Included

TB

PROCEEDINGS OF THE BOS MEETING

THE UG BOARD OF STUDIES (BIOCHEMISTRY) MEETING WAS HELD ON 13-01-2017 AT 11.00A.M IN THE DEPT OF BIOCHEMISTRY, KUVEMPU UNIVERSITY, SHAKARAGHATTA, SHIMOGA.

Members Present:

1. Dr. A.N. Rajeshwara
   Chairman (BOS).
   Dept. of Biochemistry, Kuvempu University,
   Shankaraghatta, Shimoga.

2. Dr. Pramod S.N.
   Dept. of Biochemistry
   Sahyadri Science College (Ind), Shimoga

3. Dr. Nagesh Babu
   Dept of Biochemistry
   Maharani Science College for Women,
   Palace Road, Bangalore-560001

4. Shri H.T. Vijaya Kumar
   Dept. of Biochemistry
   S.R.N.M College of Applied Sciences,
   N.E.S, Shimoga - 577201

Members Absent

1. Mrs. Kavitha K.R,
   Associate professor, Dept. of Biochemistry,
   Maharani's Science College for women,
   Jhansi Lakshmi Bai Road, Mysore 570 005

The Chairman, Dr. A.N. Rajeshwara, welcomed the members of UG Board of Studies in Biochemistry. The following issues were discussed in the meeting.

1. Keeping in view of the current requirements, the board revised the syllabus and question paper pattern for both theory and practical for all the semesters.
2. The board prepared the exhaustive list of examiners (both Internal and External) for B.Sc Biochemistry examinations and authorized the chairman to send the same to The Registrar (Evaluation), Kuvempu University, for further needful.

The meeting was concluded with the vote of thanks proposed by the Chairman.

Chairman (BOS),
Department of Biochemistry,
Kuvempu University, Shankaraghatta

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KUVEMPU UNIVERSITY
DEPARTMENT OF BIOCHEMISTRY
SYLLABUS FOR B.Sc., COURSE IN BIOCHEMISTRY
(REVISED - JANUARY 2017)

SEMESTER – I

BC-01: BASIC PRINCIPLES OF BIOCHEMISTRY
PBC-01: BIOCHEMISTRY Practical - I

SEMESTER – II

BC-02: CELLULAR BIOCHEMISTRY
PBC-02: BIOCHEMISTRY Practical – II

SEMESTER – III

BC-03: BIOMOLECULES
PBC-03: BIOCHEMISTRY Practical – III

SEMESTER – IV

BC-04: NUTRITIONAL BIOCHEMISTRY AND HUMAN PHYSIOLOGY
PBC-04: BIOCHEMISTRY Practical – IV

SEMESTER – V

BC-05: BIOANALYTICAL TECHNIQUES, ENVIRONMENTAL BIOCHEMISTRY AND BIOINFORMATICS
BC-06: MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY
PBC-05: BIOCHEMISTRY Practical – V
PBC-06: BIOCHEMISTRY Practical – VI

SEMESTER – VI

BC-07: ENZYMOLOGY AND INTERMEDIARY METABOLISM
BC-08: IMMUNOLOGY AND CLINICAL BIOCHEMISTRY
PBC-07: BIOCHEMISTRY Practical – VII
PBC-08: BIOCHEMISTRY Practical – VIII

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PBC-02: BIOCHEMISTRY Practical – II

SEMESTER – III
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PBC-08: BIOCHEMISTRY Practical – VIII

I SEMESTER
PRINCIPLES OF BIOCHEMISTRY

Paper I - 4H/W **TOTAL- 60 hours**

Unit I (15 h)

General Introduction: Brief introduction to biochemistry -cellular, chemical, physical, genetic evolutionary foundations (fundamental study only). Scope, history, mile stones and developmen Biochemistry, Composition of Living organisms, Water as a solvent of life.

Acids, Bases and Buffer: Dissociation of water, ionic product of water, concepts of pH and pOH, numerical problems, determination of pH using indicators, pH meter. Dissociation of weak acids and w bases Bronsted-Lowry theory of acids and bases, titration curves of strong and weak acids and ba Meaning of Ka and pKa, buffers, buffer action and buffer capacity. Buffers in biological system an importance, Henderson -Hasselbalch equation-derivation preparation of buffers problems.

Atomic structure and chemical Bonding: Structure of atom, Ionization potential, Nature and ty chemical bonding (electrovalent, covalent and coordinate), Characteristics of bonding (Bond length, an strength and energy), hydrogen bonds and weak interactions. Valance bond theory-postulates, Sigma pi bonds. Hybridization of orbitals and directional characteristics sp, sp^2 and sp^3. Molecular orbital the postulates, Atomic and molecular orbitals, bonding and antibonding orbitals.

Unit II (15 h)

Colligative properties: Osmotic pressure: Definition and its measurements by the Berkley's Har method, Hypotonic, hypertonic and isotonic solutions. Effect of osmotic pressure on living cells. Law osmotic pressure (only statement) Plasmolysis, Turgid state and reverse osmosis. Relative lowering vapour pressure: Raoult's law, relation between molar mass of solute and relative lowering vapour press Elevation in boiling point: Determination of molecular weight by Walker Lumsden method. Depressio freezing point: Determination of freezing point depression by Beckmann's method. Abnormal molec weight and van't Hoff factor, degree of dissociation, degree of association.

Stoichiometry: Concentration terms: molarity, molality, normality, ppm and ppb. Primary and Second standards, Requirement of primary standards. Titrimetric method of analysis: Types of titrations, acid-base titration, theory of acid – base indicators. Ostwald's theory, Redox iodo-metry, precipitation. Complexometric titrations with examples.

Radioactivity: Natural and artificial radioactivity (definition with examples) Nuclear stability, n/p ra binding energy, instability of nuclei. Types of radio-active decay, properties of α, β, γ radiations. Isoto and their applications. Radioactivity decay series and radioactive equilibrium. Application of C^{14}, P^{32}, C Cr^{51}, Te^{99} and I^{131}. Biological effects of and safety measures of radiation.

Unit III (15 h)

Introduction to organic chemistry: Classification and IUPAC nomenclature of bi-functional compounds Elemental analysis: Estimation of sulphur by Carius method, nitrogen by Kjeldhal's method. Mechanis of organic reactions: Types of reagents and reactions, Electronic Effects and Hyper-conjugation, Mesoe effects, Steric Effects and hydrogen bonding, reactive intermediates: Carbo cation, carbanion, carbenes, nitrenes and free radicals – their generation, geometry and stability.

Hydrocarbons: Aliphatic hydrocarbons: Markownikoff's rule, peroxide effects (mechanism to be discussed) and anti-Markownikoff's rule, Ozonolysis and Oxidation to detect the position of the double bond with example. Dienes: types with examples. Conjugative dienes – Stability of 1,3 butadiene, mechanism of addition of bromine to 1,3 butadiene, Diel's Alder Reaction. Arenes: structure of benzene, aromaticity, 4n+2 rule, mechanism of electrophilic substitution in benzene - nitration and Friedal Craft's Alkylation. Electronic interpretation of the orienting influence of substituents in the electrophilic substitution of toluene, chlorobenzene and nitrobenzene. Resonance structures of naphthalene.

Unit IV (15 h)

Alkyl halides: SN_1 and SN_2 reaction mechanisms, properties influences towards SN reactions and its stereo chemistry, Elimination reactions - E1 and E2 and Saytzeff's rule and Hoffmann elimination. Stereochemistry of E1 and E2 reactions.

Alcohols: Classification, mono and dihydric alcohols; examples, general and distinguishing reactions. Glycols- Preparation, properties, trihydric alcohols glycerol-synthesis from propene, properties and uses.

Colloids: Meaning of true solution, colloidal solution, and coarse suspension, distinction between lyophilic and lyophobic sols, electrical properties of colloids. Fundamental study of Donnan equilibrium- application in biological system. Methods of preparation of colloidal solution, membrane permeability, separation of colloidal solutions, elementary studies- Tyndall effect, applications of emulsions in lipid chemistry.

I SEMESTER: PBC-01: BIOCHEMISTRY Practical - I

Major Experiment

Organic qualitative/functional group analysis: Urea, Benzoic acid, Salicylic acid, Aniline, Benzaldehyde, Benzyl alcohol, Benzene, Toulene, Chlorobenzene, Acetamide, Nitrobenzene, Benzamide, Cresols, Benzophenone etc.

Minor Experiment

Lab handling and preparations:

1. Handling of laboratory apparatus and glass wares. Use of analytical and digital balance
2. Calibration of weights and volumetric glass ware
3. Preparation of solutions:
   a. percentage solutions, b. Molar solutions, c. Normal solutions
4. Standardization of pH meter, Preparation of biologically important buffers (phosphate buffer pH 7.2, acetate buffer 4.0, bicarbonate buffer 9.8).
5. Determination of pKa value of a given weak acid using pH meter.

I SEMESTER
PRINCIPLES OF BIOCHEMISTRY

Paper I - 4H/W **TOTAL- 60 hours**

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1. Handling of laboratory apparatus and glass wares. Use of analytical and digital balance
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3. Preparation of solutions:
   a. percentage solutions, b. Molar solutions, c. Normal solutions
4. Standardization of pH meter, Preparation of biologically important buffers (phosphate buffer pH 7.2, acetate buffer 4.0, bicarbonate buffer 9.8).
5. Determination of pKa value of a given weak acid using pH meter.

II SEMESTER
BC-02: CELLULAR BIOCHEMISTRY

Paper II - 4H/WEEK **TOTAL- 60 hou**

Unit I (15 h)

Electrochemistry: Strong and weak electrolytes, Definition –specific and equivalent conducta conductivity cell, cell constant. Determination of equivalent conductance and, dissociation cons Conductometric titrations: Strong acid versus strong base, weak acid v/s strong base, weak acid v/s w base. Activity, activity coefficient, ionic strength (definition with example) common ion effect, Solub product and their applications in the preparation of pure sodium chloride and salting of soap. Ionic mobi ionic conductance. Kohlrausch's law and its applications in the determination of equivalent conductanc infinite dilution for weak electrolyte, and determination of ionic product of water. Electromotive fo Electrochemical cells, cell convention, emf of cell, determination of emf of cell, reversible electrodes cells. Single electrode potential (definition only), Sign of electrode potential and reduction potential t adapted. Nernst equation of standard electrode potential (no derivation) Reference electrodes: Calo electrode. Determination of pH using Quinhydrone and Glass electrode (relation b/w cell emf and pH t discussed) Potentiometric titrations - acid base and redox titrations. Relation b/w free energy and emf cell.

Unit II (15 h)

Co-ordination chemistry: Transition metal ions- definition, electronic configuration states of follow metals- Fe, Co, Mn. Co-ordination compounds: definition of different terms involved in it. Ligands: typ monodentate, bidentate, polydentate, ambidentate and macrocyclic ligands with examples. Stability complexes and factor effecting stability. Applications of complexes in qualitative and quantitative analys Valence Bond Theory- Assumptions, with examples – $Fe(CN)_6^{4-}$, $Fe(CN)_6^{3-}$, Cu(CN)4, Shapes of orbita Crystal field theory – Assumptions, Splitting in tetrahedral and octahedral complexes, Spectrochemic series of ligands, geometrical and optical isomers of complexes with co-ordination number 4 and 6.

Bioinorganic chemistry: Elements in biological systems: Iron (co-ordination environment in hem structure, Structure of heme, functions of haemoglobin & cytochromes. Role of iron in heme. Zinc (Zi containing metallo enzymes, role of carbonic anhydrase and carboxy peptidase). Magnesium (co-ordinatio environment in chlorophyll, Skeletal structure of chlorophyll, role of chlorophyll in photosynthesis. Coba (Vitamin B12), Molybdenum, Metallo enzymes.

Unit III (15 h)

Phenols: Classification, Electronic interpretation of acidity of phenols, effect of substituents on the acidity Mechanism of Kolbe's reaction, Riemer - Tiemann and bromination reactions.

Amines: Classification, isomerism; distinguishing reactions of primary, secondary and tertiary amine using Hinnsberg reagent and Nitrous acid. Effect of substituents on the basic strength of amine. Som biologically important amines (DOPA and Histamine)

Carbonyl compounds: Nomenclature and structure of C=O group. Relative reactivity of aldehydes an ketones. Addition of alcohols to aldehydes and ketones, keto-enol tautomerism. Explanation of HC addition to an aldehyde. Aldol, Claisen Condensation. Condensation reactions of hydroxylamine Hydrazine and phenyl hydrazine with mechanisms. Quinones: Ortho and parabenzoquinones, properties.

II SEMESTER
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Electrochemistry: Strong and weak electrolytes, Definition –specific and equivalent conducta conductivity cell, cell constant. Determination of equivalent conductance and, dissociation cons Conductometric titrations: Strong acid versus strong base, weak acid v/s strong base, weak acid v/s w base. Activity, activity coefficient, ionic strength (definition with example) common ion effect, Solub product and their applications in the preparation of pure sodium chloride and salting of soap. Ionic mobi ionic conductance. Kohlrausch's law and its applications in the determination of equivalent conductanc infinite dilution for weak electrolyte, and determination of ionic product of water. Electromotive fo Electrochemical cells, cell convention, emf of cell, determination of emf of cell, reversible electrodes cells. Single electrode potential (definition only), Sign of electrode potential and reduction potential to adapted. Nernst equation of standard electrode potential (no derivation) Reference electrodes: Calo electrode. Determination of pH using Quinhydrone and Glass electrode (relation b/w cell emf and pH to discussed) Potentiometric titrations - acid base and redox titrations. Relation b/w free energy and em cell.

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arboxylic acids: Classification; Acidity of monocarboxylic acids, effect of constituents of acid strength. Hydroxy acids: Effect of heat on alpha, beta & gamma hydroxy acids structures of tartaric acid, malic acid nd isocitric acid and citric acid. Dicarboxylic acids: Saturated dicarboxylic acids - effect of heat on first ive members. Keto acid: Structures, properties of and biological importance of pyruvic acid, alpha - ketoglutaric acid and oxaloacetic acids.

AL- 60 hou

Unit IV (15 h)

Ultrastructure of cell: Prokaryotic and eukaryotic cell. Sub cellular particles and marker enzymes. Nucleus, chromosomes, mitochondria, chloroplasts, ribosomes, endoplasmic reticulum, Golgi complex, lysosomes, glyoxosomes, and peroxysomes. Cytoskeletons-microfilaments, microtubules and intermediate filaments- distribution, types, structure and chemical composition. Biological importance, Structure, functions and difference b/w animal and plant cellular systems.

Biological membranes: Structure, functions and chemical composition of biological membranes. Structure of fluid mosaic model. Simple diffusion-definition, with examples. Facilitated transport-definition, types with examples. Symport, uniport and antiport. Active transport- primary active transport, secondary active transport, ion channels, sodium potassium ATPase. V, P and F type transports. Endocytosis, phagocytosis, receptor mediated endocytosis, protein trafficking in endocytosis.

Cellular interactions: cell-cell interaction and cell-matic interaction, extracellular matrix, proteoglycan collagen, cell- cell adhesion, catherins, desmosomes, gap junction and tight junction.

Cell cycle: Cell cycle- different phases including cell division- Mitosis and Meiosis (fundamental study), Apoptosis-definition, difference b/w apoptosis and necrosis and outline study of apoptotic pathway, role of caspases, regulation of cell cycle.

II SEMESTER: PBC-02: BIOCHEMISTRY Practical - II

Major Experiments

1. Estimation of HCl using approximate N/10 NaOH and oxalic acid crystals.
2. Estimation of NaOH using approximate N/10 HCl and sodium carbonate crystals.
3. Estimation of ferrous ion titrometric method using potassium dichromate.
4. Estimation of ferric ion by titrometric method using potassium dichromate.
5. Estimation of Copper sulphate by iodometric method.
6. Determination of hardness of water by complexometric titration.
7. Estimation of Mohr's salt using N/10 potassium permanganate and oxalic acid crystals.
8. Determination of cell constant of conductivity cell and equivalent conductivity of given electrolyte.
9. Determination of Ka value of weak acid by conductometric method.
10. Determination of density & viscosity of the given sample by Ostwald's Viscometer method.
11. Determination of equivalent conductivity of strong electrolyte at infinite dilution.
12. Determination of Molar mass of non-volatile salt by Walker Lumsden's method.
13. Determination of percentage of glycerol-water using Ostwald's Viscometer.

Minor experiments:

1. Identification of prokaryotic and eukaryotic cells using microscopic observation
2. Study of stages of meiosis using onion root tip
3. Comments on:
   - i) Phases of mitotic and meiotic stages of cell division
   - ii) Apoptosis and Necrosis
   - iii) Identification of Transport mechanism

Note: Practical proper: 20 Marks (Part A: 12, Part B: 06; Part C: 02), Record: 05 Marks, Viva: 05 Marks.

III SEMESTER
BC-03: BIOMOLECULES

Paper III - 4H/WEEK **TOTAL- 60 hours**

Unit I (15 h)

Carbohydrates: Definition, classification (based on hydrolysis, function and reducing property) a biological importance of carbohydrates. Monosaccharides - Definition, Stereochemistry monosaccharides - D and L designations, configurational relationships of aldoses and ketoses. Enantiom Epimers and diasteromers. Glucose: Open chain, configuration and ring structure, chair and b conformations. Anomers, mutarotation. Fructose: properties, configuration and ring structure (elucidati not required). Linear and cyclic structure (galactose, mannose, ribose and arabinose). Reactions a characteristics of aldehyde and keto group, action of acids and alkalies on sugars, reactions of sugars d to hydroxyl group. Derived monosaccharides: Definition, structure and biological importance of ami sugars, sugar acids and deoxysugars.

Disaccharides - Definition, establishment of glycosidic linkage, structure, occurrence, chemistry a functions of sucrose, lactose, trehalose, maltose, isomaltose and cellobiose.

Polysaccharides: Definition, classification structure and biological importance. Homopolysacchari Occurrence, structure, chemistry and functions of cellulose, starch, glycogen, chitin. dextrin and inuli Heteropolysaccharides: Occurrence, types, composition and functions of glycosaminoglycans li chondroitin sulphate, hyaluronic acid, keratin sulphate, dermatan sulphate and heparin. Bacterial cell- components; peptidoglycan.

Unit II (15 h)

Amino acids and Proteins: Amino acids: Definition, structure and classification of amino acids based o polarity and charge, D & L-amino acids. Standard and nonstandard amino acids. General reactions of amin acids – reaction with nitrous acid, $LiAlH_4$, phenyl isothiocyanate, dansyl chloride, ninhydrin, and HCHO and their significance. Essential and non-essential amino acids. Acid-base properties - zwitter ioni properties.

Peptides: Formation and characteristic properties of peptide bond, nomenclature, structure and biological importance of glutathione, oxytocin and vasopressin.

Proteins: Classification based on shape and functions of proteins. Structural organization of proteins - primary, secondary, tertiary and quaternary structure of proteins. Denaturation and denaturation of proteins Anfinsen's experiment.

Unit III (15 h)

Lipids: Biological importance; classification. Fatty acids – nomenclature, classification, physical and chemical properties of fatty acids. Essential and non -essential fatty acids with examples. Eicosonoids- Prostaglandin (structure of PGE1 and PGE2) and leukotrienes. Acyl glycerols: hydrolysis, rancidity and significance of saponification, acid and iodine number and their applications. Compound lipids: Structure and functions of phospholipids, glycolipids, sphingolipids, cerebrosides and gangliosides. Lipoproteins and waxes. Steroids: Structure of steroid nucleus, cholesterol, ergosterol, stigmasterol, calciferol. Membranes: formation of micelles, bilayer and vesicles, Functions and chemical composition of biological membrane and its structure (Fluid Mosaic model).

Carboxylic acids: Classification; Acidity of monocarboxylic acids, effect of constituents of acid strength. Hydroxy acids: Effect of heat on alpha, beta & gamma hydroxy acids structures of tartaric acid, malic acid and isocitric acid and citric acid. Dicarboxylic acids: Saturated dicarboxylic acids - effect of heat on first five members. Keto acid: Structures, properties of and biological importance of pyruvic acid, alpha - ketoglutaric acid and oxaloacetic acids.

Unit IV (15 h)

Ultrastructure of cell: Prokaryotic and eukaryotic cell. Sub cellular particles and marker enzymes. Nucleus, chromosomes, mitochondria, chloroplasts, ribosomes, endoplasmic reticulum, Golgi complex, lysosomes, glyoxosomes, and peroxysomes. Cytoskeletons-microfilaments, microtubules and intermediate filaments- distribution, types, structure and chemical composition. Biological importance, Structure, functions and difference b/w animal and plant cellular systems.

Biological membranes: Structure, functions and chemical composition of biological membranes. Structure of fluid mosaic model. Simple diffusion-definition, with examples. Facilitated transport-definition, types with examples. Symport, uniport and antiport. Active transport- primary active transport, secondary active transport, ion channels, sodium potassium ATPase. V, P and F type transports. Endocytosis, phagocytosis, receptor mediated endocytosis, protein trafficking in endocytosis.

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1. Estimation of HCl using approximate N/10 NaOH and oxalic acid crystals.
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4. Estimation of ferric ion by titrometric method using potassium dichromate.
5. Estimation of Copper sulphate by iodometric method.
6. Determination of hardness of water by complexometric titration.
7. Estimation of Mohr's salt using N/10 potassium permanganate and oxalic acid crystals.
8. Determination of cell constant of conductivity cell and equivalent conductivity of given electrolyte.
9. Determination of Ka value of weak acid by conductometric method.
10. Determination of density & viscosity of the given sample by Ostwald's Viscometer method.
11. Determination of equivalent conductivity of strong electrolyte at infinite dilution.
12. Determination of Molar mass of non-volatile salt by Walker Lumsden's method.
13. Determination of percentage of glycerol-water using Ostwald's Viscometer.

Minor experiments:

1. Identification of prokaryotic and eukaryotic cells using microscopic observation
2. Study of stages of meiosis using onion root tip
3. Comments on:
   - i) Phases of mitotic and meiotic stages of cell division
   - ii) Apoptosis and Necrosis
   - iii) Identification of Transport mechanism

Note: Practical proper: 20 Marks (Part A: 12, Part B: 06; Part C: 02), Record: 05 Marks, Viva: 05 Marks.

III SEMESTER
BC-03: BIOMOLECULES

Paper III - 4H/WEEK **TOTAL- 60 hours**

Unit I (15 h)

Carbohydrates: Definition, classification (based on hydrolysis, function and reducing property) a biological importance of carbohydrates. Monosaccharides - Definition, Stereochemistry monosaccharides - D and L designations, configurational relationships of aldoses and ketoses. Enantiom Epimers and diasteromers. Glucose: Open chain, configuration and ring structure, chair and b conformations. Anomers, mutarotation. Fructose: properties, configuration and ring structure (elucidat not required). Linear and cyclic structure (galactose, mannose, ribose and arabinose). Reactions characteristics of aldehyde and keto group, action of acids and alkalies on sugars, reactions of sugars to hydroxyl group. Derived monosaccharides: Definition, structure and biological importance of am sugars, sugar acids and deoxysugars.

Disaccharides - Definition, establishment of glycosidic linkage, structure, occurrence, chemistry a functions of sucrose, lactose, trehalose, maltose, isomaltose and cellobiose.

Polysaccharides: Definition, classification structure and biological importance. Homopolysacchari Occurrence, structure, chemistry and functions of cellulose, starch, glycogen, chitin. dextrin and inuli Heteropolysaccharides: Occurrence, types, composition and functions of glycosaminoglycans li chondroitin sulphate, hyaluronic acid, keratin sulphate, dermatan sulphate and heparin. Bacterial cell- components; peptidoglycan.

Unit II (15 h)

Amino acids and Proteins: Amino acids: Definition, structure and classification of amino acids based o polarity and charge, D & L-amino acids. Standard and nonstandard amino acids. General reactions of amin acids – reaction with nitrous acid, $LiAlH_4$, phenyl isothiocyanate, dansyl chloride, ninhydrin, and HCH and their significance. Essential and non-essential amino acids. Acid-base properties - zwitter ioni properties.

Peptides: Formation and characteristic properties of peptide bond, nomenclature, structure and biologica importance of glutathione, oxytocin and vasopressin.

Proteins: Classification based on shape and functions of proteins. Structural organization of proteins primary, secondary, tertiary and quaternary structure of proteins. Denaturation and denaturation of protein Anfinsen's experiment.

Unit III (15 h)

Lipids: Biological importance; classification. Fatty acids – nomenclature, classification, physical and chemical properties of fatty acids. Essential and non -essential fatty acids with examples. Eicosonoids- Prostaglandin (structure of PGE1 and PGE2) and leukotrienes. Acyl glycerols: hydrolysis, rancidity and significance of saponification, acid and iodine number and their applications. Compound lipids: Structure and functions of phospholipids, glycolipids, sphingolipids, cerebrosides and gangliosides. Lipoproteins and waxes. Steroids: Structure of steroid nucleus, cholesterol, ergosterol, stigmasterol, calciferol. Membranes: formation of micelles, bilayer and vesicles, Functions and chemical composition of biological membrane and its structure (Fluid Mosaic model).

Nucleic acids and Metals in Biological systems: Components of nucleic acids. Structure of purine and pyrimidine bases, tautomeric forms of bases, structure of nucleosides and nucleotides and polynucleotides. DNA: structure and biological role of Double helix Watson and Crick model (B-DNA). Physical properties of DNA. Conformational forms of DNA; A, B, C and Z forms. RNA: Types and biological role of RNA. Unusual bases in t-RNA. Denaturation of renaturation of nucleic acids. Isolation of nucleic acids and sequencing.

Unit IV (15 h)

Terpenes: Isoprene rule, structure of mono terpenes, Limonene, menthol, camphor. Structural elucidation of citral synthesis from methyl heptinine. Sequiterpenes- Sautonin, juvenile hormone-1, abscission-2. Diterpenes – Phytol, gibberlic acid, Triterpenes- Lanosterol. Tetraterpenes- lucopene.

Heterocyclic compounds: Classification, Nomenclature, Structural formulae and occurrence of furan, pyran, thiophene, oxazole, thiazole, pyrrole, imidazole, pyridine, quinoline, indole, isoquinoline, purine and pyrimidine. Aromaticity and chemical properties of furan, thiophene, pyrrole and pyridine. Electrophilic substitution reactions of pyrrole, furan and basicity of pyrrole and pyridine.

Alkaloids: Introduction and general characteristics. General method of Extraction. Survey of physiological functions/medical uses. Structural elucidation of Nicotine. Structure of nicotine, atropine and LSD.

Drugs: Elementary account of chemotherapy. Theory of sulpha drugs action. Synthesis and uses of antipyrine, aspirin, sulphathiazole and sulphanilamide and paracetamol. Antibiotics: Structure and bacterial spectrum of penicillin, chloramphenicol, streptomycin and tetracycline.

III SEMESTER: PBC-03: BIOCHEMISTRY Practical – III

Major Experiments

Qualitative analysis:

1. Carbohydrates - general reactions of carbohydrates and schematic analysis
   Glucose, fructose, maltose, lactose, sucrose, and starch.
2. Amino acids and Proteins - general reactions and schematic analysis
   Arginine, tyrosine, tryptophan and proline - Albumin and Casein
3. Lipids - animal fats and Vegetable oils

Minor experiments:

Isolation methods (any four)

1. Starch from potato
2. Casein from milk
3. Oil from oil seeds
4. DNA from onion leaves, coconut endosperm
5. Caffeine and tannin from Tea leaves
6. Citric acid from lemon juice

Note: Practical proper: 20 Marks (Part A: 05, Part B: 15 Marks), Record: 05 Marks, Viva: 05 Marks.

IV SEMESTER
BC-04: NUTRITIONAL BIOCHEMISTRY AND HUMAN PHYSIOLOGY

Paper IV - 4H/WEEK **TOTAL- 60 hours**

Unit I (15 h)

Nutrition and Energy Balance: Basic principle of balanced diet. Energy source and nutrients. nutritio requirements, food as source of nutrients. Proximate analysis of foods (in brief). Calorific value of foo units – bomb calorimeter. Respiratory quotient (RQ) –Calculation of non-protein RQ w.r.t carbohydra and lipids. Basal metabolic rate (BMR) – Definition, measurement of BMR by Benedict's Roth appara method. Factors affecting BMR. Specific dynamic action of food (SDA) – Energy requirement a recommended dietary allowances (RDA) for different physical activities for children and during pregnan and lactating women.

Unit II (15 h)

Macronutrients: Carbohydrates, Proteins and lipids: role as fuel molecules, sources, requirements, storag forms. Protein sparing effects of carbohydrates. Dietary fibers and their importance. Essential fatty aci cholesterol and biological importance. Proteins: role in the diet. Nitrogen balance. Essential amino acid Complete, incomplete and nutritive value of proteins and its Methods for assessment. Mutu supplementation and protein energy malnutrition.

Micronutrients: Vitamins: structure, rich sources daily requirements, functions and deficiency disord of fat soluble vitamins (A, D, E and K) and Water soluble vitamins (C and B complex-thiamine, riboflo niacin, pyridoxine, pantothenic acid, lipoic acid, biotin, folic acid and vitamin B12). Minerals: rich sourc daily requirements, function and deficiency disease of macro elements (Ca, P, Mg, Na, K and Cl and micr elements Co, Cu, I, Fe, Mn, Zn and Se).

Unit III (15 h)

Digestion and absorption of carbohydrates, proteins, and lipids. Generation of gastric HCl, gastric an bile juice - composition and function, Structure of villi, absorption mechanism and importance of porta vein in nutrient transport.

Blood: Body fluids, intra and extracellular fluid components, Constituents of blood and their functio (brief). Mechanism of blood clotting (intrinsic and extrinsic pathway), Clotting factors, anticoagulants, and function of hemoglobin, Sickle cell anemia, thalassemia, polycythemia and blood buffers (in brief).

Respiration- Transport of oxygen and carbon dioxide in blood, carbonic anhydrase, chloride shift, oxygen dissociation curve and Bohr-effect.

Renal function- Kidneys, location structure and importance. Structure of nephrons, renal excretory mechanism (glomerular filtration, tubular reabsorption and secretion). Composition of urine, regulation water and electrolyte balance.

Respiratory and renal regulation of pH - Role of kidney and lungs in in acid-base balance, acidosis and alkalosis (in brief).

Unit IV (15 h)

Liver: Structure and functions of the lobule, mechanism of detoxification (in brief).

Muscle: types and muscle cell-sarcomere. Muscle proteins organization and mechanism of muscle contraction (Sliding filament theory). Role of myoglobin and creatinine phosphate.

Nerve system: classification and structure of neuron. Mechanism of conduction of nerve impulse, membrane action potential, and synaptic transmission and neurotransmitters.

Brief account on blood brain barrier and special sensory organs: skin, eye, ear, nose and tongue.

Bone: Composition and structure of long bone, growth and remodeling of bone.

Endocrine system: organization and Classification of hormones based on structure and mechanism of action Receptors and secondary messengers and functional regulation. Brief study on the structure, physiological functions and abnormalities of hormones from hypothalamus, pituitary, adrenal cortex and medulla, pancreas, gonads, thyroid, parathyroid, placenta, kidney and GIT.

IV SEMESTER: PBC-04: BIOCHEMISTRY Practical – IV

Major Experiment

1. Estimation of amino acid by Sorenson's formal titration method
2. Estimation of calcium in milk using $KMnO_4$ and oxalic acid crystals.
3. Estimation of ascorbic acid in biological sample by indophenol method.
4. Estimation of inorganic phosphorous in Biological sample by Fiske-Subbarao method.
5. Estimation of oxalate content in biological sample
6. Estimation of antacid present in commercial samples by titration method.
7. Determination of Saponification value of oil.
8. Determination of Iodine value of oil
9. Determination of pKa and pI value of amino acid conductometrically

Minor experiments:

1. Qualitative analysis of food adulterants in
   a) Oils and fats
   b) Milk, milk products and synthetic milk
   c) Beverages, spices and condiments and pulses
2. Isolation of blood cells and study of hemolysis.

Note: Practical proper: 20 Marks (Part A: 05 marks, Part B: 15 Marks), Record: 05 Marks, Viva: 05 Marks.

V SEMESTER

BC-05: BIOANALYTICAL TECHNIQUES, ENVIRONMENTAL BIOCHEMISTRY AND BIOINFORMATICS

3H/WEEK **TOTAL- 45 hours**

Unit I (15 Hr)

Introduction: Scope of isolation and purification of biomolecules- strategy, aim, objective and sources brief). Sample selection, methods of tissue homogenization. Salt and organic solvent extraction fractionation. Dialysis, Reverse dialysis, ultrafiltration, lyophilization.

Chromatography: Principle, procedure and application of partition chromatography, adsorp chromatography, ion-exchange chromatography, column or size exclusion chromatography, affi chromatography, GLC and HPLC.

Electrophoresis: Principle and applications of free flow, zone electrophoresis (Paper electrophoresis, electrophoresis, PAGE, SDS-PAGE and *Disc* PAGE). Isoelectric focusing, High voltage electrophoresi Pulse field electrophoresis, Immuno-electrophoresis, 2D PAGE.

Unit II (15 Hr)

Centrifugation: Principle of sedimentation technique. Different types of centrifuge and rotors. Princip procedure and application of differential centrifugation, density gradient centrifugation, u centrifugation, rate zonal centrifugation, isopycnic centrifugation.

Colorimeter and spectrophotometry: Laws of light absorption - Beer - Lambert's law. UV and visib absorption spectra, molar extinction coefficient and quantitation. Principle and applications of colorimet and spectrophotometry. Outline principle and application of nephelometry, Turbidometry, fluorometry, a atomic absorption spectra, NMR and Mass spectrophotometer (in brief).

Biostatistics: Aims, scope, definition and elementary idea of statistics in biology. Computatio classification, tabulation and diagrammatic presentation of statistical data. Basics of measures of centr tendencies- mean, median, mode- measures of variations, standard deviation (SD), standard error mea (SEM). Basics of correlation and regression and its applications in biology.

Unit III (15 Hr):

Environmental Biochemistry: Air pollution: Pollutants and their control, carbon dioxide, sulphur dioxide oxides of nitrogen and hydrogen. Carbon dioxide and greenhouse effect. Chlorofluorocarbon and the ozone layer. **Water pollution**: BOD and COD. Treatment of sewage and industrial effluents, Pesticide hazards. Structures and uses of the following: insecticide: malathion, Herbicide: 2,4 D & 2,4 S, Disposal of radioactive wastes. Biochemical effects of lead, mercury, arsenic and cadmium.

BIOINFORMATICS: Introduction to bioinformatics, its importance and scope, different disciplines of bioinformatics, relationship with various branches of life sciences. Computational approaches to Biological sciences. Detailed study of various databases - Definition, information generation, Storage, editing and retrieval. Classification- Database management, public agencies-NCBI data model and structure of EIC and genome net and Genebank sequence database.

Sequence alignment and database searching: Introduction, protein and nucleic acid sequence analysis models of sequence analysis, tools for sequence search, analysis and alignment. Sequence, comparison b BLASTA and FASTA, human genome project and its significance.

V SEMESTER: PBC-05: BIOCHEMISTRY Practical – V

Major Experiments

1. Separation of amino acids by ascending paper chromatography
2. Separation of amino acids by descending paper chromatography
3. Separation of amino acids by circular paper chromatography
4. Separation of amino acids by thin layer chromatography (TLC)
5. Separation of amino acids by column chromatography.
6. Measurement of pKa & pI value of amino acid using pH meter (glycine or alanine)
7. Study of construction and operation of colorimeter.
8. Measurement of the absorption maxima of colored solution.

Minor experiments

Preparation by oxidation, acetylation, bromination and nitration reactions

a. Aspirin from salicylic acid
b. Benzoic acid from benzaldehyde
c. Bromoacetanilide from acetanilide
d. m-dinitrobenzene from nitrobenzene

Note: Practical proper: 20 Marks (Part A: 05 marks, Part B: 15 Marks), Record: 05 Marks, Viva: 05 Marks.

V SEMESTER

BC-06: MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOI

3H/WEEK **TOTAL**

Unit I (15 Hr)

Genetics: Mendel's laws of inheritance, gene interaction, Dominance relationship-compl and co-dominance, Concept of gene- allele, multiple alleles, pseudo allele, complementatio Chromosomal aberrations: Monosomy, trisomy. Translocations, inversions, duplications, d

Methods in Genetics: Gene mapping in haploid and diploids, recombination mapping, co analysis- physical mapping and restriction mapping.

Genetic material: DNA as a genetic material - Griffith transformation experiment and H experiment.

DNA Replication: Types of replication-conservative, semi conservative, dispersive. verification of semi conservative mode of replication. Enzymes involved in replication. DNA replication in prokaryotes - Initiation, Elongation and Termination. DNA damage and RNA replicase, RNA dependent RNA polymerase in replication of RNA viruses.

Unit II (15 Hr)

RNA Biosynthesis: Transcription in prokaryotes - Transcription factors and machinery, initiation complex, activators and repressors, Role of RNA polymerase, elongation, termina transcriptional modifications.

Genetic code: Deciphering of the genetic code - Nirenberg and Khorana work general fea properties of t-RNA, wobble hypothesis.

Protein synthesis: A brief account of ribosome's (in prokaryotes), activation of amino acid Initiation complex, initiation factors and their regulation, elongation and elongation factors, Post translational modification and inhibitors of protein synthesis.

Gene regulation: Regulation of gene expression in prokaryotes its types, Operon concept- Tryp Operon; Inhibitors - Replication, Transcription and Translation as targets for Antibiotic a

Unit III (15 Hr)

Introduction: Brief history and principles of genetic engineering, molecular tools of genetic e

Enzymes used in r-DNA technology - Types, detail account of restriction endonuclease

Vectors (The cloning vehicles)-Salient features of vectors, plasmids, bacteriophage, cosm chromosomal vectors.

Methods of gene transfer- Transformation, Conjugation, Electroporation, Liposome me transfer and direct transfer of DNA.

Gene cloning strategies: Cloning from genomic DNA or m-RNA- Construction of chim Introduction of chimeric vectors to the host cell. Selection of transformed cell. Genomic libı construction, c-DNA synthesis.

Basic techniques in genetic engineering- Isolation and purification of nucleic acid, cellulai RNA, blotting techniques - Types (Southern, Northern and Western) and application. DNA s method-PCR: Principle, methodology and applications. Site directed mutagenesis and protein er

Applications of r-DNA: In disease diagnosis and medical forensic: DNA chip - Microarray of ge DNA in the diagnosis of infectious disease, Genetic disease. Construction of gene bank, D printing, DNA markers in diseases, RFLP, VNTR, and SNP's.

pharmaceutical products of r-DNA technology - Insulin in Diabetes, Recombinant vaccines, DNA accines, transgenic animals, transgenic clones, benefits and adverse effects of r-DNA technology in

ciety.

V SEMESTER: PBC-06: BIOCHEMISTRY Practical – VI

Major Experiments

1. Isolation of DNA from sheep liver & assessment of its purity
2. Estimation of DNA by Diphenylamine method.
3. Verification of Beer-lamberts law for a given colored solution
4. Estimation of glucose colorimetrically by DNS method
5. Estimation of glucose colorimetrically by Folin-Wu method
6. Estimation of protein colorimetrically by Biuret method
7. Estimation of ferric ion using ammonium thiocyanate solution.
8. Estimation of Creatinine by Jaffe's method.
9. Estimation of Cholesterol by Zak's method.

Minor experiments

1. Demonstration of the activity of urease from horse gram
2. Demonstration of the activity of phosphatase from potato

Note: Practical proper: 20 Marks (Part A: 05 marks, Part B: 15 Marks), Record: 05 Marks, Viva: 05 Marks.

Pharmaceutical products of r-DNA technology - Insulin in Diabetes, Recombinant vaccines, DNA vaccines, transgenic animals, transgenic clones, benefits and adverse effects of r-DNA technology in society.

V SEMESTER: PBC-06: BIOCHEMISTRY Practical – VI

Major Experiments

1. Isolation of DNA from sheep liver & assessment of its purity
2. Estimation of DNA by Diphenylamine method.
3. Verification of Beer-lamberts law for a given colored solution
4. Estimation of glucose colorimetrically by DNS method
5. Estimation of glucose colorimetrically by Folin-Wu method
6. Estimation of protein colorimetrically by Biuret method
7. Estimation of ferric ion using ammonium thiocyanate solution.
8. Estimation of Creatinine by Jaffe's method.
9. Estimation of Cholesterol by Zak's method.

Minor experiments

1. Demonstration of the activity of urease from horse gram
2. Demonstration of the activity of phosphatase from potato

Note: Practical proper: 20 Marks (Part A: 05 marks, Part B: 15 Marks), Record: 05 Marks, Viva: 05 Marks.

VI SEMESTER

BC-07: ENZYMOLOGY AND INTERMEDIARY METABOLISM

3H/WEEK TOTAL- 45 hour

Unit I:

ENZYMES: IUB system of classification and nomenclature of enzymes (Class and subclass wi example) Holoenzyme, apoenzyme, prosthetic group. Interaction between enzyme and substrate- loc key model, induced fit model. Features of active site, activation energy, enzyme specificity and

Enzyme kinetics: Importance, order of reaction, study of the factors affecting the velocity of en catalyzed reaction- enzyme concentration, temperature, pH, substrate concentration, inhibitors activators (explanation with graphical representation). Derivation of Michalis - Menten equation an value determination and its significance. Definition of Vmax value of enzyme and its signific Lineweaver- Burk plot (Only for single substrate enzyme catalyzed reaction). Unit of enzyme activ definition and importance.

Enzyme inhibition: Reversible and irreversible – examples. Reversible- competitive, noncompetitive uncompetitive inhibition- explanation of double reciprocal plot with examples. Brief account of Allos enzymes-ATcase, Multi enzyme complex-PDH.

Immobilization of enzymes, methods of immobilization, characterization and general applicat Industrial uses of enzymes: Detergent enzymes, thermo stable alpha amylase, papain, chymotrypsin.

Unit II (15 Hr)

Introduction: Anabolism, catabolism, stages in catabolism, compartmentalization and integratio metabolic pathway in cells. General modes regulation of metabolic pathways.

Carbohydrate metabolism: Glycolysis, entry of other carbohydrates into glycolysis, oxidation pyruvate, fates of pyruvate, TCA cycle the amphibolic and integration role of the TCA cycle, anaplero Energetics of glucose, metabolism of glycogen, gluconeogenesis, pentose phosphate pathway, Cori cy Their regulation and its significance.

Metabolism of lipids: Fatty acid oxidation - β oxidation of even and odd chain fatty acid and its energe Biosynthesis of fatty acids, Fatty acid elongation. Cholesterol synthesis and significance.

Metabolism of proteins: Protein turn over, proteolytic enzymes. transamination, oxidative deaminati non-oxidative deamination and decarboxylation of amino acids. Metabolism of ammonia - Urea cyc Integration of urea cycle with TCA cycle. Metabolic fate of amino acids - glucogenic, ketogenic and glu ketogenic.

Unit III (15 Hr)

Bioenergetics: Laws of thermodynamics - Role of high energy phosphates in energy transfer, free ener concept.

Biological oxidation: Step wise process of biological oxidation, standard redox potential of some bio chemically important half reactions. Calculation of energy yield from biological oxidation reduction reaction.

Mitochondrial electron transport chain: components, schematic representation indicating sites of A synthesis. Oxidative phosphorylation - chemiosmotic theory (an outline) substrate level phosphorylatic Uncouplers and inhibitors of oxidative phosphorylation, p/o ratio and its significance.

Photosynthesis: The photosynthetic apparatus, outlines of the light and dark reactions. C-4 pathway a Crassuacean acid metabolic (CAM) Pathway.

VI SEMESTER: PBC-07: BIOCHEMISTRY Practical – VII

Major Experiments

1. Qualitative analysis of Inorganic and organic constituents in Urine
2. Qualitative analysis of abnormal constituents in Urine
3. Qualitative analysis of Saliva
4. Qualitative analysis of Milk
5. ABO blood grouping- Identification of blood type.
6. Antigen-antibody precipitation reaction by agarose diffusion method.
7. Isolation of Leucocytes (WBC) by gradient centrifugation method.
8. Differential counting of blood cells by Haemocytometer.
9. Estimation of Keto acid by DNPH method.
10. Estimation of Urea by DAMO method.
11. Assay of salivary amylase
    a) Determination of activity and specific activity by DNS method
    b) Determination of effect of pH
    c) Determination of effect of temperature
    d) Determination of time kinetics
    e) Determination of Km and Vmax.

Minor experiments

1. Demonstration of Rocket Electrophoresis or ELISA.
2. Demonstration of glucose tolerance (GTT) using glucometer and strips to identify the insulin tolerance

Note: Practical proper: 20 Marks (Part A: 05 marks, Part B: 15 Marks), Record: 05 Marks, Viva: 05 Marks

VI SEMESTER
BC-08: IMMUNOLOGY AND CLINICAL BIOCHEMISTRY

3H/WEEK **TOTAL- 45 ho**

Unit I (15 Hr)

Introduction: Cells and Organs of Immune system: Primary and secondary lymphoid organs, lymp cells, stem cells, B and T lymphocytes, Null cells, Mononuclear cells, granulocytic cells **Immunity**: I immunity (Nonspecific) - Anatomic barriers, Physical barrier, Phagocytic, Inflammatory. Ada (Specific) Immunity- Humoral and cell mediated immune responses, Recognition of antigens by B a lymphocytes. Processing and presentation of antigens, Clonal selection of lymphocytes. Cellular intera for generation of humoral and cell mediated response.

Antigens: types, characteristics, antigenicity. Immunogens and factors that influence immunogenicity, epitopes, haptens.

Immunoglobulins- Structure, classes and functions of immunoglobulins. Antigenic determinants immunoglobulins. Recognition and production of antibody, clonal expansion theory and antibody divers Monoclonal antibody and its production, Abzymes.

Unit II (15 Hr)

Antigen-antibody interactions: Precipitation reaction, agglutination, ELISA, RIA, Immuno-precipitati Immunofluorescence. T-cell receptors, maturation, activation and differentiation. B- cell recept maturation, activation and proliferation. Cytokines- structure, importance and function, Antagonist **Ma histo-compatability complex (MHC):** Definition and types and their structure – MHC I & II. Anti processing, presentation by MHCs, activation and differentiation of B and T cells. Transplantation-type graft, graft rejection (in brief). ABO blood group, compatibility and immunosuppressive dru **Complement system**: The function of complement, complement activation. **Hyper-sensitivity reaction** types, mechanisms (in brief). **Immunity in health and diseases:** Immune response during bacter (tuberculosis), parasitic (malaria) and viral (HIV) infections, Congenital and acquired immunodeficienc autoimmune diseases - osteo and rheumatoid arthritis. **Vaccine**: Active and passive immunization, type of vaccine, mechanism of immune boosting by vaccines.

Unit III (15 Hr):

Introduction: Definition, scope of biochemistry in diagnosis, quality control external quality contro accuracy, precision, specificity. Collection and preservation of biological fluids - Blood and urine **Disorder of carbohydrate metabolism:** Blood sugar level and its clinical significance - hypoglycemia and hyperglycemia. Diabetes mellitus - definition, clinical features, biochemical and metabolic changes (i brief). Glucose tolerance test - definition, types (oral GTT to be discussed in brief).

Disorder of lipid and amino acid metabolism: Ketosis and their clinical significance Hypercholesterolemia, atherosclerosis. Disorder of aminoacid metabolism - Alkaptonuria and phenylketonuria

Organ function tests: Kidney: Renal Function test- types (in brief), **Clearance test**: Definition, urea clearance test (in brief). **Liver:** Disorders of Liver-Jaundice types and diagnosis by Van den Berg reaction **Clinical significance of Enzymes:** Definition of functional and nonfunctional plasma enzymes. Isoenzymes and diagnostic tests. Enzyme pattern in health and disease with special mention of plasma lipase, amylase, choline esterase, alkaline and acid phosphatase, SGOT, SGPT, LDH and Creatinine Kinase.

VI SEMESTER: PBC-08: BIOCHEMISTRY Practical – VIII

1. **PROJECT / DISSERTATION**
2. **SEMINAR**
3. **STUDY TRIP**