

# SYLLABUS

## B.Sc. (Honours) - Biochemistry (3<sup>rd</sup> Semester)

Three/Four Years Undergraduate Degree Course [CBCS Semester Mode]

[As per the "Guidelines for Multiple Entry and Exit in Academic Programmes offered in Higher Education Institutions" issued by UGC New Delhi under NEP 2020]

Session: 2022-26

**SCHOOL OF STUDIES IN BIOCHEMISTRY  
JIWAJI UNIVERSITY  
GWALIOR - 474 011 (MP)**

*Muzamil*

*netus diva*

*AD*

**Jiwaji University, Gwalior**  
**B.Sc. (Hons) Biochemistry 2021-25**

**Course Structure and Scheme of Examination**

**THIRD SEMESTER (Examination Dec 2023)**

Course Code	Course Name	Total Marks	Credit	End Sem Exam Marks		Sessional Marks	
				MAX	MIN	MAX	MIN
<b>BCH CC-V-T</b> (Major Course)	Intermediary Metabolism (Theory)	100	4	60	21	40	14
<b>BCH CC-VI-T</b> (Minor Course)	Membrane Biology and Bioenergetics (Theory)	100	4	60	21	40	14
<b>BCH CC-V-P</b>	Intermediary Metabolism-Lab	100	2	60	21	40	14
<b>BCH CC-VI-P</b>	Membrane Biology and Bioenergetics-Lab	100	2	60	21	40	14
<b>GE-III-T</b>	Chemistry-I (Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons) (Theory)	100	4	60	21	40	14
<b>SEC-I-T</b>	Tools and Techniques in Biochemistry (Theory)	100	4	60	21	40	14
	<b>Grand Total</b>		<b>20</b>				

*Handwritten signatures and initials:*  
 - A signature that appears to be "Ajay Kumar"  
 - Another signature that appears to be "Rajesh Kumar"  
 - A circular stamp or initials "CO" with a checkmark.

## **B.Sc. [Honors] Biochemistry [CBCS Structure]**

### **Courses (BCH CC – V to VI, GE – III & SEC – I)**

**BCH CC – V – T: Intermediary Metabolism (Theory)**

**BCH CC – VI – T: Membrane Biology & Bioenergetics (Theory)**

**BCH CC – V – P: Intermediary Metabolism – Lab**

**BCH CC – VI – P: Membrane Biology & Bioenergetics – Lab**

**SEC – I – T: Tools and Techniques in Biochemistry (Theory)**

**GE – III – T: Chemistry I (Theory)**

(Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons)

*Ajay Kumar*  
*Indira Kishore*

## BCH CC – V – T: INTERMEDIARY METABOLISM (THEORY)

Total Hrs: 60

Credit: 4

### UNIT-I Basic concept of intermediary metabolism

1. Carbohydrate metabolism: Glycolysis, Krebs's cycle, pentose phosphate pathway, glyoxalate pathway
2. Glycogenolysis, glycogenesis and its regulation
3. Calvin cycle, CAM pathway
4. Regulation of carbohydrate metabolism and inborn errors of carbohydrate metabolism

### UNIT-II Basic concept of lipid metabolism

1. Electron transport and oxidative phosphorylation
2. Fatty acid degradation and biosynthesis
3. Biosynthesis and degradation of cholesterol and its regulation
4. Regulation of lipid metabolism and inborn errors of lipid metabolism

### UNIT-III Nitrogen assimilation and amino acids metabolism

1. Nitrogen cycle, digestion and absorption of dietary proteins
2. Biosynthesis and degradation of amino acids
3. Urea cycle
4. Regulation of amino acid metabolism and inborn errors of amino acid metabolism

### UNIT-IV Degradation of purine and pyrimidine nucleotides and Integration of Metabolism

1. Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides.
2. Inhibitors of nucleotide metabolism.
3. Disorders of purine and pyrimidine metabolism
4. Regulation of nucleotides metabolism and inborn errors of nucleotide metabolism

### UNIT V- Integration of metabolism

1. Integration of metabolism
2. Hormonal regulation of fuel metabolism
3. Tissue specific metabolism
4. Metabolic disorders: Diabetes mellitus and Obesity

*Myamal*  
*revised*  
*CS*

## BCH CC – V – P: INTERMEDIARY METABOLOSM (PRACTICALS)

Total Hrs: 30

Credit: 2

1. Estimation of blood glucose.
2. Assay of salivary amylase.
3. Isolation of cholesterol from egg yolk and its estimation
4. Assay of serum transaminases – SGOT and SGPT.
5. Estimation of serum urea.
6. Estimation of serum uric acid.
7. Estimation of serum creatinine

### SUGGESTED READINGS

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.
2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN:978-0-470-28173-4.
3. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York), ISBN:10:1-4292-2936-5, ISBN:13:978-1-4292-2936-4.

*My journal*  
*valin binabun*  
*CO*

## BCH CC – VI – T: MEMBRANE BIOLOGY AND BIOENERGETICS (THEORY)

Total Hrs: 60

Credit: 4

### UNIT-I Introduction to biomembranes and Structure

1. Composition of biomembranes - prokaryotic, eukaryotic, neuronal and subcellular membranes. Study of membrane proteins.
2. Fluid mosaic model with experimental proof. Monolayer, planer bilayer and liposomes as model membrane systems.
3. Polymorphic structures of amphiphilic molecules in aqueous solutions - micelles and bilayers. Membrane asymmetry. Macro and micro domains in membranes.
4. Membrane skeleton, lipid rafts, caveolae and tight junctions. RBC membrane architecture.

### UNIT-II Membrane dynamics and Membrane Transport

1. Lateral, transverse and rotational motion of lipids and proteins.
2. Techniques used to study membrane dynamics - FRAP, TNBS labeling etc.
3. Transition studies of lipid bilayer, transition temperature. Membrane fluidity, factors affecting membrane fluidity.
4. Membrane transport: Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport - glucose transporter, anion transporter and porins.
5. Primary and secondary active transporters, ABC family of transporters, Ion channels - voltage-gated ion channels, aquaporins, bacteriorhodopsin. Ionophores - valinomycin, gramicidin.

### UNIT-III Vesicular transport and membrane fusion

1. Types of vesicle transport and their functions
2. Molecular mechanism of vesicular transport. Membrane fusion. Receptor mediated endocytosis of transferrin.
3. Bioenergetics: Laws of thermodynamics, state functions, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, other phosphorylated compounds and thioesters.
4. Redox reactions, standard redox potentials and Nernst equation. Universal electron carriers.

### UNIT-IV Oxidative phosphorylation

1. Mitochondria. Electron transport chain - its organization and function.
2. Inhibitors of ETC and uncouplers. Peter Mitchell's chemiosmotic hypothesis. Proton motive force. Fo F1ATP synthase, structure and mechanism of ATP synthesis. Metabolite transporters in mitochondria.
3. Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms. Thermogenesis.
4. Alternative respiratory pathways in plants.

### UNIT-V Photophosphorylation

1. General features of photophosphorylation, historical background,
2. Hills reaction, photosynthetic pigments, light harvesting systems of plants and microbes and resonance energy transfer.

*My journal*  
*not to be used*  
*AO*

3. Bacterial photophosphorylation in purple bacteria, Green sulfur bacteria and Halobacterium salinarum.
4. Photophosphorylation in plants - structure of chloroplast, molecular architecture of Photosystem I and Photosystem II, Z-scheme of photosynthetic electron flow, oxygen evolving complex and action of herbicides. Cyclic photophosphorylation and its significance. Photo inhibition. Evolution of oxygenic photosynthesis.

*M. J. Armal*  
*Head of Department*  
*[Signature]*

## BCH CC – VI – P: MEMBRANE BIOLOGY AND BIOENERGETICS (PRACTICALS)

Total Hrs: 30

Credit: 2

1. Effect of lipid composition on the permeability of a lipid monolayer.
2. Determination of CMC of detergents.
3. RBC ghost cell preparation and to study the effect of detergents on membranes.
4. Separation of photosynthetic pigments by TLC.
5. Isolation of mitochondria from liver and assay of marker enzyme SDH.
6. Study photosynthetic O<sub>2</sub> evolution in hydrilla plant.
7. Isolation of chloroplast from spinach leaves, estimation of chlorophyll

### SUGGESTED READINGS

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.
2. Molecular Cell Biology (2013) 7th ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., W.H. Freeman & Company (New York), ISBN:13:978-1-4641-0981-2.
3. Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2.
4. Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York), ISBN:13: 978-0470-23396-2

*Mujamal*

*shweta*

*CS*



**B.Sc. [Honors] Biochemistry [CBCS Structure]**

**Generic Elective Course (GE – III – T)**

**Chemistry – I (Theory):** Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons

*Pranjal*  
*valivkaval*  
*oo*

## Generic Elective – III – T (Theory)

### GE – III – T: Chemistry – I: Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons (Theory) [Theory Course is offered by School of Studies in Chemistry]

Total Hrs: 60

Credit: 4

#### UNIT-I Atomic Structure & Elementary Quantum Mechanics:

1. **Quantum Numbers Shapes of s, p, d, f orbitals.** Aufbau principle and Pauli exclusion principles, Hund's multiplicity rule. Electronic configurations of the elements, effective nuclear charge.
2. Dual nature of Electron, Photo Electric Effect, Compton effect, Idea of the de-Broglie matter waves, Heisenberg Uncertainty principle, Bohr's Model of Hydrogen atom (no derivation) and its defects.
3. **Molecular orbital theory, basic ideas:** Criteria for forming M.O, construction M.O's by LCAO-H<sub>2</sub><sup>+</sup> ion calculation of energy levels from wave functions, concept of  $\sigma$ ,  $\sigma^*$ ,  $\pi$ ,  $\pi^*$  & n orbitals and their characteristics.
4. Hybrid orbitals – (sp, sp<sup>2</sup>, sp<sup>3</sup>), calculation of co-efficient of A.O.'s used in these hybrid orbitals. Schrödinger wave equation, Significance of  $\psi$  and  $\psi^2$ .

#### UNIT-II Periodic Properties & Bonding

1. Atomic and ionic radii, ionization energy, electron affinity and electro negativity definition, methods of determination
2. Trends in periodic table and applications in predicting and explaining the chemical behaviour.
3. Covalent Bond: Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions. Valence Shell Electron Pair Repulsion (VSEPR) theory to NH<sub>3</sub>, H<sub>3</sub>O<sup>+</sup> and H<sub>2</sub>O. MO theory, homonuclear and heteronuclear (CO and NO) diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electro negativity difference.
4. Ionic Solids: Ionic structures, radius ratio effect and coordination number, limitation of radius ratio rule, Lattice defects, Semiconductors, Lattice energy and Born-Haber cycle, Solvation energy and Solubility of Ionic solids, polarizing power and polarisability of ions, Fajan's rule. Metallic bond: free electron, valence bond and bond theories.
5. Weak Interactions –: Hydrogen bonding, Vander Waals forces.

#### UNIT-III Basics of Organic Chemistry and Stereochemistry

1. Basics of Organic Chemistry: *Organic Compounds*: Classification, Hybridization, Shapes of molecules.
2. Electronic Displacements: Inductive, electromeric, resonance mesomeric effects and hyperconjugation. Homolytic and Heterolytic fission with suitable examples. Electrophiles and Nucleophiles.

*Original*  
*Vali Divakar*  
*CO*

3. Stereochemistry: Fischer Projection and Newmann Projection formulae Geometrical isomerism: cis-trans and, syn-anti isomerism.
4. Optical Isomerism: *Criteria for Optical Activity*, Enantiomers and Distereoisomers, meso structures, Threo and Erythro isomers.

#### UNIT-IV Aliphatic Hydrocarbons

1. Chemistry of alkanes: Formation of alkanes, Wurtz Reaction
2. Carbon-Carbon pibonds: Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions.
3. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition) and Diels-Alder reaction.
4. Reactions of alkynes: Electrophilic and Nucleophilic additions.

#### UNIT-V Cycloalkanes

1. Types of cycloalkanes and their relative stability
2. Conformation analysis of alkanes: Chair, Boat and Twist boat forms; Relative stability
3. Aromatic hydrocarbons:Electrophilic aromatic substitution: halogenation, nitration
4. Ssulphonation and Friedel-Craft's alkylation/acylation with their mechanism.

#### SUGGESTED READINGS:

1. Lee, J.D. Concise Inorganic Chemistry ELBS, 1991.
2. Cotton, F.A., Wilkinson, G. &Gaus, P.L. Basic Inorganic Chemistry, 3rd ed., Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. &Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.
5. Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
6. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
7. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
8. Eliel, E.L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education, 2000.
9. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
10. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
11. Bahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
12. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
13. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009
14. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996
15. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

*ap*  
*apjurnal*  
*valius Sivarlan*  
*ao*

**B.Sc. [Honors] Biochemistry [CBCS Structure]**  
**Skill Enhancement Course – I Theory (SEC – I – T)**

**SEC – I (Theory): Tools and Techniques in Biochemistry**

*Muzamil*

*Neelam Kiran*

*CS*

## Skill Enhancement Course – I – T (Theory)

### SEC – I – T: Tools and Techniques in Biochemistry (Theory)

[Theory Course is offered by School of Studies in Biochemistry]

**Total Hrs: 60**

**Credit: 4**

#### UNIT-I Biochemical Reagents and Solutions

1. Safety practices in the laboratory. Preparation and storage of solutions.
2. Concepts of solution concentration and storing solutions. Quantitative transfer of liquids
3. Concept of a buffer, Henderson-Hasselbalch equation
4. Working of a pH meter.

#### UNIT-II Exercises

1. Preparation of a buffer of given pH and molarity
2. Preparation of phosphate buffer
3. Preparation of acetate buffer
4. Preparation of Tris-HCl buffer

#### UNIT-III Spectrophotometric techniques

1. Principle and instrumentation of UV-visible spectroscopy
2. Principle and instrumentation of fluorescence spectroscopy

#### UNIT -IV Exercises

1. Determination of the absorption maxima and
2. Determination of molar extinction coefficient (of a relevant organic molecule).
3. Determination of concentration using molar extinction coefficient
4. Measurement of fluorescence spectrum
5. Determination of concentration of a protein solution by Lowry/BCA method.

#### UNIT-V Sedimentation Techniques

1. Centrifuge: Principle and instrumentation
2. Methods of separation of cells, organelles and other coarse materials
3. Other applications of sedimentation techniques

#### Exercises

1. Use of angle and swinging bucket rotors
2. Separation of cells
3. Separation of subcellular components

#### SUGGESTED READINGS

1. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN:978-0-470-85602-4 / ISBN:978-0-470-85603-1.
2. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder, D., W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.
3. An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.

*Mujamal*  
*relu kumar*