Cooper *et al.*)

Signaling molecules and their receptor; functions of cell surface receptors; Intracellular signal transduction pathway; signaling networks.

Unit 4. The Cell Cycle (Ch 16 Cooper *et al.*)

Eukaryotic Cell Cycle, Regulation of Cell cycle progression, Events of Mitotic Phase, Meiosis and Fertilization.

Unit 5. Cell Death and Cell Renewal (Ch 17 Cooper *et al.*)

Programmed Cell Death, Stem Cells and Maintenance of adult tissues, Embryonic Stem Cells and Therapeutic cloning.

Unit 6. Cancer (Ch 18 Cooper *et al.*)

Development and Causes of Cancer, Tumor Viruses, Oncogenes, Tumor Suppressor genes, Cancer Treatment- molecular approach.

PRACTICALS

1. To demonstrate the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B.
2. Study of polyploidy in Onion root tip by colchicine treatment.
3. Preparations of temporary mount of Grasshopper testis / onion flower bud anthers and study the different stages of Meiosis.
4. Study of mitosis and meiosis from permanent slides.
5. Identification and study of cancer cells- Slides/Photomicrographs.

SUGGESTED BOOKS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

BIOCHEM 404: MOLECULAR BIOLOGY-II

1. THEORY

Unit 1. Mechanism of Transcription (Ch 12 Watson/ Ch 21 Becker)
RNA Polymerase and the transcription unit
Transcription in Prokaryotes
Transcription in Eukaryotes

Unit 2. RNA Modifications (Ch 13 Watson)
Split genes, concept of introns and exons, removal of Introns, spliceosome machinery, splicing pathways, alternative splicing, exon shuffling, RNA editing, and mRNA transport.

Unit 3. Translation (Prokaryotes and Eukaryotes) (Ch 14 Watson/ Ch 22 Becker/ Ch 21 DeRobertis)
Assembly line of polypeptide synthesis - ribosome structure and assembly, various steps in protein synthesis. Charging of tRNA, aminoacyl tRNA synthetases. Proteins involved in initiation, elongation and termination of polypeptides. Fidelity of translation. Inhibitors of protein synthesis.
Regulation of translation
Translation-dependent regulation of mRNA and Protein Stability.

Unit 4. Transcription Regulation in Prokaryotes (Ch 16 Watson)
Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons

Unit 5. Transcription Regulation in Eukaryotes (Ch 17 Watson)
Conserved mechanism of regulation, Eukaryotic activators, Signal integration, combinatorial control, transcriptional repressors, signal transduction and control of transcriptional regulator, Gene Silencing

Unit 6. Regulatory RNAs (Ch 18 Watson)
Riboswitches, RNA interference, miRNA, siRNA, Regulatory RNA and X-inactivation

PRACTICALS

1. Preparation of culture medium (LB) for *E.coli (both solid and liquid)* and raise culture of *E.coli*.
2. Demonstration of antibiotic resistance. (Culture of *E.coli* containing plasmid (pUC 18/19) in LB medium with/without antibiotic pressure and interpretation of results).
3. Isolation and quantitative estimation of salmon sperm / calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement).
4. To perform Ames test in *Salmonella / E.coli* to study mutagenicity.

SUGGESTED BOOKS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

BIOCHEM 501: Membrane Biology

1. **Introduction**: A historical perspective of different models of membranes , their characteristics with experimental basis of the model (Langmuir trough experiment, freeze fracture technique, X- ray diffraction).

2. **Composition of Biomembranes** : Lipids, proteins(Integral, peripheral& lipid anchored) & Carbohydrates. Hydropathy plots & membrane Topology . Composition variation between membranes (Prokaryotic / Eukaryotic / neuronal, Membranes / Sub cellular compartments).

3. **Model Membrane Systems** : Monolayers, Planar bilayer & Liposomes (synthesis and drug targeting tool) . Isolation & purification of membrane and membrane proteins, use of detergents, density gradient centrifugation etc., Criteria of membrane purification & enzyme markers.

4. **Membrane Structures**: Polymorphic structures of amphiphilic molecules(soaps, detergents ,lipids) in aqueous solutions : Micelles & Bilayers. Thermodynamic forces and other factors affecting the formation of different structures. Critical packing parameter.

5. **Asymmetry in Membranes:** Lipid and Protein Lateral and Transverse Asymmetry. Macro and micro domains in membranes, Specialized features of plasma membrane : Lipid rafts, Caveolae, Tight Junctions. Membrane Skeleton : Role in maintaining cell structure, and membrane asymmetry. Gates and fences model. RBC membrane as a model.

6. **Membrane Dynamics:** Lateral diffusion, Transverse / Flip Flop diffusion & rotational motion of lipids and proteins. Techniques used to study different motion of molecules in membranes: FRAP, FRET. Translational diffusion coefficient. Phase Transition studies of lipid bilayer. Transition temperature. Membrane fluidity. Factors affecting membrane fluidity : Composition, Temperature, salt /water stress, Anesthetics, Age, pH, Nutrition etc. Homeoviscous adaptation. Membrane fusion.

7. **Membrane transport:** Study of different transport systems ; their structure, thermodynamics (free energy change involved, electro chemical potential, membrane potential , Nerst equation) , kinetics regulators, Inhibitors / blockers biochemical function and significance. Simple diffusion , Facilitated diffusion : Passive transport (Glucose transporter , anion transporter) ; Active transport (P type ATPases V type ATPases , F type ATPases , Na^+ / H^+ symport systems) . ABC family of transporters (MDR ATPase family, CFTR). Transport processes driven by light (Bacteriorhodopsin, halorhodopsin). Group translocation. Specialized membrane Pores : Porins in Gram –ve bacterial membranes (E.coli OmpF, OmpC, LamB) , Pore forming toxins (colicins ,α hemolysin, anthrax toxin protective antigen) and Aquaporins. Ion channels : Voltage gated ion channels (Na^+ / K^+ voltage gated ion channel) , Ligand gated ion channels (Acetyl choline / IP_3 / cGMP gated ion channel) , Leaky channels. Role of ion channels in nerve transmission & action potential propagation. Neurotransmitters : Acetyl choline, glutamate, & glycine (Metabolism ,&

signaling with type of receptors). Ionophores : Carriers and channel forming (valinomycin , gramicidin).

Suggested Textbooks

1. Nelson, D.L. and Cox, M. M.(2005). Lehninger Principles of Biochemistry, W.H. Freeman & Com.
2. Voet, D. and Voet, J.G.(2004) Biochemistry, John Wiley & Sons,Inc.
3. Darnell, J.,Lodish, H. and Baltimore, D.(2008). Molecular Cell Biology, Scientific American Books.

Practicals

1. RBC ghost cell preparation and separation of proteins by SDS PAGE
2. CMC of detergent and phospholipids.
3. Intestinal mobility of Histidine
4. Effect of detergents and other membrane active substances on Erythrocytes.

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BIOCHEM 502: Hormone Biochemistry

1. **Introduction** - History, endocrine glands, hormones as chemical messengers, stimulus for hormone release: change in homeostasis , sensory stimulus and others.

2. **Cell signaling & Mechanism of Hormone action :** Receptor study , Binding affinity, specificity, Scatchard plot and purification. G protein linked receptor family ; Signal transduction pathways involving G- proteins , Adenyl cyclases, Ca^{2+} , Phosphoinositides, PI-3 Kinase, DAG, cAMP, cGMP, NO , Protein kinases (A,B,C,G), Phosphoprotein phosphatases & Phosphodiesterases. Receptor tyrosine kinase family- EGF receptor family, Insulin receptor family, & Cytokine/erythropoietin receptor family associated with non receptor Tyrosine kinase (Signal transduction pathways involving : SH2 proteins, ras, IRS-1 , Raf, MEK, MAP kinase, JAK-STAT pathway).

3. **Intra-cellular Receptors** - Steroid hormone receptors, Thyroid hormone receptors.Sensitisation & Desensitization of receptors; Short term regulation & Long term regulation. Drugs and Toxins affecting cell signaling : Cholera toxin, pertussis toxin, anthrax toxin, Bubonic Plague virulence, Forskolin, theophyllin, Phorbol esters, Seldenafil (Viagra).

4. **Hormones-** Structures, Receptor type, Regulation of biosynthesis and release (including feed back mechanism). Physiological and Biochemical actions, & Pathophysiology (hyper & hypo secretion).

5. **Hypothalmic Hormones**: CRH, TRH, GnRH, PRL/PRIH, GHRH/GHRIH.

6. **Pituitary Hormones -** Anterior Pituitary hormones- Growth hormone, Prolactin, POMC peptide family, LH, FSH, TSH; Posterior Pituitary : Vasopressin, Oxytocin.

7. **Endocrine disorders** : Gigantism, Acromegaly, dwarfs, pigmies; Pathophysiology: Diabetes insipidus. Thyroid Hormone (include biosynthesis) Goiter, Graves disease, Cretinism, Myxedema, Hashimoto's disease.

8. **Hormones regulating Ca^{2+} Homeostasis**: PTH, Vit D, Calcitonin .
   Pathophysiology : Rickets, Osteomalacia, Osteoporosis.

9. **Pancreatic Hormones:** Insulin, Glucagon, Diabetes type I & II .

10. **GI tract Hormones :** Gastrin , Secretin, CCK, GIP, Ghrelin.

11. **Hormones of Adrenal Cortex**: Aldosterone (renin angiotensin system)& cortisol. Pathophysiology: Addisons disease, Conn's syndrome, Cushings syndrome. Hormones of Adrenal Medulla, Epinephrine & norepinephrine.

12. **Reproductive Hormones**: Male & female Sex hormones. Interplay of hormones during Reproductive cycle, Pregnancy, Parturition, & Lactation. Oral Contraception.

13. **Other organs with endocrine function**: Heart (ANP), Kidney(erythropoietin), Liver(Angiotensinogen, IGF-1), Adipose tissue(Leptin, adiponectin). Pathophysiology : Obesity. Growth factors: PDGF, EGF, IGF-I,II , & NGF.

Suggested Textbooks

1. Nelson, D.L. and Cox, M.M.(2005). Lehninger Principles of Biochemistry, W.H. Freeman & Com

2. Widmaier, E.P.,Raff, H. and Strang, K.T.(2008).Vander,Sherman,Luciano's Human Physiology, McGraw- Hill Higher Education.

3. Darnell, J.,Lodish, H. and Baltimore, D.(2008). Molecular Cell Biology, Scientific American Books.

Practicals

1. Lipid profile-TAG, Lipoproteins, Cholesterol
2. Glucose tolerance test
3. Vitamin D assay
4. Assay of estrogen
5. T3/T4 assay by ELISA
6. Estimation of Calcium.

BIOCHEM 503: Immunology I

1. **Introduction**: Historical Perspective; early studies on humoral and cellular immunity.

2. **Cells and organs of the immune system**: cells of the immune system; hematopoiesis; HSC; hematopoietins and the role of stromal cells in blood cell formation; key characteristics, distribution and function(s) of lymphoid and myeloid cells; CD nomenclature; structure and function of primary and secondary lymphoid tissues and organs; lymphatic circulation.

3. **Innate immunity**: Non- immunological barriers; cells and soluble mediators of innate immunity; pattern recognition receptors (PRR)-soluble and cell surface and pathogen associated molecular patterns (PAMPS); induced innate response and acute phase proteins; acute inflammatory response; role of cell adhesion molecules, cytokines and chemokines in recruiting cells. Complement system, biological consequences of activation and complement regulatory proteins.

4. **Adaptive immunity**: salient features; clonal selection theory; collaboration between adaptive and innate immunity.

B-Cell Biology

(i) **Antibody structure**: structure of IgG, IgM, IgA, IgD & IgE; structure of the B-cell receptor (BCR) and co-receptor; immunoglobulin (Ig) fold and Ig super family; isotype, allotype and idiotype; characteristics of B-cell epitopes; epitope- paratope interactions; distribution and effector functions of Ig and cells expressing Fc- receptors.

(ii) **B-cell development**: Antigen-independent phase of B-cell development; characteristics of the major stages of maturation & important cell surface changes; B-1 and B-2 cells; and generation of central tolerance.

(iii) **Receptor diversity**: Dreyer- Bennett model for the structure of Ig and its experimental demonstration; organization of Ig genes- kappa, lambda and heavy chain multi-gene families; mechanism of DNA rearrangement and the role of RAG recombinase, Tdt and DNA repair enzymes; immunoglobulin diversification mechanisms.

(iv) **Humoral response**: Initiation in peripheral lymphoid organs and tissues; signals required for the activation of naïve B-cells; T-dependent proliferation, maturation, somatic hyper-mutation, class switching & the formation of plasma and memory cells; role of activation induced deaminase (AID); peripheral tolerance; T-independent B-response; requirements for immunogenicity; haptens carriers and adjuvant.

T-Cell Biology

T-cell development; structure of T-cell receptor (TCR) - αβ and γδ and co-receptors; positive and negative selection in the thymus; other mechanisms of tolerance induction; MHC restriction; MHC locus; structure, function and distribution of MHC glycoproteins; non-classical MHC proteins; characteristics of professional antigen presenting cells; pathways of antigen processing and presentation; T cell epitopes and cell mediated immune responses by different T-cell sub populations.

5. **Mucosal immune system**: organization and distinctive features; lymphocytes populations and their role; mucosal response to infection, regulation of the immune responses; oral tolerance.

Recommended textbooks

1. Kindt, T.J.,Goldsby, R.A. and Osborne, B.A.(2007). Kuby Immunology, W.H. Freeman and Co, New York.

2. Murphy, K.,Travers, P. and Walport, M.(2008). Janeway's Immunobiology, Garland Science, Taylor and Francis Group, LLC.

Practicals

1 To isolate peripheral blood mononuclear cells (PBMC) from whole blood

2 . Preparation of single cell suspension from spleen.

3. Viability and cell counting of peritoneal macrophages

4. Isolation of a IgG,IgA,IgM antibody using Ion Exchange chromatography.

5. Antibody-antigen reactions in gels-DID,SRID and immunoelectrophoresis.

6. Phagocytic activity of Macrophages.

7. Dissection of animal to visualize lymphoid system.

BIOCHEM 504: GENETICS AND GENOMICS-I

1. THEORY

Unit 1. Introduction to Genetics (Ch 1 Klug and Cummings)

Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information.

Unit 2. Mitosis and Meiosis (Ch 2 Klug and Cummings)

Interrelation between the cell structure and the genetics function, Mitosis, Meiosis (explaining Mendel's ratios).

Unit 3. Mendelian Genetics and its Extension (Ch 3-4 Klug and Cummings)

Principles of Inheritance, Chromosome theory of inheritance, Laws of Probability, Pedigree analysis Incomplete and codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked inheritance.

Unit 4. Linkage, Crossing Over and Chromosomal Mapping (Ch 5 Klug and Cummings, Ch 7, Gardner)

Linkage and crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics – an alternative approach to gene mapping.

Unit 5. Mutations (Ch 8 Klug and Cummings/ Ch 11 Gardner)

Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations, Molecular basis of Mutations in relation to UV light and chemical mutagens, Detection of mutations: CLB method, Attached X method, DNA repair mechanisms.

Unit 6. Sex Determination (Ch 7 Klug and Cummings)

Chromosomal mechanisms, Environmental factors determining sex determination, Barr bodies, Dosage compensation.

Unit 7. Extrachromosomal Inheritance (Ch 9 Klug and Cummings/ Ch 20 Gardner)

Chloroplast mutation/Variegation in Four o' clock plant and *Chlymodomonas,* Mitochondrial mutations in *Neurospora* and yeast, Maternal effects, Infective heredity-Kappa particles in *Paramecium.*

Unit 8. Quantitative Genetics (Ch 25 Klug and Cummings/ Ch 21, Gardner)

Quantitative and multifactor inheritance, Transgressive variations, Heterosis.

PRACTICALS

1. Mendelian laws and gene interaction using *Drosophila* crosses.
2. Chi-square and probability.
3. Study of Linkage, recombination, gene mapping using marker based data from *Drosophila*.
4. Study of Human and *Phlox/ Allium* Karyotype (normal and abnormal).
5. Pedigree analysis of some human inherited traits.
6. Study of Hardy-Weinberg Law using simulations (seeds).

SUGGESTED BOOKS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). VIII ed. Principles of Genetics. Wiley India.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. XI Edition. Benjamin Cummings.
4. Russell, P. J. (2009). *i*Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
6. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.
7. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis.

ADDITIONAL READINGS

Both students as well as teachers of genetics can further benefit from knowledge of following topics as given below-

- **Epigenetics-** http://www.nature.com/nrg/focus/epigenetics/index.html
- **Tetrad Analysis in fungi**
- **Centromere Mapping**
- **Cytogenetic Mapping**

BIOCHEM 601: Molecular Physiology

1. **The body fluid compartments:** Intracellular, extracellular and interstitial fluid. Plasma as an extracellular fluid;plasma composition; plasma proteins; Blood cellular components; RBC; Hemostasis and molecular mechanism of Blood coagulation; Role of Vitamin K in coagulation; Anti coagulant and fibrinolytic systems. Anemias, Polycythemia, Haemophilia and Thrombosis.

2. **The cardio vascular system:** Anatomy of heart; Physiology of the cardiac muscle; automacity of the cardiac muscle; Excitation contraction coupling; relationship between cardiac cycle, heart sound ventricular volumes and the ECG; Control of cardiac function and output.Physics of blood pressure, flow and resistance; the arterial system; the venous system; the microcirculation and mechanics of capillary fluid exchange; Control of blood flow to the tissues; Portal circulations.Arterial pressure and its regulation Hypertension,Congestive heart disease, atherosclerosis and Myocardial infarction.

3. **Renal physiology:** Anatomy of the kidney and the nephron; Regulation of renal blood flow; Cell biology of the Bowmans capsule; physiology of glomerular filtration; GFR ; Tubular processing of the glomerular filtrate; Renal clearance; Assessment of kidney function. Regulation of urine volume and pH**.**Regulation of ECF electrolyte and water content,blood volume and long term blood pressure. Micturition reflex and voluntary control of micturition. Glomerular nephritis, renal failure, definition and use of dialysis and diuretics.

4. **Respiration:** Organization of the pulmonary system; Mechanism of respiration; Pulmonary ventilation and related volumes; Pulmonary circulation. Principles of Gas exchange and transport; Regulation of respiration; Pulmonary edema and regulation of pleural fluid. Blood buffer systems, renal and pulmonary control of blood pH; Acidosis and Alkalosis. Hypoxia,hypercapnea, pulmonary distress, emphesema.

5. **Gastrointestinal and hepatic physiology:** Histology of the gastrointe stinal tract; Propulsion and motility of food and digested material; Enteric reflexes; Secretory functions of the gastrointestinal tract; Digestion and absorption of macro and micronutrients.Peptic ulcer, Sprue, celiac disease, regurgitation, diarrhoea and constipation. Anatomy of the hepatic lobule; blood flow into the liver; Formation and secretion of bile; enterohepatic cycle; reticuloendothelial system; Metabolic importance of liver; Liver function tests. Jaundice and Liver cirrhosis.

6. **Musculosketetal system :** Bone structure and formation. Physiology of muscle contraction in striated and nonstriated muscle.

7. **Reproductive physiology:** Sex determination; development of female and male genital tracts; Spermatogenisis; capacitation of sperm; testis blood barrier; Physiology of female reproductive of placenta; the feto placental unit.

8. **Neurophysiology:** Organization of the central nervous system; cells of the nervous system and anatomy and physiology of Blood Brain Barrier. Introduction to neural networks: central, autonomic and peripheral; the sensory and motor tracts;

mechanism and importance of myelination. Sensory perception of Pain, temperature, touch and vision; Physiology of reflex action; The motor cortex; corticospinal tracts. Basic physiology and biochemistry of Learning and Memory

Suggested Textbooks

1. Widmaler, E.P, Raff.H, Strang,K.T. (2008) Vander's Human Physiology 11th edition, McGraw Hill International Publications.
2. Fox, S.I. (2002)Human Physiology 7th edition, McGraw Hill Publications.

Practicals

1. Separation of isoenzymes of LDH by electrophoresis
2. Liver function test
3. Creatine kinase for muscular function
4. Kidney function test
5. Estimation of Iron,Hb,Met Hb and Tranferrin Binding Protein
6. Complement fixation test.
7. Clotting time.

BIOCHEM 602: Recombinant DNA Technology.

1. **Concept and emergence of r-DNA technology** : Basic techniques involved in rDNA technology. Restriction Enzymes, DNA methylation systems in E.coli, other enzymes used in cloning (DNA polymerases, RNA Polymerases, Reverse Transcriptase, Ligases, Taq polymerase etc.) Cloning vectors – Plasmids, λ bacteriophage based, M13 phage based, phagemids. High capacity vectors: Cosmids, yeast artificial chromosomes, bacterial artificial chromosomes, Covalent linkage of DNA fragments to vector molecules: Linkers, Adapters, homopolymer tailing. Generation of genomic and cDNA libraries (different methods of cDNA synthesis), Solid phase synthesis of DNA

2. **Nucleic acid blotting**: Southern, Northern, Western, dot and slot blot.

3. **Selection and screening of recombinant clones**: Probe preparation (radiolabelled and non radiolabelled) via nick translation, random priming etc. Guessmers and degenerate probes. Sequence dependent and independent screening, southern-western, colony and plaque hybridization, in situ chromosomal hybridization, chromosome walking, etc.).

4. **Expression of cloned DNA** : Expression vectors (lac promoter, tryptophan promoter, Lambda cI promoter, arabinose promoter based) optimization of protein expression in heterologous systems(using upstream and downstream signals) Fusion proteins, In vitro translation systems. RNAi vectors.

5. **DNA transactions in Microorganisms:** Cloning DNA/RNA in bacteria (Transformation, transduction and conjugation), methods of gene transfer into yeast (YIp, YEp, YCp, YRp, shuttle vectors) fungi, plant and animal host systems.

6. **Characterization of cloned DNA** : Restriction mapping. DNA sequencing (dideoxy chain termination, chemical degradation, shotgun sequencing, contig assembly and pyrosequencing etc.) Polymerase Chain Reaction, VNTRs, DNA fingerprinting, SNPs, RFLPs.

7. **Modification of cloned DNA** : Site directed mutagenesis, Protein engineering.

8. **Comparative genomics:** analysis and comparison of size and complexity of genomes RNA level –expression profiling with microarrays, MPSS, Chromatin immunoprecipitation, protein level -yeast two hybrid system, yeast surface display, phage display loss of function Knock out ,knock down, antisense RNA and RNA i,

9. **Human Genome Project :** Progress, goals and issues

10. **Applications of recombinant DNA technology:** Production of recombinant proteins in bacterial and eukaryotic cells – Recombinant insulin, growth hormone, factor VIII, recombinant vaccines etc. Identification of genes responsible for human diseases, diagnostics, gene therapy. Genetically modified plants. Ethical, legal and social issues.

Suggested Textbooks

1. Glick, B.R. and Pasternak, J.J. (2003) Molecular Biotechnology: Principles and applications of recombinant DNA technology. Asm Press,Washington, USA.
2. Primrose, S.B. and Twyman. R.M. Principles of gene manipulation and genomics. Blackwell Publishing , MA, USA.
3. Sambrook, J. and Russell, D. (2001) Molecular cloning : a laboratory manual , 3rd Edition. Cold Spring Harbor Laboratory Press, New York .

Practicals

1. Isolation of Plasmid DNA
2. Restriction enzyme digestion of plasmid DNA and size estimation of fragments.
3. Preparation of competent cells and transformation.
4. Designing of primers for any selected genes.
5. Demonstration of PCR technique.

BIOCHEM 603: Immunology II

1. **Techniques based on antigen- antibody interactions** inhibition; ELISA and variations of the basic technique; radioimmnoasay, RAST and RIST; complement fixation test; western blotting, immunoprecipitation and immunofluorescence; Hybridoma technology and their application.

2. **Hypersensitivity**: Gell and Coombs classification; representative examples of type I, II, III and IV hypersensitive reactions against innocuous antigens, auto antigens (wherever applicable) and potentially harmful antigens.

3. **Autoimmunity**: Organ specific and systemic autoimmune diseases; animal models for autoimmune disease; mechanisms for the induction of autoimmunity and treatment.

4. **Immunodeficiency**: primary (humoral and cell mediated) and secondary immunodeficiency; treatment.

5. **Immune response against major classes of pathogens**: bacteria (extracellular and intracellular); viruses (influenza); protozoan's (Plasmodium) and parasitic worms (helminthes); reemergence of some infectious diseases; **e**vasion and subversion of immune defenses: antigenic variation; immunosuppression; inappropriate immune responses; blocking antigen processing and presentation etc.

6. **Transplantation immunology**: typing of tissues; characteristics of graft rejection; major and minor histocompatability antigens; alloreactivity of T cells; immunosuppressive therapy; Graft Vs host disease (GVHD) and privileged sites.

7. **Tumor immunology**: Introduction to malignant transformation of cells; tumor antigens; immune response against tumors; tumor evasion of immune system and cancer immunotherapy.

8. **Immunomodulation**

   (i) Immunosuppressive drugs: corticosteroids, cytotoxic drugs; cyclosporine and rapamycin.

   (ii) Vaccines: types of vaccines-live attenuated, inactivated organisms, toxoids, subunit vaccines, DNA vaccines and recombinant vector vaccines; requirements for an effective vaccine and recommended childhood vaccination schedules in India.

   (iii) Cytokines

Suggested Textbooks:

1. Kindt, T.J., Goldsby, R.A. and Osborne, B.A. (2007). Kuby Immunology, W.H. Freeman and Co, New York.

2. Murphy, K, Travers, P. and Walport, M. (2008). Janeway's Immunobiology, Garland Science, Taylor and Francis Group, LLC

Practicals

1. SDS electrophoresis and Western Blotting

2. Enzyme-linked Immunosorbent assay (ELISA)

3. Dot Blot

4. Cytotoxic Assay-LDH

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BIOCHEM 604: GENETICS AND GENOMICS II

THEORY

Unit 1. Genetic Analysis and Mapping in Bacteria and Bacteriophages (Ch 6, Klug and Cummings/ Ch 5, Griffith *et al.*)

Conjugation; Transformation; Transduction, Recombination.

Unit 2. Genome Dynamics-Transposable genetic elements, Eukaryotic Viruses (Ch 22, Klug and Cummings/ Ch 14, Griffith *et al.*)

Prokaryotic transposable elements- IS elements, Composite transposons, Tn-3 elements; Eukaryotic transposable elements- Ac-Ds system in maize and P elements in *Drosophila*; Uses of transposons; Eukaryotic Viruses.

Unit 3. Developmental Genetics and Model System (Ch 19, Klug and Cummings*)*

Study of model systems in developmental genetics- *Drosophila melanogaster Sachharomyces cerevisiae, Caenorhabditis elegans, Arabidopsis thaliana,* and *Xenopus laevis*.

Unit 4. Genomics, Bioinformatics and Proteomics (Ch 21, Klug and Cummings/Ch 8-9, Russell/ Ch2, 3, 4 Ghosh, Z. and Mallick,V.)

Genomes of bacteria, *Drosophila* and Humans*;* Human genome project; Evolution and Comparative Genomics.

Introduction to Bioinformatics, Gene and protein databases; Sequence similarity and alignment; Gene feature identification.

Gene Annotation and analysis of transcription and translation; Post-translational analysis- Protein interaction.

Unit 5. Genomic Analysis- Dissection of Gene Function (Ch 23, Klug and Cummings)

Genetic analysis using mutations, forward genetics, genomics, reverse genetics, RNAi, functional genomics and system biology.

Unit 6. Population Genetics (Ch 27, Klug and Cummings)

Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift.

Unit 7. Evolutionary Genetics (Ch 28, Klug and Cummings)

Genetic variation and Speciation.

PRACTICALS

1. Genomic DNA isolation from *E.coli* (without plasmid*)*.
2. Restriction enzyme digestion of genomic DNA from *E.coli*.
3. Isolation of plasmid DNA and genomic DNA together from *E.coli*. and restriction enzyme digestion.
4. Restriction enzyme digestion (*Eco*RI) of genomic and plasmid DNA (obtained from Expt.3).
5. Estimation of size of a DNA fragment after electrophoresis using DNA markers.
6. Construction of Restriction digestion maps from data provided.
7. Demonstration of DNA fingerprinting.

SUGGESTED BOOKS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). *i*Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
6. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.
7. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis.
8. Ghosh, Z. and Mallick,V. (2008). Bioinformatics-Principles and Applications. Oxford Univ. Press