



Dr. Ambedkar Veedhi, Central College Campus  
Bengaluru-560001

*Scheme and Syllabus*

*For*

**Biochemistry**

**for B. Sc. Degree with three majors**

*As per SEP 2024*

**for I and II Semesters**

**(With effect from 2024-25)**

**Department of Biochemistry,  
Central College Campus  
Bengaluru -560 001**

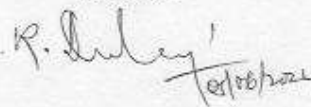

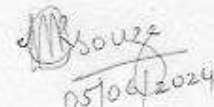
**June, 2024**



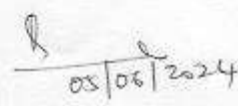
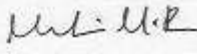



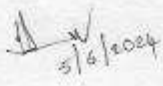
**Department of Biochemistry,  
Central College Campus, Bangalore -560001**

**Proceedings of the Meeting of Board of Studies in Biochemistry (UG),  
held on Wednesday, the 5<sup>th</sup> June, 2024 in the chambers of the Chairman,  
Dept. of Biochemistry, Central College Campus, Bangalore -560001**

The meeting started with the Chairman welcoming the members and requesting the board to deliberate on the syllabus contents for B.Sc. Biochemistry UG course and propose the titles for all the six semester under SEP, and prepare the syllabus for the first two semesters. After a detailed discussion on the titles and contents, the board finalized the titles, and prepared the syllabi for I and II semester B.Sc. under the SEP scheme, effective from 2024-25. The meeting concluded with the chairman thanking the members for their valuable inputs and cooperation.

<b>Members Present</b>		<b>Signature</b>
1. Prof. V. R. Devaraj, Chairman, Dept. of Biochemistry, Bangalore University.	Chairman	 05/06/2024
2. Dr. S. Kantharaju Dept. of Chemistry, SJRC College, Ananda Rao Circle Bangalore -560004	Member	
3. Ms. Vidya, A.S. Dept. of Biochemistry, Seshadripuram College Yalahanka Bangalore -560064.	Member	 05/06/2024
4. Dr. (Mrs.) Myrene D'souza Dept. of Biochemistry, Mount Carmel College # 58, Palace Road, Bangalore - 560052	Member	 05/06/2024

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|-----|---|--------|---|
| 5.  | Dr. R. Nagesh Babu,<br>Dept. of Chemistry,<br>Maharani's Science College for women,<br>Palace Road, Bangalore-560001        | Member | <br>05/06/2024 |
| 6.  | Ms. Malini, M.R.<br>Dept. of Chemistry,<br>M.S Ramaiah College of Arts, Science & Commerce<br>Bangalore-54                  | Member |                |
| 7.  | Dr. Rajeev Ramachandra Kolagi<br>Dept. of Biochemistry,<br>Nrupathunga University<br>Bengaluru-560001.                      | Member | <br>05/06/2024 |
| 8.  | Dr. Kamala, A.<br>Dept. of Biochemistry,<br>MLA College for women<br>Malleswaram 18 <sup>th</sup> Cross<br>Bangalore-560004 | Member | <br>5/6/24     |
| 9.  | Mrs. Ramya Kumari B.S<br>Dept. of Biochemistry<br>M.S Ramaiah College of Arts, Science & Commerce<br>Bangalore-54           | Member | <br>05/06/24    |
| 10. | Mrs. Madhukala, K. L.<br>Dept. of biochemistry<br>Acharya B School,<br>Magadi Road,<br>Bengaluru-560091                     | Member | <br>5/6/2024  |
| 11. | Dr. Bhagyalakshmi<br>Dept. of biochemistry<br>University College of Science<br>Tumkur University<br>Tumkur-572101           | Member | Absent  |
| 12. | Mrs. Savitha, K.R.<br>Dept. of biochemistry<br>University College of Science<br>Tumkur University<br>Tumkur-572101          | Member | Absent  |

  
05/06/2024

## SCHEME OF EXAMINATION

Title of the paper	Contact h/week	Exam. hours	I A	Marks	Total Marks	Credits
<b>First Semester</b>						
Biochemistry-I: BCT-01 Chemical Foundations of Biochemistry	4	3	20	80	100	3
Biochemistry practical-IBCP-01 Experimental Biophysical Chemistry	3	3	10	40	50	2
<b>Second Semester</b>						
Biochemistry-II: BCT-02 Bioorganic Chemistry	4	3	20	80	100	3
Biochemistry practical-II: BCP-02 Experimental Bioorganic Chemistry	3	3	10	40	50	2
<b>Third Semester</b>						
Biochemistry-III: BCT-03 Biochemistry of Macromolecules	4	3	20	80	100	3
Biochemistry practical-III: BCP-03 Qualitative and Quantitative analysis of Macromolecules	3	3	10	40	50	2
<b>Fourth Semester</b>						
Biochemistry-IV: BCT-03 Physiology & Cell Biology	4	3	30	70	100	3
Biochemistry practical-IV: Clinical Biochemistry and physiology	3	3	10	40	50	2
<b>Fifth Semester</b>						
Biochemistry-V: BCT-05 Biochemical Techniques	4	3	20	80	100	3
Biochemistry practical-V Bio-analytical methods	3	3	10	40	50	2
Biochemistry-VI: BCT-06: Bioenergetics & Metabolism	4	3	20	80	100	3
<i>Biochemistry Elective-1:BCOE-1*</i> <i>Microbiology &amp; Immunology</i>	3	1.5	10	40	50	2
<b>Sixth Semester</b>						
Biochemistry-VII: BCT-07: Enzymology	4	3	20	80	100	3
Biochemistry practical-VI:BCP-06 Enzymology	3	3	10	40	50	2
Biochemistry-VIII: BCT-08: Molecular biology	4	3	20	80	100	3
<i>Biochemistry Elective-2: BCOE-2*</i> <i>Membrane Biochemistry</i>	3	1.5	10	40	50	2

**Theory question paper pattern:**

Each theory question paper has *three Sections*;

1. 20% of the marks seeking short answers;  
Student has answer 8 out of 10 questions of 2 marks each
2. 40% of marks seeking medium size answers:  
Student has to answer 8 out of 10 questions of 4 marks each.
3. 40% of question seeking comprehensive answers:  
Student has to answer 4 out of 5 questions of 8 marks each.  
These questions may include sub questions (5+3).

**Internal Assessment: Tests: 10 Marks** (two internal tests to be conducted and average is considered for assessment)

**Scheme of Practical Examination:**

Duration	3 hours
Max. Marks	40 Marks
Marks for practical record	5 Marks
Marks for Viva-Voce	5 Marks
Marks for performing major experiment	20 Marks
Marks for performing minor experiment	<b>10 Marks</b>

**Assessment in Practical Examination**

Awarding marks for performance	
Deviation of experimental values:	
0-5%	100% of allotted marks
6-10%	80% of allotted marks
11-20%	60% of allotted marks
20% and above	50% of allotted marks

**Practical Record:**

Recording 8 or more different experiments	5 Marks
Recording 6-7 different experiments	4 Marks
Recording 4-5 different experiments	3 Marks
Recording 3 different experiments	2 Marks
Recording Less than 3 experiments	0 Marks

**Syllabus for Biochemistry major for  
B.Sc. Degree program with three majors**

**SEMESTER – I**

<b>Course title</b>	<b>Chemical Foundations of Biochemistry</b>
<b>Course Code</b>	BCT -01
<b>Course credits</b>	3
<b>Total contact hours</b>	56
<b>Duration of ESA</b>	3
<b>Formative assessment marks</b>	20
<b>Summative assessment marks</b>	80

**Learning outcomes:**

This course will enable students to understand basic physical principles of biological systems, measurements in biochemical study, nature of chemical bonds. Also, helps them appreciate the physical properties of molecules, colloids, and basics of chemical kinetics essential for biochemistry.

**Course content:**

**UNIT-I**

**15 Hours**

- 1. Overview of Biochemistry:** Origin of Biochemistry as a discipline. Definition, scope and significance of Biochemistry. Chemical composition of living organisms.
- 2. Units and Measurements:** Avogadro's number, mole, mole fraction, molarity, equivalent weight, normality, molality, percentage. Graphical representation of data – types of graphs. Errors in quantitative analysis –types, sources and minimizations. Precision and accuracy. Significant figures and its computation (Problems to be worked out).
- 3. Properties of water:** Molecular structure of water (VSEPR theory), physical properties of water, its effect on biomolecules. Effect of non-polar compounds on water.
- 4. Physical properties of molecules:** Adsorption -Definition, Freundlich and Langmuir's adsorption isotherm. Applications of adsorption. 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.

**UNIT-II****13 Hours**

1. **Colligative properties:** Osmotic pressure and its measurements by Berkely and Hartley's method. Laws of osmotic pressure. Hypo, hyper and isotonic solutions. Effects of osmotic pressure on living cells. Donnan membrane equilibrium.
2. **Ionic equilibria:** Lewis concept of acids and bases. Ionic product of water. pH scale, buffers, Henderson-HasselBalch equation, buffer capacity, preparation of acidic and basic buffer solutions. Theory of acid base indicators. Choice of indicators. pH titration curves and isoelectric pH of amino acids. Electrodes (Hydrogen Electrode & Calomel electrode), glass electrode. Conductometric titrations [Strong acid against strong base, weak acid (amino acid) against NaOH. Measurement of pKa of amino acid by using pH meter.

**UNIT-III****14 Hours**

3. **Chemical bonding:** Types of bonds & bond characteristics - Ionic, covalent, co-ordinate bonds. Atomic orbitals and molecular orbitals – Molecular Orbital Theory, LCAO, 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. Van der 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).
4. **Co-ordination compounds:** Transition metals, properties (Colour, oxidation states, magnetic properties). 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). Bile pigments – Types, structure and chemical nature.

**UNIT- IV****14 Hours**

5. **Chemical kinetics:** Introduction, Rate of reactions, rate law or rate equation, molecularity and order of a reaction with examples, velocity constant or rate constant and half-life period expressions for zero, first and second order reactions with derivations ( $a=b$  and  $a \neq b$ ), rate constant of irreversible reaction, kinetics of reversible reaction (without derivation). Numerical problems. Effect of temperature, pressure and catalyst on rate of reaction, Arrhenius equation and Arrhenius interpretation of energy of activation. Transition state theory with brief explanation.
6. **Colloids:** true solutions, classification, peptisation, purification, ultrafiltration, Brownian movements, electric properties, coagulation, mutual, lyophilic sols, boiling, dialysis, electro- and persistent dialysis, addition of electrolytes, colloids in daily life and

applications. Emulsion, types, micelles with biomolecules and its biological applications.

### Suggested Readings:

- Puri, Sharma, Pathania Text Book Of Physical Chemistry
- Puri, Sharma, Pathania Text Book Of Inorganic Chemistry
- A Guide To Organic Reaction Mechanism- P. Sykes
- General & Inorganic Chemistry-R.P.Sarkar
- Inorganic Chemistry-R.L.Dutta
- New Concise Inorganic Chemistry-J.D.Lee
- F. A. Cotton & G. Wilkinson. Basic Inorganic Chemistry, John Wiley (1998)
- Douglas, McDaniel And Alexander: Concepts And Models In Inorganic Chemistry, John Wiley, 3<sup>rd</sup> Edition (1994).
- James E. Huheey, Ellen Keiter And Richard Keiter : Inorganic Chemistry: Principles Of Structure And Reactivity, Pearson Public, 4<sup>th</sup> Edition (2013).
- Pattabhi. V. And Gautham.N. (2002) Biophysics. Narosa Publishing House, India.

Course title	Experimental Biophysical Chemistry
Course Code	BCP- 01
Course credits	2
Total contact hours	42
Duration of ESA	3
Formative assessment marks	10
Summative assessment marks	40

### Learning outcomes:

In this practical course, students will be introduced to laboratory exercises which provide skills to apply biophysical/chemical principles to understand biological processes. Also, helps them appreciate the physical properties of molecules, colloids, and basics of chemical kinetics essential for biochemistry.

### Practical content:

1. Calibration of volumetric glassware (Burette, pipette and volumetric flask).
2. Preparation of standard sodium carbonate solution, standardization of HCl (Methyl orange) and estimation of NaOH in the given solution. (Methyl orange or phenolphthalein).
3. Preparation of standard oxalic acid. Standardization of NaOH and estimation of H<sub>2</sub>SO<sub>4</sub> in the given solution (phenolphthalein).
4. 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.



5. Preparation of  $\text{ZnSO}_4$ . Standardization of EDTA and estimation of total hardness of water using eriochrome black-T indicator.
6. Preparation of standard potassium biphthalate. Standardization of NaOH and estimation of HCl in the given solution. (Phenolphthalein).
7. Calibration of pH meter and Preparation of buffers - acetate and phosphate buffers.
8. Conductometric titration of strong acid against strong base.
9. Conductometric titration of weak acid (amino acid) against strong base.
10. Determination of rate constant of decomposition of  $\text{H}_2\text{O}_2$  using  $\text{KMnO}_4$  by volumetric analysis method.
11. Determination of density and viscosity of the given liquid using specific gravity bottle and Ostwald's viscometer.
12. Determination of density and surface tension of the given liquid using specific gravity bottle and stalagmometer.

**SEMESTER - II**

<b>Course title</b>	<b>BIO-ORGANIC CHEMISTRY</b>
<b>Course code</b>	<b>BCT-02</b>
<b>Course credits</b>	<b>03</b>
<b>Total contact hours</b>	<b>56</b>
<b>Duration of ESA</b>	<b>03</b>
<b>Formative assessment marks</b>	<b>20</b>
<b>Summative assessment marks</b>	<b>80</b>

**Learning outcomes:**

This course helps the students to understand the significance of organic reactions and their relevance to biological systems. It help them gain a good understanding of aliphatic and aromatic compounds, nomenclature, reactivity of functional groups and the importance of stereoisomers in biological systems, and structure activity relationships in biomolecules.

**Course Content:****UNIT-I****14 Hours**

- 1. Introduction to organic chemistry:** Classification of organic compounds, unique characteristics, IUPAC nomenclature of organic compounds (including bi-functional) and biomolecules.
- 2. Hydrocarbons:** Markownikoff and anti-Markownikoff addition. Addition of HBr to propene. Alkenes – Ozonolysis, oxidation. Dienes – types with examples, 1, 3 butadiene – Preparation, stability and mechanism of addition of HBr. Diels-Alder reaction. Conformational analysis of ethane.
- 3. Reaction mechanisms:** Concept of inductive effect, resonance and hyperconjugation. 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 (Formation and Stability).
- 4. Alkyl halides and organometallic compounds:**  $SN^1$ ,  $SN^2$  and  $SN^i$  reactions, their mechanism with one example for each. Concept of elimination reactions ( $E^1$ ,  $E^2$  and  $E^1CB$  with an example). Organometallic compounds – definition and applications of organo lead, organo lithium, cis-platin.

**UNIT-II****14 Hours**

- 5. Arenes:** Structure of benzene – by Resonance and Molecular orbital theories.

Aromaticity (Huckel's rule). Mechanism of Nitration and Friedel- craft reaction. Electronic interpretation of the orientating influence of substituents in the electrophilic substitution of toluene, chlorobenzene, nitrobenzene and phenol. Resonance structures of naphthalene and anthracene.

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

### UNIT-III

**14 Hours**

7. **Cycloalkanes:** Reactivity and relative stability. Bayer's strain theory. Sachse-Mohr theory. Boat and chair forms of cyclohexanes. Axial and equatorial bonds and their relation with biological activities of carbohydrates
8. **Alcohols:** Definition, classification, monohydric alcohols-distinguishing reactions for primary, secondary and tertiary alcohols. Dihydric alcohols: Glycol, preparation (any 2 methods) and uses. Trihydric alcohols: Glycerol, synthesis from propene, properties, (reaction with conc.  $H_2SO_4$ ,  $HNO_3$ , Oxalic acid and HI). Phenols: Acidity of phenols, effect of substituent on acidity.
9. **Hydroxy acids and dicarboxylic acids:** Structure & properties of hydroxy acids: Lactic acid, citric acid and isocitric acid. Dicarboxylic acid: Maleic and fumaric acid. Ketoacids: Pyruvic,  $\alpha$ -ketoglutaric, oxaloacetic acids.
10. **Carbonyl compounds:** General properties. Aldehydes and ketones. Keto-enol tautomerism, Mechanism: Claisen and aldol condensations. Quinones: Biologically important quinones.
11. **Amines:** Classification, properties, functional amino group – Basicity of amines, acylation. React with  $HNO_2$  & Schiff's base formation. Distinguishing reactions of primary, secondary and tertiary amines.

### UNIT-IV

**14 Hours**

12. **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.
13. **Terpenes:** Definition, isoprene rule, classification, isolation, structure and biological importance of menthol, camphor, farnesol, phytol, lanosterol, lycopene and dolichols.
14. **Steroids:** Basic ring structure in steroids. Structure and biological importance of cholesterol, phytosterols and ergosterol. Bile acids [Mono, Di & Tri cholic acids].
15. **Alkaloids:** Definition, classification based on their structure and biological functions,

isolation, structure and biological action of morphine, nicotine & atropine. Chemical synthesis of nicotine and atropine.

16. **Drugs:** Classification of drugs; synthesis and uses of sulphanilamide and paracetamol. Antibiotics: Definition; types; sources; structures and antimicrobial spectrum of action of penicillin, chloroamphenicol, streptomycin and tetracyclines.

### Suggested Readings:

- Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry*, S. Chand. (2019)
- L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S. (2002)
- R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall. (2011)
- Organic Chemistry (vol.1&2) – I. L. Finar
- Stereochemistry of Carbon Compounds- D. Nasipuri
- Basic Stereochemistry of Organic Compounds- S. Sengupta
- A Guide To Organic Reaction Mechanism- P. Sykes

<b>Course title</b>	<b>Experimental Bioorganic Chemistry</b>
<b>Course code</b>	<b>BCP-02</b>
<b>Course credits</b>	<b>02</b>
<b>Total contact hours</b>	<b>42</b>
<b>Duration of ESA</b>	<b>03</b>
<b>Formative assessment marks</b>	<b>10</b>
<b>Summative assessment marks</b>	<b>40</b>

### Learning outcomes:

This laboratory course is aimed at imparting skills of identifying organic compounds, demonstrating reactivity of various functional groups, and synthesis of simple organic compounds of biological importance.

### Practical content:

1. **Systematic qualitative analysis of the organic compounds:** Urea, glucose, benzamide, benzaldehyde, aniline, acetophenone, nitrobenzene, chlorobenzene, *p*-toluidine, benzoic acid, salicylic acid, resorcinol, and ethyl acetate.
2. **Organic preparations:** Aspirin from salicylic acid, benzoic acid from benzaldehyde, and meta-dinitrobenzene from nitrobenzene.