



**KUVEMPU UNIVERSITY**  
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## **SEP SYLLABUS FOR B.Sc., COURSE IN BIOCHEMISTRY (2024)**

### **SEMESTER I FUNDAMENTALS OF BIOCHEMISTRY**

#### **Unit 1:**

**12h**

**General Introduction:** Origin of Biochemistry as a discipline. Definition, scope and significance of Biochemistry. Chemical composition of living organisms. Water as a solvent of life.

**Acids, Bases and Buffer:** Dissociation of water, ionic product of water, concept of pH and pOH, Dissociation of weak acids and weak bases, Bronsted Lowry theory, Lewis concept of acids and bases. Titration curves of strong and weak acids and bases. Meaning of  $K_a$  and  $pK_a$ . Buffers, preparation of buffers, buffer action and buffer capacity, Buffers in biological system and its importance. Henderson-Hasselbalch equation and derivation. pH meter, Electrodes (Hydrogen Electrode & Calomel electrode), glass electrode, standard hydrogen electrode.

Stoichiometry: Molarity, molality, normality, ppm and ppb. Primary and secondary standards, Requirement of primary standards. Types of titrations, acid-base titration, Redox iodometry, precipitation. Complexometric titrations with examples. Choice of indicators.

#### **Unit 2:**

**12h**

**Chemical Bonding:** Types of bonds & bond characteristics - Ionic, covalent, co-ordinate bonds. Atomic orbitals and molecular orbitals – Molecular Orbital Theory, bonding and anti-bonding of molecular orbitals, sp, sp<sup>2</sup>, sp<sup>3</sup> and sp<sup>3</sup>d<sup>2</sup> hybridizations with suitable examples. Sigma and pi bonds with examples. Vander Waal's forces, ion-dipole, dipole – dipole interactions, London forces, hydrophobic interaction, hydrogen bonding. Effect of chemical forces on physical properties (Solubility, BP and MP).

**Colligative properties:** Osmotic pressure: Definition and its measurements by the Berkley's Hartley method, Hypotonic, hypertonic and isotonic solutions. Effect of osmotic pressure on

living cells. Laws of osmotic pressure (only statement), Plasmolysis, Turgid state and reverse osmosis. Viscosity - Definition, Experimental method of measuring viscosity of liquids and solutions by Ostwald's viscometer. Surface tension – Definition and its measurement. Distribution law - Distribution law, partition coefficient. Applications of distribution law. Radioactivity, types of radioactivity, importance in biological system.

**Co-ordination compounds:** Co-ordinate bond, double and complex salts – differences with examples. Postulates of Werner's theory. Types of ligands – uni, bi and polydentate with examples. Co-ordination number. Porphyrin nucleus and classification. Important metalloporphyrins occurring in nature, structure and their biological importance (Hb, cytochrome, chlorophyll, Vitamin B12). Bilepigments–Types, structure and biological importance.

### **Unit 3:**

**12h**

**Reaction mechanisms:** Concept of inductive effect, resonance and hyper conjugation with examples. Classification of organic reactions (substitution, addition, elimination and rearrangement), with two examples for each. Concepts of the following – carbanions, carbocations, free radicals, carbenes, nucleophiles and electrophiles.

**Stereochemistry:** Stereoisomerism, types, Fischer-projection formulae, chiral carbon atom, asymmetry and dissymmetry, chirality, conditions for optical isomerism ex: glyceraldehyde, lactic acid, tartaric acid, enantiomers, diastereomers. D and L notation, R and S system, racemisation and resolution (Biochemical, chemical and physical methods). Geometrical isomerism. E and Z notations.

**Carbonyl compounds:** General properties. Aldehydes and ketones. Keto-enol tautomerism, Mechanism: Claisen and aldol condensations. Quinones: Biologically important quinones.

### **Unit 4:**

**12h**

**Heterocyclic compounds:** Definition, classification with examples, structure and biological importance of furan, pyrrole, thiophene, pyridine, pyran, thiazole, pyrimidine, purine, indole, imidazole, quinoline and isoquinoline. Basicity of pyrrole and pyridine.

**Terpenes:** Definition, isoprene rule, classification, isolation, structure and biological importance of menthol, camphor, phytol.

**Steroids:** Basic ring structure in steroids. Structure and biological importance of cholesterol, phytosterols and ergosterol. Bile acids [Mono, Di & Tri cholic acids].

**Alkaloids:** Definition, classification based on their structure and biological functions, isolation, structure and biological action of morphine, nicotine & atropine.

**Drugs:** Classification of drugs; synthesis and uses of sulphanilamide and paracetamol.  
**Antibiotics:** Definition; types; sources.

#### **REFERENCES:**

1. Puri, Sharma, Arun Bhal & B S Bhal, Pathania Text Book of Physical Chemistry
2. Puri, Sharma, Arun Bhal & B S Bhal, Pathania Text Book of Inorganic Chemistry
3. A Guide to Organic Reaction Mechanism - P. Sykes
4. General & Inorganic Chemistry - R.P.Sarkar
5. Inorganic Chemistry - R.L.Dutta
6. New Concise Inorganic Chemistry - J.D.Lee
7. F.A.Cotton & G.Wilkinson. Basic Inorganic Chemistry, John Wiley (1998)
8. Douglas, Mcdaniel and Alexander: Concepts and Models In Inorganic Chemistry, John Wiley, 3<sup>rd</sup> Edition (1994).
9. James E.Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Public, 4<sup>th</sup> Edition (2013).
10. Pattabhi.V. and Gautham.N. (2002) Biophysics. Narosa Publishing House, India.
11. Stereochemistry of Carbon Compounds- D.Nasipuri

## **Practical-1 Content:**

1. Calibration of volumetric glassware (Burette, pipette and volumetric flask).
2. Preparation of normal, molar and percentage solution and dilutions.
3. Preparation of standard sodium carbonate solution, standardization of HCl (Methyl orange) and estimation of NaOH in the given solution. (Methyl orange or phenolphthalein).
4. Preparation of standard oxalic acid. Standardization of NaOH and estimation of H<sub>2</sub>SO<sub>4</sub> in the given solution (phenolphthalein).
5. Preparation of standard K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>. Standardization of Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> and estimation of CuSO<sub>4</sub> in the given solution.
6. Preparation of ZnSO<sub>4</sub>. Standardization of EDTA and estimation of total hardness of water using eriochrome black-T indicator.
7. Preparation of standard potassium biphthalate. Standardization of NaOH and estimation of HCl in the given solution. (Phenolphthalein).
8. Calibration of pH meter and determination of pH of aerial drinks and Preparation of buffers - acetate and phosphate buffers.
9. Determination of density and viscosity of the given liquid using specific gravity bottle and Ostwald's viscometer.
10. Determination of density and surface tension of the given liquid using specific gravity bottle and stalagmometer.
11. Preparation of standard potassium biphthalate. Standardization of NaOH and Determination of alkalinity of antacids.

## **REFERENCES:**

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Dr. O. P. Pandey, D. N. Bajpai, dr. S. Giri, Practical Chemistry S. Chand and Co. Ltd.,
4. Principles of Practical Chemistry- M. Viswanathan
5. Instrumental Methods of chemical Analysis B.K Sharma.
6. Experiments in Physical Chemistry R.C. Das and B. Behra, Tata Mc Graw Hill
7. Advanced Practical Physical Chemistry J.B. Yadav, Goel Publishing House
8. Advanced Experimental Chemistry. Vol-I J.N.Gurtu and R Kapoor, S. Chand and Co.
9. Practical Chemistry K.K. Sharma, D. S. Sharma (Vikas Publication).
10. General Chemistry experiment – Anil J Elias (University press).

## SEMESTER II:

### BIOMOLECULES AND CELLULAR BIOCHEMISTRY

#### Unit 1:

12h

**Carbohydrates:** Definition and classification of carbohydrates (based on hydrolysis, function and reducing property),

**Monosaccharides** - Definition, Stereochemistry of monosaccharides - D and L designations, configurational relationships of aldoses and ketose. Enantiomers, Epimers and diastereomers. Glucose - properties, open chain, configuration and ring structure, chair and boat configurations. Anomers, mutarotation. Fructose - properties, configuration and ring structure. Linear and cyclic structure (galactose, mannose, ribose and arabinose). Reactions and characteristics of aldehyde and keto group, action of acids and alkalies on sugars, reactions of sugars due to hydroxyl group.

**Derived monosaccharides** - Definition, structure and biological importance of amino sugars, sugar acids and deoxy sugars.

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

**Polysaccharides** - Definition, classification structure and biological importance. Homopolysaccharides - Occurrence, structure, chemistry and functions of cellulose, starch, glycogen, chitin. dextrin and inulin. Heteropolysaccharides - Occurrence, types, composition and functions of glycosaminoglycans like chondroitin sulphate, hyaluronic acid, keratin sulphate, dermatan sulphate and heparin. Bacterial cell wall components – peptidoglycan. Biological importance of carbohydrates.

#### Amino acids and Proteins:

**Amino acids:** Definition, structure and classification of amino acids based on polarity and charge, D & L amino acids, Standard and non standard amino acids. General reactions of amino acids- reaction with nitrous acid,  $\text{LiAlH}_4$ , phenyl isothiocyanate, dancyl chloride, ninhydrin, and HCHO and their significance. Essential and non essential amino acids. Acid-base properties, zwitter ionic properties.

**Peptides** - Definition, formation of peptide bond, characteristic properties of peptide bond, nomenclature, structure and biological importance of glutathione, oxytocin and vasopressin.

**Proteins:** Definition, classification based on shape and functions of proteins. Structural organization of primary, secondary, tertiary and quaternary structure of proteins. Denaturation, renaturation (Anfinsen experiment should be discussed), precipitation of proteins.

## **Unit 2:**

**12h**

**Lipids:** Biological importance. Classification of lipids with examples. Fatty acids - nomenclature, classification, physical and chemical properties of fatty acids. Essential and non essential fatty acids with examples, eicosanoids, prostaglandin (structure of PGE1 and PGE2).

**Acyl glycerols** - hydrolysis, rancidity and significance of saponification number, acid number and iodine number and their application.

**Compound lipids** - Structure and functions of phospholipids, glycolipids, sphingolipids, cerebrosides and gangliosides. Lipoproteins and waxes.

**Nucleic Acids:** Components of nucleic acids. Structure of purine and pyrimidine bases, tautomeric forms of bases, structure of nucleosides and nucleotides and polynucleotides. Isolation of nucleic acids. DNA: structure and biological role of Double helix Watson and Crick model, A, B, and Z forms of DNA, physical properties of DNA. RNA - Types and biological role of RNA - (tRNA, rRNA, mRNA, ssRNA), unusual bases in tRNA, denaturation and renaturation of nucleic acids.

## **Unit 3:**

**12h**

### **Cellular Biochemistry:**

**Ultrastructure of cell:** Prokaryotic and eukaryotic cell. Sub cellular organelles. Cytoskeletons - microfilaments, microtubules and intermediate filaments - distribution, types, structure and chemical composition. Difference b/w animal and plant cellular systems.

**Biological membrane:** 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. Endocytosis, phagocytosis.

## **Unit 4:**

**12h**

**Cellular interactions:** cell-cell interaction and cell - matrix interaction, extracellular matrix, proteoglycan and 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, outline study of apoptotic pathway, role of caspases, regulation of cell cycle.

## References:

1. Principles of Biochemistry, Donald Voet, Judith G Voet, Charlotte W. Pratt, 4<sup>th</sup> Edition, John Wiley and Sons Inc, 2012
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications 2012
3. Biochemistry- the chemical reactions of living cells, David E Metzler, 2<sup>nd</sup> Edition, Elsevier Academic Press,
4. Fundamentals of Biochemistry, Jain, J.L, S.Chand publication 6th Edition, 2005.
5. Biochemistry, Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, Freeman and company, 7th Edition, 2010.
6. Harper's Illustrated Biochemistry, Victor W Rodwell, et.al, 31st edition, McGraw Hill Education Lange ® 2018.
7. Biochemistry, Lubert Stryer 5th edition 2015
8. Cell Biology by Veer Bala Rastogi, C B Powar, P S Verma and V K Agarwal
9. Karp's cell biology by Janet Iwasa and W Marshall

## **Practical-2 content:**

### **1. 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, cysteine, Albumin and Casein
3. Lipids- animal fats and Vegetable oils

### **2. Isolation methods (any four)**

1. starch from potato
  2. Casein from milk
  3. DNA from onion leaves, coconut endosperm
  4. Caffeine or tannin from Tea leaves
  5. Citric acid from lemon juice
3. Identification of prokaryotic and eukaryotic cells using microscopic observation
  4. Study of stages in mitosis using onion root tip
  5. Comments on:
    1. Phases of mitotic and meiotic stages of cell division
    2. Apoptosis and Necrosis
    3. Identification of Transport mechanism.

## **References:**

1. Practical Biochemistry, Geetha Damodaran, Jaypee, 2011
2. Biochemical methods, S. Sadasivam , A. Manickam, 3<sup>rd</sup> Edition, New Age International Pvt Ltd, 2007
3. An Introduction to Practical Biochemistry, David Plummer , 3rd edition 2017
4. Laboratory manual in Biochemistry , J. Jayaraman 2011



Semester	Paper Titles	Contact hours/week	Credits
1	Fundamentals of Biochemistry Practical-1	3 4	3 2
2	Biomolecules and Cellular Biochemistry Practical-2	3 4	3 2
3	Bioanalytical Techniques Practical-3	3 4	3 2
4	Human Physiology and Nutrition Practical-4	3 4	3 2
5	Enzymology and Metabolism Practical-5	3 4	3 2
6	Molecular Biology and Immunology Practical-6	3 4	3 2

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