UNIVERSITY OF DELHI

SCHEME OF EXAMINATION

AND

COURSE OF READING

FOR

B.Sc. (Hons.) Biochemistry

Part I Examination 2001

Part II Examination 2002

Part III Examination 2003

Syllabus application for the Students seeking Admission to B.Sc. (Hons.) Biochemistry Course in the Academic year 2000-2001

DEPARTMENT OF BIOCHEMISTRY

UNIVERSITY OF DELHI

B.Sc. (Hons) Biochemistry

(Scheme of Examination)

Proposed scheme for B.Sc. (Hons) Biochemistry

1. The duration of the course will be three years.
2. There will be five theory papers in each year and each theory paper will carry 80 marks.
3. There will be 2 practical examinations each year. In first and 2nd year, practical examinations will carry 75 marks each. However, in the Illrd year, practical examinations will carry 100 marks each (25% and 15% marks in practical examinations will be reserved for internal assessment and viva-voce, respectively). Thus, total marks during the 3 years duration will be 1200 for theory examinations and 500 for practical examinations.
4. The minimum pass marks for theory and practical examinations will be 40%.

THEORY
1st year

	Examination	**Duration Hrs**	**Maximum Marks**	**TP**
				02
Paper I	Physical Chemistry	3	**80**	
Paper II	Inorganic & organic chemistry	3	**80**	
Paper III	Physics	3	**80**	
Paper IV	Mathematics and Statistics	3	**80**	
Paper V	Introduction to Biology and Chemistry of Biologically Important molecules	3	**80**	

llnd year

Paper VI	Biochemical Biophysical Techniques	3	80
Paper VII	Proteins, Enzymes and Co-enzymes	3	80
Paper VIII	Human Physiology and Endocrinology	3	80
Paper IX	Metabolism of carbohydrates and lipids	3	80
Paper X	Metabolism of Amino acids, Nucleotides and porphyrins	3	80

Illrd year

Paper XI	Molecular Biology 1	3	80
Paper XII	Molecular Biology II Gene Expression and Recombinant DNA Technology	3	80
Paper XIII	Membrane Biochemistry and and Bioenergetics	3	80
Paper XIV	Cell Biology	3	80
Paper XV	Immunology	3	80

PRACTICALS

1st year

Practical I

Part A: Based on practical courses for theory paper I (Physical Chemistry)	35
Paper B : Based on practical courses for the theory Paper II (Inorganic and Organic Chemistry)	40

Practical II

Part A : Based on practical courses for theory Paper III	35
Part B : Based on practical .courses for theory Paper V	40

llnd year

Paper ill

Based on practical courses prescribed for llnd year	75

Paper IV

Based on practical courses prescribed for llnd year (2 papers, 2 days, 6 hours each) 40 marks are reserved for assessment by the class teachers of the day to day laboratory work of the candidates. (20 marks reserved for viva voce)	75

Illrd year

Paper V

Based on practical courses prescribed for Illrd year	100

Paper VI

Based on practical courses prescribed for Illrd year (2 papers, 2 days, 6 hours each) 50 marks are reserved for assessment by the class teachers Of the day to day laboratory work of the candidates. (30 marks reserved for viva voce)	100

1. For Theory papers of 80 marks, 4 periods/week will be allotted.
2. For a practical paper of 150 marks, 14 periods will be allotted per week in I and II year.

   Organic and Inorganic practical class i.e. of 4 periods duration and physical chemistry practical class of 3 period duration.

   [Chemistry 7 periods (2 periods organic, 2 periods Inorganic and 3 periods for physical chemistry]

   [For Physics 3 periods per week and for Chemistry of Biologically important molecules 4 periods per week will be allotted].
3. For a practical paper of 200 marks, 18 periods will be allotted.
4. Two periods will be allotted for second and third year student seminars.

B.Sc. (Hons) BIOCHEMISTRY

Paper I

Physical Chemistry

Acids and Bases

Dissociation of water and pH scale, Ionic equilibria in solution up to dibasic/diacid bases, pH changes during acid base titration (**weak** and strong), acid bases indicator common ion effect. Hasselbach Henderson equation, buffer solution, buffer index and buffer capacity.

Conductance

Elementary idea of conductance, Kohlrauch law and its application.

Fundamentals of Solution Thermodynamics

Globular Macromolecules, Membrane Equilibria, Osmotic pressure, Dialysis Equilibrium, The Donnan Equilibrium, and Active transport.

Chemical kinetics

Basics of orders and molecularity. Experimental methods for the determination of order of a reaction up to 2nd order. Steady state approximation and reaction mechanism. Complex reactions, opposite, parallel consecutive and chain reactions (qualitative idea). Effect of temperature on reaction rate, collision theory and absolute reaction rate theory.

Adsorption and catalysis

Homogenous and heterogenous catalysis, adsorption, physical adsorption and chemisorption various types of adsorption, isotherms, nature of adsorbed state, heterogeneous catalysis, kinetics of catalytic decomposition. Promotors and inhibitors.

Chemical thermodynamics

Enthalpies of ionization and enthalpy of formation of ions, use of Born Haber cycle for calculation of lattice energy, Kirkhoff's

Equation, maximum flame temperature and its calculations. Second law, Basic idea of entropy and its variation with temperature and pressure.

Third Law, Statement of third law, Gibb's free energy and Helmholtz free energy (a) Variation of S, G, and A with P, V, and T. Gibbs Helmholtz equation criteria of thermodynamic equlibria.

Concept of chemical potential

Electrochemical cell, Electrolytic cell and Galvanic cell.

Reversible and Irreversible cells.

Electromotive force of a cell and its measurement.

Free energy, entropy, and enthalpy changes of cell reactions.

Nernst equation, standard electrode (reduced) potential, types of electrode (including reference electrode).

Determination of equilibrium constant, liquid junction potential, pH determination using hydrogen electrode, glass electrode and quinone, isoquinone electrode, potentiometric (acid and bases, redox and precipitation) titrations.

The molecular spectroscopy consisting of generation of different spec ra viz. X-rays, UV, IR, NMR, ESR and microwave.

B.Sc. (Hons) BIOCHEMISTRY

Paper II

Organic Chemistry

Organic chemistry as chemistry of compounds, its interactior of everyday life.

Tetrahedral concept in carbon compounds, nomenclature.

Hybridization and types of bonds, atomic and molecular orbitals. Electronic displacements inductive, eiectromeric, hyper conjugative and resonance effects.

Nucleophiles and electrophiles and their importance in biological! Systems.

Characteristics and types of organic reactions. Additions, eliminations, substitutions and rearrangements. Ketoenoi tautomerism, stereoisomerism, geometrical isornerism, E&Z designations of geometrical isomers, optical isomerism, Specify and molar notations, O&L designations, absolute configurations in terms of R&S notations.

Aldol Condensations, Cannizzaro's reaction, lodoform reaction, Wurtz reaction, Claisen ester modification, Hoffmann brornarnide reaction, Markownikoff's rule (with their mechanism).

Preparation, typical reactions and uses of the following class of compounds.

Aliphatic end aromatic hydrocarbons (electrophilic substitutions) alkyel and aryl halides (nucSeophilic substitution) alcohols and phenols, aldehydes and ketones, monocarboxylic acids and their derivatives.

Inorganic

1. Chemical bonding
2. Ionic: General characteristics, types of ions, size effects, radius ratio, packing of ions in crystals, lattice energy.
3. Covalent: General characteristics, coordinate covalent bonds, valence bond approach, directional characteristics of covalent

Bond, multiple bonding, sigma and pi bonding, bond lengths, bond order, formal charge, valence, electron pair repulsion (VSEPR) theory of directed valence. Hydrogen bond (theories of hydrogen bonding), Metallic bond.

4. Chemistry of s & p block elements (excluding metallurgy and compounds) General trends in groups, electronic configuration, atomic radii, ionic radii, ionization, potential, electron affinity, electro negativity, oxidation states.

5. Concept of coordination of complex and coordination number, Werner' s theory, isomerism in coordination compounds, bonding in coordination compounds, Inorganic biomolecules.

B.Sc. (Hons.) BIOCHEMISTRY

Paper III

Physics

Centrifugal centripetal forces, sedimentation

Moments of inertia, Radius of gyration, Theorem of parallel and perpendicular axis, Expression for M.I. of regular shaped bodies (no derivation).

Acceleration due to gravity and its variation with depth, altitude and latitude, determination of ' g' by compound pendulums.

Surface tension and vapour pressure over flat and curved liquid surface and effects on evaporation and condensation, determination of surface tension by Jaegers method.

Viscosity - Poiseuille' s formula and method of determination of coefficient of viscosity.

Colloids, colligative properties.

Coulombs law, Gauss theorem and its application, force on surface of a charged conductor, Energy per unit volume of the medium.

Magnetic field due to a current, Ampere' s law, field due to current in a straight and circular wire and solenoid.

Kirchoff' s laws and their application, wheat stone bridge, Carey foster' s bridge, Crompton potentiometer.

Semiconductors, p n junctions Transistors, rectifier, use of filters, Oscillators, Bark hausen criteria of oscillation with one example, Amplifier transistor as an amplifier ex; CE amplifier.

Free damped and forced vibration, resonance, nature and equation of wave motion. Superposition of waves, standing waves, Doppler Effect.

Coaxial system of two thin lenses separated by distance, cardinal points, Defects of images chromatic and spherical aberrations. Achromatic combination of lenses and prism, Direct vision spectroscope. Eye piece (Ramsden and Huygens)

Electron microscope.

Interference of two beams, Division of amplitude and division Of wave front, double slit, biprism, colour of thin films, Newton' s ring, vlicelson interferometer.

Rectilinear propagation of light, diffraction - Diffraction of straight edge, slit and wire, Fraunhofer class of diffraction, Expression for intensity due to a single slit (no derivation), Rayleigh criterion for resolving* power, resolving power of telescope and eye double refraction, Polarization.of light and Polarimetry.

Measurement of charge of "e" by Millikan expt., e/m of electron by Thompson' s Method, Rutherford model of atom, Bohr' s model of hydrogen atom, Atomic spectra, De broglie waves, Heisenberg uncertainty relation, Schrodinger wave equation and its solution for square well potential.

Vibrational, electronic and nuclear magnetic spectroscopy.

Heat

Chemical Equilibria and thermodynamics

Mosley' s expt. On Xrays, Diffraction of X-rays, Bragg' s law. Liquid drop model of nucleus, Nuclear fission and fusion.

Radioactivity, alfa, Beta and gamma rays, radioactive decay, consequences of decay and unit of radioactivity, production of radioisotopes, Interaction of radiation with matter and effect of ionizing radiation on biomolecules, detection of radiation GM and scintillation counters.

B.Sc. (Hons.) BIOCHEMISTRY

Paper IV

Mathematics and Statistics

Mathematics

Differential calculus:

Derivatives of inverse functions, Inverse trigonometric functions, logarithmic functions and exponential functions, Derivatives of implicit functions and derivatives of functions defined pararnetrically. Successive differentiation, Leibnitz' s theorem, Rolle' s theorem, Mean value theorems, Taylor' s theorem, Maclaurin' s theorem (without proofs), Maclaurin' s expansions, Indeterminate forms, Maxima and minima, Partial differentiation, Euler' s theorem, Tangents and Normals, Curvature (Cartesian and polar coordinates), Asymptotes, Singular points of curves, Cure tracing.

Integral Calculus :

Integration by partial fractions, Integration of rational and irrational functions, Properties of definite integrals, Reduction formulae for integrals of trigonometric functions.

Infinite Series :

Ratio test and root rest for positive term series, Leibnitz' s test for alternating series.

Trigonometry and Algebra :

Trigonometry: De Moivre' s theorem and its simple application.

Algebra : Relations between roots and coefficients of algebric equations, Solution of cubic equations, Algebra of matrices. Determinants and their simple properties, Rank of a matrix and its invariance under elementary row and column transformations, System of linear equations.

Differential Equations :

, Separable variable, homogenous, exact and linear equations of second order.

Statistics

Concepts in statistics, probability significance level, Degree of freedom, relative frequency presentation of data, types of graphics, Normal distribution, Measurement of central tendency, Arithmetic mean, median and mode, measure of variation, Range, standard deviation, standard error, coefficient of variation, Exponential and Logarithmic functions, Binomial, Poisson and normal distribution. Tests of significance, test for proportion, to and t tests, contingency tables of X^2 (Chisquare) tests of goodness of fit and homogenety, additive property of X^2 and the normal approximation, meaning of very small X^2 values.

Theory of errors, errors and residual precision, probable error of a function, rejection of observations, averages, least squares and linear regression, associated test of significance, Analysis of variance for one and two way classification and Design of experiments, randomization, replication local control, completely randomized and randomized block design.

B.Sc. (Hons.) BIOCHEMISTRY

Paper V

Introduction to Biology and Chemistry of

Biologically important molecules

Definition and characteristics of life, General account of various classes of living organisms such as viruses, bacteria, algae, fungi higher eukaryotes and plants, Cell theory, cell cycle, mitosis, meiosis and their significance. Structure and function of cellular constituents: Cell wall, plasma membrane, protoplast and its colloidal nature, chloroplast, mitochondria, endoplasmic reticulum, ribosome, lysosomes, golgi apparatus, centrioles, basic granules, cells, flagellum and mitochondria.

Biomolecules - Structure, function, diversity and distribution. General composition of Living matter - A brief introduction.

Carbohydrates

Monosaccharides and their inter relationship, structure of sugars, Stereoisomerism and optical isomerism of sugars, Reactions of aldehyde and ketone groups, Ring structure and tautomeric forms, mutarotation, Reaction of sugars due to OH groups, Important derivatives of Monosaccharides, Disaccharides and Trisaccharides (Glucose, fructose, maltose, lactose, cellobiose, gentiobiose, Melibiose, Turanose, Sucrose, Trehalose, Mannotriose, Rabinose, Rhamnose, Raffinose, Gentionose, Melizitose.) Identification and analysis of mono and oligosaccharides, structure and importance. Structure, occurance and biological importance of structural polysaccharides e.g. Cellulose, chitin, agar, algenic acids, pectins, proteoglycans, sialic acids, blood group polysaccharides, bacterial cell wall polysaccharides etc.

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, Prostaglandins. Classes, structure and synthesis. Isoprenoids- types and structures, Chemistry 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.

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 peptide e.g. Insulin, Functional diversity of proteins with examples.

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.

Vitamins

Discovery and role in body functions. Chemistry of fat soluble vitamins A, D, E & K. Water soluble vitamins such riboflavin, pantothenic acid, niacin, pyridoxine, biotin, cobalamine, folic acid and ascorbic acid.

B.Sc. (Hons) BIOCHEMISTRY

Paper VI

Biochemical and Biophysical Techniques

1. Separation techniques

(a) Salt and organic solvent fractionation.

(b) Dialysis, reverse dialysis, ultra filtration

(c) Chromatography

1. Partition chromatography
2. Adsorption chromatography
3. Ion exchange chromatography
4. Thin layer chromatography
5. Molecular sieve (Gel chromatography)
6. Hydrophobic chromatography
7. Gas liquid chromatography
8. Affinity chromatography
9. High pressure liquid chromatography

(d) Electrophoresis - free flow, zone (disc, slab- SDS PAGE) and paper electrophoresis.

(e) Isoelectric focussing

(f) Centrifugation - centrifuge of various types, rotors, boundary, differential, density gradient, Zonal Isopycnic, equilibrium.

2. Instrumental methods

i. Spectrophotometry - UV, visible

ii. Fluorometry

iii. Radioactive counters • GM, liquid scintillation

3. Radioisotopes in Biology, applications and precautions.

4. Microbiology

Types of media, selective and enrichment media, sterilization, cell counting, cell number, viable & non-viable, Growth, maintenance of cultures, staining procedures, plating, microtony.

Microscopy.

Compound, electron, phase contrast, confocal and Preparation of samples.

B.Sc. (Hons) BIOCHEMISTRY

Paper VII

Proteins, enzymes and coenzymes

Peptide bond - nature, identification and conformation.

Primary, Secondary, tertiary and quaternary structure of proteins. N and C terminal determination, Ramachandran plot, peptide mapping with respect to myoglobin and hemoglobin.

Characterization of proteins - Physicochemical (molecular weight, molecular size, isoelectric point, viscosity, Svedberg' s coefficient), immunological and biological characteristics.

Purification of Protein, Criteria for homogenity for peptides and proteins, techniques for sequencing of proteins, Isoelectric point. Solid phase synthesis of proteins:

Protein folding - Role of molecular chaperone

Enzymes - Historical background and importance of enzymes.

I. Chemical nature of enzymes, enzymes as catalysts, Units of enzyme action, Turnover number, Assay of enzymes, Enzyme specificity, Concept of active centres, concept of holoenzyme, coenzyme, apoenzyme and prosthetic groups.

II. **Enzyme classification** and nomenclature.

III. **Purification of enzymes,** criteria of purity (affinity and ion exchange chromatography).

IV. **Kinetics** of enzyme catalyzed reactions -

Michaelis Menten equation, V_{max}, significance of K_m .applicability of Michaelis Menten equation, Methods of determination of K_m and V_{max} and their limitations, various factors influencing the rate of enzyme catalyzed reactions.

Enzyme inhibitions - competitive, non-competitive, uncompetitive and mixed inhibitors, reversible and non-reversible inhibitions, suicide inactivators.

V. **Mechanism** of enzyme catalysis (acid base and covalent catalysis, proximity effect, induced fit theory, catalysis, due to

strain and distortion e.g. lysozyme, chymotrypsin and hexokinase two substrate reactions, general mechanisms (ordered and ping pong).

VI. **Chemistry and enzymatic function of water soluble vitamins** such as riboflavin, pantothenic acid, niacin, pyridoxine, biotin, cobalamine, folic acid, lipoic acid, and ascorbic acid.

VII. Regulation of enzyme activity

(a) Allosteric enzymes, feedback inhibitions, concerted and sequential model, homotropic effect, negative and positive cooperativity e.g. Atcase.

(b) Zymogens, isoenzymes, multienzyme complexes.

(c) Isoenzymes and their role in metabolism.

VIII. Immobilized enzymes and their applications.

IX. Applications of enzymes for diagnostic purposes.

B.Sc. (Hons) BIOCHEMISTRY

Paper VIII

Human Physiology and Endocrinology

Introduction to physiology and hormones

I. Cell signalling and mechanism of hormone action.

Receptor families

G protein linked receptors

Enzyme linked receptors (self & intracellular)

Intracellular receptors

Steroid receptors & superfamilies

Thyroid hormone receptors

Signal transduction - cAMP, cGMP, Ca£+, IPS, DAG

G proteins (RAS) Protein kinase (RAF, MAP Calmodulin, Prostaglandin.

II. **Ca^{a+} homeostasis** - Calcitonin, PTH, Vit D_3

Bone turnover and related pathophysiology Osteoporosis, Osteomalacia and Rickets

Pitutary hypophysial axis

III. **Neuro endocrine control of Gl** tract, Secretin and Gastrin family.

IV. **Hepatic physiology** Functional anatomy of hepatic lobule, Detoxification, Bile secretion.

Related pathophysiology - Obstructive and hemolytic jaundice.

V. **Glucose homeostasis •** Glucagon, insulin and glucocorticoid Related pathophysiology.

VI. **Thyroid hormone** - T_3 & T_4 related pathophysilogy - Goitre, Cretinism, Myxedema.

VII. Renal physiology, Nephron, Na^u homeostasis - Aldosterone, Renin, angiotensin system, Kallikrein kinin system, Regulation

of water balance, ADH, counter current mechanism, Related pathophysiology - Cushing' s, Conn' s, Diabetis insipidis

VIII. **Physiology of blood and cardiovascular system**

Imposition of blood Plasma, RBC Hemosta .is, cardiac muscle and action Potential; Blood p assure regulation, blood -H ^gulation, blood brain barrier, Related pathophysiolog,
Anemia, thallesemia, sickle cell anemia, atherosclerosis, hypertensions, Myocardial infar on, Stress - hormonal control.

IX. **adrenal medullary** hormores, Parkinson' s disease

X. **Growth and development** GH, insulin. Growth factors, EGF, **NGF,** IGF-l & **II.**

Xl. **Reproduction** - male and female sex hormones, Reproductive cycle, Gestation, lactation and contraception.

B.Sc. (Hons) BIOCHEMISTRY

Paper IX

Metabolism of Carbohydrates and Lipids

Dynamic state of body constituents

General features of regulation of metabolism

Sources of carbohydrates

Glycolysis

Gluconeogenesis

Enzymatic and hormonal control of glycolysis and gluconeogenesis.

Alcoholic fermentation

Pasteur and crab free effect.

Futile cycles

Metabolism of 2,3 diphosphoglyceric acids.

Tricarboxylic acid cycle, regulation of TCA cycle, Design of TCA cycle and nutritional consequences.

Hexose monophosphate shunt and its regulation.

Metabolism of glycogen, glycogenolysis and glycogenesis and regulation of glycogen metabolism.

Synthesis of sugars in plants, Calvin cycle, Hatchin Slack Cycle

General outlines of lipid metabolism

Digestion and absorption.

(a) Enzymatic hydrolysis in intestine

(b) Enzymatic resynthesis in intestine

(c) Packaging into chylomicrons

Uptake of fatty acids from circulating chylomicrons by tissues, role of lipoprotein lipase.

Mobilization of Triglycerides

I. Hydrolysis of TG to FFA in adipose tissues by hormone sensitive lipase.

ii. Resynthesis of TG from FFA in adipose tissues and role of carbohydrate metabolism.

iii. Transport of net free fatty acids from adipose tissues as FFA-albumin complex and uptake of FFA by tissue.

Oxidation of fattyaclds

(a) Activation of Fatty acids

(b) Entry of long chain fatty acyl CoAs into mitochondrial matrix.

(c) Beta-oxidation

(d) Oxidation of unsaturated fatty acids.

(e) Beta-oxidation of fatty acids in mitochondria and in peroxisomes.

Formation of ketone bodies, Oxidation of ketone bodies, Ketosis, Propionic acid metabolism.

Biosynthesis of fatty acids, Biosynthesis of phosphoglyceride, Sphingolipids.

Diseases of lipid metabolism, Refsum disease, Respiratory distress syndrome, ganglioside breakdown, fatty livers, Synthesis of cholesterol, bile acids and bile salts, biosynthesis of eicosanoids.

B.Sc. (Hons) BIOCHEMISTRY

Paper X

Metabolism of Amino acids, Nucleotides and Porphyrins

Amino acids

Nitrogen cycle - Protein calorie malnutrition. Outlines of

amino acids metabolism.

Fixation of nitrogen, mechanisms of reduction of elemental nitrogen, incorporation of ammonia into amino acids, uptake of amino acids by cell.

Urea synthesis.

Catabolic pathways of individual amino acids.

Glucogenic and ketogenic amino acids.

Metabolism of one-carbon atom groups.

Role of pyridoxal phosphate.

Precursor functions of amino acids.

(a) Synthesis of creatine, creatine phosphate and creatinile.

(b) Synthesis of amines - Spermine, spermidine, epinephrine, nor epinephrine, Serotonin, GABA, Glutathione.

Synthesis of non-essential amino acids, Nitrogen balance.

Disorders of amino acids metabolism, Phenylketonuria, Aikaptonuria, Mapiesyrup disease, Methyimalonyluna, Parkinson' s diseases.

Metabolism of purine and pyrimidine nucleotides.

Biosynthesis of purine nucieotides, Biosynthesis of IMP, pathway from IMP to AMP and GMP, conversion to trjphosphates, regulation of purine, nucleotide biosynthesis, salvage pathways.

Biosynthesis of pyrimidine nucleotides

Biosynthesis of UMP, conversion of triphosphate, Regulation of pyrimidine nucleotide synthesis, Biosynthesis of deoxyribon-ucleitdes, biosynthesis and formation of coenzyme nucleotides.

Anticancer drugs.

Degradation of purine and pyrimidine nucleotides.

Digestion of nucleic acids, degradation of mononucleotides catabolism of purines, catabolism of pyrimidines.

Disorders of purine and pyrimidine biosynthesis - Lesh Nyhan syndrome, Gout, SCID, Adenosine deaminase deficiency.

Classification, structure and biological function of porphyrins.

B.Sc. (Hons) BIOCHEMISTRY

Paper XI

Molecular Biology I

Genetics

Mendels laws of inheritance; gene interaction; Dominance relationships - complete, incomplete and co dominance; multiple alleles; linkage; gene mapping in haploids and diploids; recombination mapping; complementation analysis, temporal mapping, physical mapping and restriction mapping; mode of gene information transfer in bacterial-conjugation, transformation and, transduction; use of following organisms in development of the gene concept- Neurospora, Yeast, Drosophila, Maize, E.coli; concept of cistron; genetic basis of sex determination; pedigree analysis, evidence for the role of DNA as genetic material universally.

DNA

Base composition of DNA, Watson and Crick model, alternate double helical structures.

DNA topology - linking number, topoisomerases; Organization of DNA; - Prokaryotes, viruses, eukaryotes.

Organelle DNA palindromic DNA sequences; repetative DNA sequences-moderately, highly repetetive; concept of split genes.

Chromatin structure - euchromatin, heterochromatin and facultative heterochromatin.

Transposition elements • pro & eukaryotic

Properties of DNA - denaturation and reassociation kinetics.

DNA technology - sequencing, hybridization, electrophoresis pulse field, RFLP, DNA fingerprinting, RAPD, PCR, DNA foot printing; molecular basis of mutagenesis, Spontaneous and induced, types of mutagens, point, frame shift, chromosomal aberrations (monosomy, trisomy, translocations, inversions, duplications and deletions) Use of mutants to study gene functions, conditional mutantst

DNA replication

Fidelity of replication, general principles - bidirectional replication, semi- conservative, semi-discontinuous RNA priming, various models of DNA replication including rolling circle, D-loop (mitochondrial), 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; Topology of DNA replication.

Recombination various models and mechanism; role in conjugation transformation, transduction, meiosis.

Repair of **DNA** - direct, photoreactivation, O_6 methyl guanine, **DNA** methyl transferase, excision repair-base and nucieotide. Mismatch repair, recombinational and error prone repair.

B.Sc. (Hons) BIOCHEMISTRY

Paper XII

Molecular Biology Part II

Gene Expression and Recombinant DNA Technology

RNA - Various forms of RNA and RNA viruses

Transcription Basic transcription apparatus, RNA polymerase - various types; initiation, elongation and termination of RNA chains. Model system to study transcription, Eukaryotic transcription of mRNA, tRNA, rRNA with special reference to RNA polymerases and associated transcription factors. Inhibitors of transcription, Chromatin, organisation role of histones as regulators of gene expression, post transcriptional modifications and processing of RNA.

mRNA - capping, polyadenylation, splicing,

RNA editing. rRNA - splicing and methylation.

tRNA - splicing, addition, deletion and

modification of bases. Regulation at

transcriptional & post transcriptionat level.

Prokaryotic systems - Promoters & initiation sites, operon control-lac, gal, trp, ara, attenuator controlled operon, catabolite controlled operons; stringent response; diversity of factors (in development and temporal regulation) anti termination - regulation using phage eukaryotic systems.

Chromatin organisation role of histones as regulators of gene expression, DNA methylation; enhancers and transcription factors in tissue specific expression, combinational regulation, Nucleic acid protein interaction.

Regulated turn over of mRNA, alternate splicing, use of alternate polyadenylate site, controlling the length of poly(A) tail, RNA transport from the nucleus.

Translation

Features of genetic code and exceptions in some systems. assembly line of polypeptide synthesis - ribosome structure and assembly, mRNA, 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.

Translational control -globin synthesis (eukaryotes), RF-2 synthesis (bacteria) ribosomal protein synthesis, antisense RNA, secondary structure of RNA (RNA phages), RNA recoding, Post translational modifications.

Covalent modifications-glycosylation, phosphorylation, adenylation. ADP ribosylatibn, Carboxylation, methylation, sulphation Limited proteolysis-zymogen activation, protein splicing (protein introns).

Recombinant DNA Technology

Introduction of gene manipulation; enzymes in recombinant DNA work e.g. Restriction endonucleases, DNA ligases, terminal deoxy nucleotidetransferase, Reverse transcriptases, Vectors - plasmids, cosmids, phages, expression vectors.

Construction of gene library-genomic and cDNA library, Protein engineering, selection and screening of clones, cloning in organism other than E.coli, Bacillus, Yeast, plant and animals.

Selected techniques - chromosome walking and chromosome jumping.

Selected application in recombinant technology, vaccines, hormones, Human genome project, application in agriculture.

B.Sc. (Hons) BIOCHEMISTRY

Paper XIII

Membrane Biochemistry and Bioenergetics

A. Biological Membranes

Types of sub-cellular location. Chemical composition of biomembranes. Model lipid membranes - preparation and properties. Similarities and references between biomembranes and artificial phospholipids membranes. Detergents, micelles, Liposomes, Cytological .chemical and physical methods to study membrane structure, /components and properties. Different models of cell membrane a historical perspective. Functions of biomembranes with examples - energy transduction, signal recognition and transduction, transport of nutrients and catalysis by biomembranes, specialized forms of membranes - brush border, flagella. Gap junctions and tight junctions.

B. ' membrane transport

Nutrient transport across biomembranes. Simple diffusion and Fick' slaw, pornis facilitated diffusion, Porter molecules. Kinetics of facilitated transport. Symport, antiport and Uniport. Red cell membrane proteins. Anion porter and glucose porter. Active transport. F tein Pumps - examples and metabolic significance. Gastric HCL secretion, Bacteriorhodopsin, Electro-chemical potential, Nernst potential and membrane potential Na+, K+, -ATPase.

C. Membrane Receptors

Structure and functions, Methods to study membrane receptors. Purification and characterization of adrenergic and cholinergic receptors, Excitable membrane ion gates and action potential generation, neurotransrriitter types and action chemical and electrical snapping, Photo-receptors and vision, Receptor desensitization, Receptor mediated endocytosis, LDL receptors - biological and clinical significance. G-proteins and adenylate cyclase. Receptors and ion gates. Membrane fluidity and receptor function.

D. Membrane and environment

Membrane biogenesis - Membrane lipid biosynthesis, Assembly

of Vesicular stomatitis virus as a model. Factors influencing membrane composition and structuring of its components. Detergents and their effects on membranes. Membrane lipid dynamics in response to extra cellular environment (stress, temp, water, pH), Action of drugs, hormones, Membrane fluidity and its change in nutritional insult, Adaptation to nutrient stress, Complement mediated cell lysis, Biomembrane, liposomes and drug targetting. Membrane bound enzymes and occluded enzymes. Enzyme osmometry.

E. Bacterial and Plant cell Walls Structure, composition and
biosynthesis. Inhibitors of cell wall synthesis.

F. Bioenergetis

Principles of chemical thermodynamics. Concepts of free energy, enthalpy and entropy. Equilibrium steady-state, open and closed systems. Methods to calculate free energy changes of reactions. Energy harvesting systems of plants and microbes. Chloroplasts-structure and composition. Organization of photoreaction centres and photosystems. Catabolism and energy production. Concept of high energy bond. Nature, types and distribution of high energy compounds. Structural basis of their high energy nature. Redox reactions. Redox potentials. Nernst equation. Types of redox reaction in living systems. Redox carriers - free and membrane bound. ATP - structure, discovery, distribution and role in cellular metabolism.

G. Energy

Production, storage and utilization. Concept of coupled reactions. Metabolic flux and free energy change. Energy transformations in living systems during mechanical, metabolic and osmotic work. Oxidative energy and ATP production. Phosphorylated compounds and phosphorylation potentials. Energy charge of the cell. Substrate level, oxidative phosphorylation. Structure distribution and properties of mitochondria. Respiration and energy production. Physiology of O_2 transport in aquatic and terrestrial animals. Mitochondrial redox carriers - discovery, stoichiometry and topography. Electron transport chain. Respiration linked oxidative phosphorylation in plants and bacteria. Components and arrangement of redox in cyclic and non cyclic photophosphorylation. Hill reaction and Hill reagents. Action of herbicides. Bioluminescence-phenomenon and biological significance. Mechanism of luciferase catalysis. Reaction intermediates.

B.Sc. (Hons) BIOCHEMISTRY

Paper XIV

Cell Biology

Introduction to the eukaryotic cell with its various organelle elements and subcellular particles.

Structure and biogenesis of cell components

Nucleus - the nuclear pore complex, its role for protein movement, nucleolus.

Mitochondria - cytosolic synthesis and localization of mitochondrial proteins. Proteins synthesised within mitochondria. Cytoplasmic inheritance of mitochondria. Mutations in mitochondrial DNA leading to genetic diseases.

Chloroplast - synthesis and targetting of non-chloroplast encoded proteins. Differentiation of proplastids into chloroplasts or other plastids.

Peroxisomes - Structure and biogenesis of catalase.

Lysosomes - nature and role in proteolytic degradation, endocytosis.

Microfilament - dynamics of assembly and organization. Role in controlling cell shape and motility.

Microtubules and intermediate filaments - tubulins and microtubule associated proteins. Assembly and role in intracellular transport, mitosis, Structure and movement of cilia and flagella.

Endoplasmic reticulum and golgi - Structure and role in biosynthesis of secretory and lysosomal proteins. Signal peptide hypothesis. Cotranslat' onal movement of secretory proteins into ER. N-linked glycosylation. Role of golgi in O-linked glycosylation Processing of N-linked glycosylations and sorting of proteins for membrane insertion, secretion, lysosomes. Non-classical translocation pathways. Changes in the ER - removal of signal sequences, folding involving chaperonins.

The intracellular matrix

Cell cell and cell matrix interactions.

Components of the extra cellular matrix. Hyalouronan and profeoglgcan. Proteins- multi functional collagens, their assembly Larninins, Nidogen and migration. Cadhenins, role in cell cell interaction, morphogenesis and differentiation, cell junction-structure an4 junctions.

Rote *of* **cell-cell** and cell matrix interaction in development, selected topics - role of basal lamina in differentiation of regenerating nerve and muscle at neuromuscular junctions. Role of boss cell surface notch and delta proteins in signalling between cells during developmental regulation.

III. Regulation of eukaryotic cell cycle and cancer phases of cell
cycle, mitosis and mitotic cycling, role of cyclins, MPF catalyzed
phosphorylation of nuclear lamins and other proteins.
Regulation of MPF activity. Control of entry into S phase. Role
of check points in cell cycle, regulation-unreplicated DNA,
defects in mitotic spindle and ONA damage.

Meiosis and its significance, Characteristics of tumor cells.

Introduction to oncogenes and their proteins. Role of controlling cell cycle. DNA and RNA viruses as transforming agents. Humour tumor viruses. Chemical carcinogens, role of radiation and DNA repair in carcinogenesis.

Apoptosis or induced cell suicide as protection against cancer.

IV. Selected techniques in cell biology

Cell sorting and cell culturing, primary cell cultures, differential and undifferential cell lines, transformed cell lines, Hybrid cells in genetic analysis, nuclear transfer and cloning.

B.Sc. (Hons) BIOCHEMISTRY

Paper XV

Immunology

Concept of Immunity : Classification, Humoral and cellular immunity. Lymphoid organs, Central and peripheral.

Immunoglobulins. Structure and function Classes of Ig - (IgG. IgA, IgM, IgD, and IgE).

Antigenic determination of Ig - isotopes, Allotope and Idiotope.

Antigens and immunogens - Properties of antigens. Haptens and carriers - carrier effect, adjuvants, Nature of antigens.

Formation of antibody. Cells involved in antibody formation. B-cell markers.

Differentiation of B-cell. Clonal selection theory, cooperation of T-cell with B-cell, secretion of antibody, molecular basis of antibody diversity.

T cell development

TCR structure, T cell markers, T cell receptor diversity, cytokines.

Histocompatibility antigens - polymorphism, MHC complex -class I and class II MHC protein - structure, distribution, role and association of MHC alleles in a population with diseases.

Antigen processing and presentation

Transplantation immunology Immunomodulation

Complements - Components, activation of complements, complement fixation reaction, antigen antibody interactions.

Immunological techniques

Precipitation - Quantitative precipitation test, Imrmjnodiffusion - single and double agglutination.radioimmunoassay - RIST & RAST

Immunofluorescence • Direct, indirect and FACS, ELISA **Monoclonal antibody** - Preparation and application in biology.

Immunoelectrophoresis - counter current IEP and Rocket IEP.

Hypersensitivity - Type I, Type II, Type III and Type (V.

Immunological tolerance. Pathways leading to T cell B cell tolerance. Immunity against bacteria, viruses and parasite (Helminth infection) AIDS, Tuberculosis, Leprosy, Malaria and Hepatitis.

Auto immunity

Auto immune diseases - organ and non-organ specific diseases **Vaccines** - Types, vaccination and design

B.Sc. (Hons) Biochemistry

Syllabus for Practical Courses

1st year

Practical course for theory Paper I (Physical Chemistry)

1. Determination of viscosity of liquids.
2. Adsorption (acetic.acid on charcoal)
3. Enthalpy of Neutralization.
4. Determination of enthalpy of solution dilution.
5. Preparation of buffer solutions and measurement of their pH values using indicators and pH meters. Knowledge of ionization constant of weak acids and bases involved.
6. Conductometric titration of acids and bases.
7. Determination of order of reactions for first and 2nd order reactions.

Practical course for theory Paper II (Inorganic and Organic Chemistry)

Inorganic

1. Preparation of complex salts (two preparations)
2. Qualitative Analysis : Mixture containing not more than 4 ions including interfering radicals.
3. Oxidation reduction titration ($KMnO_4$ and $K_2Cr_20_7$) – using internal indicators.

Organic

1. Preparation of the compounds involving single state reactions:
   nitration, benzoylation, and brominations, suggested examples are : m-dinitrobenzene, benzanilide and tribromoaniline.
2. Purification of organic compounds by crystallization.
3. Systematic identification of functional group of organic compounds (Monofunctional only).

Practical Course for Theory Paper III (Physics)

1. ' g' by bar pendulum.
2. ' g' by Kater' s pendulum.
3. Focal length of combination of lens by magnification method.
4. Refractive index of liquid using Travelling Microscope.,
5. Low resistance by Carey Foster Bridge.
6. Reduction factor of a Tangent galvanometer.
7. Resistance of a galvanometer by Kelvin' s method.
8. Determination of Viscosity of water using Poisuelle method.
9. Refractive index of the material of a prism using spectrometer.
10. Wave length of sodium light by Newton's ring.
11. Wave length of sodium light by Diffraction grating.
12. Specific rotation of sugar using Polarimeter.
13. Transistor Characteristics.
14. Surface tension by Jaggers method.

Practical Course for theory Paper V (Introductory Biology)

1. Identification tests for Carbohydrates, proteins and lipids.

   Carbohydrates :
   1. Molisch test
   2. Benedicts
   3. Barfoed' s
   4. Fehling' s test
   5. Iodine test

   Proteins :
   1. Biuret
   2. Xantho protein
   3. Ninhydrin
   4. Hopkin cole

   Lipids :
   1. Salkowski
   2. LieBermann Burchard

2. Preparation of solutions of different molarities and normalities.
3. Adjusting the pH of solution and preparation of buffer
4. Isoelectric point of casein.

B.Sc. (Hons) Biochemistry

Syllabus for Practical Courses

llnd year

Measurement - Criteria of reliability, precision, accuracy, sensitivity, specificity

Laboratory rules and safety regulation - First Aid.

Principles of Colorimetry

i. Verification of Beer' s law, estimation of protein and phosphate.

ii. Finding out X_{max}. Relation between O.D. and % transmission. pH, pK, Henderson' s equationPreparation of buffer. Separation of Amino acids by paper chromatography. Isolation of phospholipids from liver and their separation on thin layer chromatography (TLC). Separation of hemoglobin and potassium dichromate by gel filtration. Ion exchange chromatography - CM cellulose, DEAE cellulose.

Isolation of enzyme Acid Phosphatase from germinating lentils (moong) using $(NH_4)_2SO_4$ precipitation and its asi,ay using p-nitrophenyl phosphate and calculation of specific activity.

Determination of - pH optimum, Temperature optimum, K_m value, Vmax value, Effect of inhibitor (Inorganic phosphate) and measurement of K..

SDS poly acrycamide Gel electrophoresis. (SDS-PAGE)

B.Sc. (Hons) Biochemistry

Syllabus for Practical Courses

Illrd year

Difference between DNA and RNA (Alkaline Hydrolysis)

Base composition of DNA after hydrolysis.

Cell fractionation (from rat liver)

Preparation of Nuclear, Mitochondrial and Cytoplasmic fractions

Estimation of Marker enzymes SDH.

Growth and E.coli cells.

Gram +ve, Gram -ve staining.

Isolation of DNA from E.coli, UV spectrum of DNA and its comparison with spectrum of a protein.

Isolation of ^BR 322 plasmid from E.coli cells. Agarose gel

electrophoresis for analysis of DNA. Immunizing the rabbits

against any homogenate preparation.

Isolation of antibodies from serum and purification using ionexchange chromatography.

Complement fixation.

Immunodiffusion using antibodies, Immunoblot, counter current electrophoresis, ELISA

Estimation of blood glucose - glucose oxidase method. Estimation

of serum cholesterol - cholesterol oxidase method. Liver function

tests. Estimation of bilirubin.