

**PUNYASHLOK AHILYADEVII HOLKAR SOLAPUR UNIVERSITY, SOLAPUR**



**Faculty of Science & Technology**

**Choice Based Credit System**

**Subject: BIOCHEMISTRY**

**(Additional Interdisciplinary Course)**

**Name of the Course: B. Sc. Part-II (Sem. III & IV )**

**(Syllabus to be implemented from June 2023)**

**PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR**

**SYLLABUS FOR B. Sc – II (BIOCHEMISTRY)  
CHOICE BASED CREDIT SYSTEM (CBCS)**

**Structure of the Course:**

- Structure of B.Sc. course in faculty of science has total of 06 semesters for 3years.
- B.Sc.-II comprises of total two semesters. Each semester will have **two** theory papers of 80 marks for university external examination and 20 marks for internal examination for eachpaper.
- At the end of academic year i.e. semester IV the practical examination will beconducted. The evaluation of practical exam is of 80 marks for university external practical examination and 20 marks for internal practical examination.
- The titles and marks distribution for each paper are asunder.

Semester	Paper No.	Title of Paper	Total Lectures	Examination			Total Credit
				Univ. Exam	Internal Exam	Total Marks	
Semester III	I	Biomolecules	30	40	10	50	02
	II	Biochemical Techniques	30	40	10	50	02
Semester IV	III	Nutrition and Metabolism	30	40	10	50	02
	IV	Molecular Biochemistry and Diseases	30	40	10	50	02
Practical	I	Biochemistry		160	40	200	04

- **University Examination**

1. Theory Paper I : 40Marks
2. Theory Paper II : 40Marks
3. Theory Paper III : 40Marks
4. Theory Paper IV : 40Marks
5. Practical : 160Marks

Practical paper has 160 marks for external university practical examination. Duration of practical examination is **TWO days**. Out of 160 marks for external university practical examination, the mark distribution is as follows.

### **Practical Course**

#### **Part I (80 Marks)**

1) Chromatographic experiments	20
2) Colorimetric experiments	20
3) Preparation experiments	20
4) Study of an Enzyme	20
(activity quantification/effect or temperature/pH/substrate concentration).	

#### **Part II (80 Marks)**

1) Volumetric Estimations	20
2) Qualitative Analysis	20
a) Carbohydrates/Lipids	
b) Enzymes/ Urine (Abnormal components)	
3) Journal	20
4) Study Tour	10
5) Oral	10

- **Continuous Internal Assessment:**

- 1) Each theory paper has 10 marks for internal examination. There will be 05 marks for unit test and 05 marks for home assignment.
- 2) Practical paper has 40 marks for internal examination.

**SEMESTER-III**  
**PAPER - I: BIOMOLECULES**

**Course outcomes:**

- Students learn about the components and structure of carbohydrate molecules.
- Students learn about the amino acids and their general classification.
- Students learn about the components and structure of protein.
- Students learn about the components and general classification of enzymes.
- Students learn about the components and structure of lipids.
- Students learn about the components and structure of nucleic acids.
- Students learn about the types and properties of vitamins.

**SEMESTER-III**  
**PAPER - I: BIOMOLECULES**

**Total marks: 50 (40+10)**

**Credits: 2**

**Contact hours: 30**

Unit No.	Content	Lectures
<b>Unit I</b>	<p><b>CARBOHYDRATES: (06 L)</b> Definition, classification, structures of-</p> <p>A) Monosaccharides- aldoses &amp; ketoses</p> <ul style="list-style-type: none"> <li>i) Trioses- glyceraldehyde &amp; dihydroxy acetone</li> <li>ii) Tetroses-erythrose, erythrulose</li> <li>iii) Pentoses-ribose, ribulose, xylose, xylulose</li> <li>iv) Hexoses-glucose, mannose, galactose, fructose.</li> </ul> <p>Reactions of monosaccharides, Derivatives of monosaccharides</p> <p>B) Oligosaccharides: glycoside bond, maltose, isomaltose, sucrose, cellobiose</p> <p>C) Polysaccharides- starch, glycogen, cellulose</p>	<b>(15)</b>
	<p><b>AMINO ACIDS: (04 L)</b> Classification of amino acids. Properties of amino acids: physical properties, chemical properties, zwitterions, pI, ninhydrin reaction.</p>	
	<p><b>PROTEINS &amp; ENZYMES: (05 L)</b> Formation of peptide bond, definition of proteins.</p> <p>i) Types of protein: Simple proteins (albumin &amp; globulin), Complex proteins &amp; Derived proteins</p> <p>ii) Structure of proteins: Primary, Secondary (<math>\alpha</math> helix &amp; <math>\beta</math> pleated), Tertiary &amp; Quaternary structure, Forces involved in stabilizing native structure of protein.</p> <p>Enzymes - Definition, apoenzyme, coenzyme, holoenzyme, prosthetic group, cofactor. Classification of enzymes with two examples of each class.</p>	
<b>Unit II</b>	<p><b>LIPIDS: (05 L)</b> Definition &amp; classification with two examples of each class. Structure &amp; functions of-</p> <ul style="list-style-type: none"> <li>a) Simple lipids- Fatty acids &amp; triglycerides.</li> <li>b) Compound lipids- phospholipids, spingolipids, glycolipids</li> <li>c) Derived lipids- steroids (cholesterol), carotenes.</li> </ul> <p>Lipid bilayer- Fluid mosaic model of plasma membrane.</p>	<b>(15)</b>
	<p><b>NUCLEIC ACIDS: (05 L)</b> Meaning, distinction between DNA &amp; RNA. Components of nucleic acids-nitrogenous bases, sugars, phosphoric acid, nucleosides &amp; nucleotides phosphodiester linkage, representation of primary structure of polynucleotide. Watson-Crick model of DNA. Structure and function of t-RNA, m-RNA and r-RNA.</p>	
	<p><b>VITAMINS: (05 L)</b> Definition, water soluble vitamins. Source, requirement, biochemical role &amp; deficiency disorders of vitamins- thiamine, niacin, riboflavin, pyridoxine &amp; pantothenic acid, their coenzyme forms.</p>	

**Reference Books:**

1. Lehninger, Principles of Biochemistry. 5th Edition (2008), David Nelson & Michael
2. Biochemistry – Lubert Stryer, 5<sup>th</sup> Edition, W.H. Freeman and Company, New York.
3. Fundamentals of Biochemistry - Voet & Voet & Pratt.
4. Fundamentals of Biochemistry – J. L. Jain, S. Chand & Company Ltd, New Delhi.
5. Biochemistry – U. Satyanarayan, 3<sup>rd</sup> Edition, Books and allied (P) Ltd.
6. Biochemistry - S.C.Rastogi.
7. Text book of Biochemistry - R. C. Dubey.

## **SEMESTER-III**

### **PAPER - II: BIOCHEMICAL TECHNIQUES**

#### **Course outcomes:**

- Students learn about the basic techniques used for protein and DNA separation.
- Students get introduced to bioinformatics .
- Students learn about the principle and working of colorimeter and spectrophotometer.
- Students learn the chemical basis of various assay methods for biomolecules.
- Students learn the principles of frequently used clinical and research techniques
- Students get a closer view of practical biochemistry.

**SEMESTER-III**  
**PAPER - II: BIOCHEMICAL TECHNIQUES**

**Total marks: 50 (40+10)**

**Credits: 2**

**Contact hours: 30**

Unit No.	Content	Lectures
<b>Unit I</b>	<p><b>CHROMATOGRAPHY (06 L)</b> Definition &amp; classification, principle, technique &amp; applications of</p> <ol style="list-style-type: none"> <li>i) Thin layer chromatography</li> <li>ii) Gel permeation chromatography</li> <li>iii) High pressure liquid chromatography</li> </ol> <p>Selection of gel, preparation of plate/column packing, application of sample, mechanism of separation, important applications &amp; advantages of the methods.</p>	<b>(15)</b>
	<p><b>ELECTROPHORESIS: (05 L)</b> Definition, electrophoretic mobility, factors affecting electrophoretic mobility. Principle, technique and applications of-</p> <ol style="list-style-type: none"> <li>1) Polyacrylamide gel electrophoresis: Native and SDS</li> <li>2) Agarose gel electrophoresis</li> </ol> <p>Preparation of gel plates, application of sample, mechanism of separation, developing the plates, important applications and advantages of the methods.</p>	
	<p><b>BIOINFORMATICS (04 L)</b> Introduction to bioinformatics, Databases, Information sources (NCBI, GDB, and MGD), Data retrieval tools (ENTREZ, OMIM and PubMed), Database similarity searching (BLAST), Applications of Bioinformatics</p>	
<b>Unit II</b>	<p><b>ABSORPTION SPECTROSCOPY (05 L)</b> Beer-Lambert's law and its derivation, meaning of the terms- transmittance, absorbance, molar and specific absorbance. Electromagnetic spectrum Difference between photoelectric colorimeter and spectrophotometer Advantages of spectrophotometer over colorimeter.</p>	
	<p><b>ESTIMATION OF BIOMOLECULES (05 L)</b> A) Carbohydrates – DNSA, anthrone, phenol-H<sub>2</sub>SO<sub>4</sub> B) Protein – BCA assay, Bradford assay, Lowery's assay. C) Lipid – acid value, saponification value, ester value and iodine number. Liberman Burchard method for cholesterol estimation. D) Nucleic acids – DPA method, orcinol method</p>	
	<p><b>MODERN TECHNIQUES (05 L)</b> A) Blotting techniques- Western, Southern &amp; Northern blotting. B) Polymerase chain reaction-technique &amp; applications. C) Enzyme linked immunosorbent assay (ELISA)-technique &amp; applications.</p>	



**Reference Books:**

1. Protein purification –Robert Scoopes
2. Instrumental Methods of Chemical Analysis – Gurudeep R. Chatwal, Sham K. Anand (Himalaya Publishing House).
3. Handbook on Analytical Instruments –R. S. Khandpur. (McGraw Hill).
4. Biophysical Chemistry - Upadhyay, Nath, Upadhyay (Himalaya Publishing House).
5. A Text Book of Biotechnology – R. C. Dubey.
6. Practical Biochemistry –Wilson & Walker.

## **SEMESTER-IV**

### **PAPER - III: NUTRITION AND METABOLISM**

#### **Course outcomes:**

- Students learn about the importance of nutrition, electrolyte and acid base balance.
- Students learn about important biochemical pathways of carbohydrate metabolism
- Students learn about mechanism and aspects related to oxidative phosphorylation.
- Students get introduced to mechanism of lipid metabolism
- Students get introduced to outline of nucleic acid metabolism.
- Students get introduced to general reactions of amino acid metabolism

## SEMESTER-IV

### PAPER - III: NUTRITION AND METABOLISM

**Total marks: 50 (40+10)**

**Credits: 2**

**Contact hours: 30**

Unit No.	Content	Lectures
<b>Unit I</b>	<b>Nutrition and its components (05 L)</b> A) Nutrition, balanced diet, calorific values of food and its measurement (bomb calorimeter) respiratory quotient, basal metabolic rate (BMR), Factors effecting BMR. B) Electrolyte & acid base balance: Functions of water, Mechanism of electrolyte balance, acid base balance in body	<b>(15)</b>
	<b>Metabolism of Carbohydrates (06 L)</b> Carbohydrate metabolism: Glycolysis , its energetics & Regulation, Fate of pyruvate, Lactic acid and ethanol fermentation, TCA cycle, energetics & regulation	
	<b>Metabolism of Lipids (04 L)</b> Lipid metabolism: Biosynthesis of palmitic acid and its energetic, $\beta$ -oxidation of palmitic acid and its energetics.	
<b>Unit II</b>	<b>Biological oxidation: (06 L)</b> Bioenergetics-Exergonic and endergonic reactions, free energy, high energy compounds and their significance, ATP as a high energy compound. Mitochondrial respiration-components of respiratory chain, respiratory chain, Oxidative phophorylation, mechanism of oxidative phosphorylation (Chemiosmotic coupling hypothesis), inhibitors of electron transport chain.	<b>(15)</b>
	<b>Metabolism of Nucleic acids (05 L)</b> Sources of the atoms in the purine and pyrimidine molecules Outline of biosynthesis and degradation of purines and pyrimidines	
	<b>Metabolism of Amino acids (04 L)</b> General reactions of amino acid metabolism viz. transamination, deamination, decarboxylation. Urea cycle	

#### Reference Books

1. Lehninger's Principles of Biochemistry –Nelson & Cox, 5<sup>th</sup> Edition, W.H. Freeman and Company, New York.
2. Fundamentals of Biochemistry – Voet & Voet, 3<sup>rd</sup> Edition, W.H. Freeman and Company, New York.
3. Biochemistry – Lubert Stryer, 5<sup>th</sup> Edition, W.H. Freeman and Company, New York.
4. Nutritional Biochemistry - Dr.S.Ramkrishna & Dr. S. Vyankatrao.
5. Fundamentals of Biochemistry – J. L. Jain, S. Chand & Company Ltd, New Delhi.
6. Biochemistry – U. Satyanarayan, 3<sup>rd</sup> Edition, Books and allied (P) Ltd.

**PAPER - IV:**

**MOLECULAR BIOCHEMISTRY & DISEASES**

**Course outcomes:**

- Students learn mechanism of enzyme catalysis and various units of enzyme activity.
- Students get a closer view of enzyme kinetics.
- Students learn about basic tools of genetic engineering.
- Students understand the process of replication, transcription and translation in prokaryotes.
- They also learn about operon concept and its importance in gene regulation.
- Students get introduced to the subject of immunology.
- Students understand biochemical and immunological basis of: AIDS and diabetes mellitus.
- Students understand how the anti AIDS and hypoglycemic drugs work.

**PAPER - IV: MOLECULAR BIOCHEMISTRY & DISEASES**

**Total marks: 50 (40+10)**

**Credits: 2**

**Contact hours: 30**

<b>Unit No.</b>	<b>Content</b>	<b>Lectures</b>
<b>Unit I</b>	<p><b>ENZYMOLGY (06 L)</b>                      A) Enzyme as a catalyst: concept of activation energy, Lock &amp; key model, Induced fit hypothesis. Active site of enzyme and its features.                      B) Enzyme activity: Definition &amp; Unit of enzyme activity, specific activity and turnover number, Factors affecting enzyme activity-pH, temperature and substrate concentration.                      C) Enzyme kinetics: Derivation of Michaelis-Menten equation for single substrate. Significance of Km and Vmax. Enzyme inhibition-irreversible, competitive and non competitive inhibition.</p>	<b>(15)</b>
	<p><b>MOLECULAR BIOLOGY AND IMMUNOLOGY (05 L)</b>                      A) Molecular biology: Replication of DNA (semi conservative), transcription in prokaryotes. Translation in prokaryotes. Regulation of gene expression: constitutive &amp; inducible genes. Operon concept, Lac operon in E. coli.</p>	
	<p><b>GENETIC ENGINEERING: (04 L)</b>                      A) Genetic engineering: Restriction endonucleases, S1 nucleases, reverse transcriptase, cloning vectors-pBR322 and λ phage. Gene cloning technique illustrated with insulin gene cloning. Applications of genetic engineering.</p>	
<b>Unit II</b>	<p><b>BASICS OF IMMUNOLOGY: (05)</b>                      Natural &amp; acquired immunity. Types and properties of antibodies, Structure of IgG. Phagocytosis and pinocytosis, Introduction to the cells involved in immune response: B cells and T cells</p>	<b>(15)</b>
	<p><b>BIOCHEMISTRY OF AIDS: (05 L)</b>                      AIDS: Structure of HIV, transmission of HIV, immunological abnormalities in AIDS. Lysis of CD4 cells. natural course of AIDS- acute, chronic, crisis phases. Anti AIDS drugs-AZT, didanosine (structure &amp; mechanism of action).</p>	
	<p><b>BIOCHEMISTRY OF DIABETES MELLITUS (05 L)</b>                      Structure of insulin, metabolic effects of insulin, mechanism of action of insulin. Types of diabetes mellitus, Symptoms, hyperglycemia, hypoglycemia, glucosourea and kidney threshold,                      Long term effects of diabetes: introduction to nephropathy, neuropathy, retinopathy and cardiovascular disease, Hypoglycemic drugs: metformin and sulfonylurea.</p>	

## Reference Books

Cell and Molecular biology - P. K. Gupta.

1. Molecular Biology; R. Weaver; 2nd Edition, McGraw Hill.
2. Molecular Cell Biology; Lodish; 6th Edition; W. H. Freeman & Company.
3. Gene VII; Benjamin Lewin; Pearson Education.
4. Elements of Biotechnology - P. K. Gupta.
5. Genetic engineering - Sandhya Mitra.
6. Biotechnology - B. D. Singh.
7. Immunology .-Kuby.
8. Essential Immunology- Roitt
9. Bioinformatics : Principle and applications - Harshawardhan P. Bal.
10. Introduction to Bioinformatics - T. K. Attwood & D. J. Parry- Smith

**B.Sc. – II Biochemistry**  
**Practical Course outcomes**

- Students learn the principle and technique of separation by chromatography.
- Students learn the basics of isolation and characterization of biological samples.
- Students understand the application of Beer Lamberts law in colorimetric estimation technique.
- Students understand the principle of estimation of biomolecules by colorimetry.
- Students learn the basics of titration and volumetric estimation of different components.
- Students learn the basics of qualitative estimation of biomolecules using specific tests.
- Students get introduced to an enzyme assay, its quantification and factors affecting on it.

## **B.Sc. – II Biochemistry**

### **Practical Course**

- Note: 1. Use of Electronic/single pan/digital balance is allowed.  
2. Use of scientific calculator is allowed.  
3. Use SI units whenever possible.

#### **Part I**

1. a) Fundamentals of Biochemical analysis.  
b) Control and accuracy.
2. **Separation/characterization (Any Two):**
  - a) Paper chromatographic separation and identification of amino acids from binary mixture.
  - b) Paper chromatographic separation and identification of carbohydrates from binary mixture.
  - c) Thin layer chromatographic separation and identification of amino acids/carbohydrates from binary mixture.
3. **Preparation of biological samples (Any Two):**
  - a) Isolation and characterization of starch from potatoes
  - b) Isolation and characterization of casein from milk
  - c) Isolation and characterization of albumin and globulin from egg yolk.
4. **Colorimetric estimations (Any five):**
  - a) Estimation of protein by Biuret method and verification of Beer-Lamberts law.
  - b) Estimation of inorganic phosphate in blood by Fiske-Subbarao method.
  - c) Estimation of reducing sugar by DNSA method.
  - d) Estimation of RNA by Bial's Orcinol method.
  - e) Estimation of creatinine in urine.
  - f) Estimation of blood urea by DAM method.
  - g) Estimation of DNA by Diphenylamine method.



## Part II

### 1. Demonstration Experiments:

- a) Soxhlet extraction of lipids from ground nuts/ egg yolk.
- b) Separation of indicators/ serum proteins by paper/ cellulose acetate electrophoresis.
- c) Antigen antibody interaction by Ouchterlony immunodiffusion procedure.
- d) Study of 3D structure and function relation of an Enzyme (Using Bioinformatics Tool).

### 2. Volumetric estimations (Any Four):

- a) Estimation of glycine by formal titration.
- b) Estimation of lactose in milk by Fehlings methods.
- c) Estimation of vitamin C in biological samples and tablets by 2,6dichlorophenol indophenols method.
- d) Estimation of saponification value of oil.
- e) Estimation of iodine number of oil.
- f) Estimation of acid value of oil.

### 3. Qualitative analysis:

- a) Carbohydrates – xylose, glucose, fructose, lactose, maltose, sucrose, starch.
- b) Lipids – oleic acid, palmitic acid, cholesterol, glycerol.
- c) Detection of any Three enzymes by qualitative tests (Urease, invertase, amylase, phenol oxidase, alkaline phosphatase, catalase)
- d) Abnormal constituents in urine (blood, reducing sugar, proteins, bilirubin, ketone bodies).

### 4. Study of Enzymes

- a) Immobilization of baker's yeast cells by gel entrapment for invertase activity.
- b) Quantitative Estimation of amylase activity.
- c) Effect temperature/pH/substrate concentration on amylase enzyme

### List of reference books for practical

1. Laboratory manual in Biochemistry – J. Jaynaraman
2. Practical Biochemistry – David Plummer
3. Hawk's physiological chemistry - Oser
4. A manual of laboratory technique (Ed) – N. Raghuramulu, K. Madhavan Nair & S. Kalyansundaram
5. Biochemistry methods – Sadasivan & Manikam.
6. Introductory Practical Biochemistry – Sawhney S. K. and Ranabir Singh
7. Viva and Practical Biochemistry – A. C. Deb.

**PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR**

**B.Sc. Part-II**

**PRACTICAL EXAMINATION IN BIOCHEMISTRY**

The practical examination of B.Sc. Part II in Biochemistry will be of 12 hours duration and will be conducted in two successive days, 6 hours per day.

The total practical examination will be of 160 Marks. The distribution of marks will be as follows.

1. Colorimetric estimation	20
2. Isolation of biological samples	20
3. Paper chromatography /Separation method	20
4. Volumetric estimation	20
5. Qualitative analysis of	20
a) Carbohydrate	
b) Lipid/enzyme	
c) Abnormal Urine components	
6 Study of Enzyme	20
a)immobilization	
b) Activity Quantification	
c) Effect of pH/temperature	
7 Oral	10
8 Journal	20
9 Visit Report of Study tour	10

The practical batch will be of maximum 24 candidates. The batch will be divided in two groups A & B. Group A will consist of 12 candidates while group B will have 12 candidates.

If the number of candidates in batch is less than 20 the number should be divided in two equal groups A & B. Any number remaining will be placed in group B.

Practical examination timing:

11.00 am to 2.00 pm

2.30 pm to 5.30 pm

Recess 2.00 pm to 2.30 pm

**PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR**

**Nature of Question Paper for choice based credit system (CBCS) Semester Pattern**

**Faculty of Science (w. e. f. June2023)**

**Time: -2hrs.**

**TotalMarks-40**

**Instructions:**

1. All questions are compulsory.
2. Draw **neat diagrams** and give **equations** wherever necessary.
3. Figures to the **right** indicate **full marks**.
4. Use of logarithmic table and calculator is allowed.

**Q. No.1) Multiple choice questions** (08)

- 1) -----  
a)      b)      c)      d)
- 2)  
3)  
4)  
5)  
6)  
7)  
8)

**Q.No.2) Answer any four of the following** (08)

- i)  
ii)  
iii)  
iv)  
v)  
vi)

**Q.No.3 Attempt any Two of the following** (08)

- i)  
ii)  
iii)

**Q. No.4) Answer any Two of the following** (08)

- i)  
ii)  
iii)

**Q.No.5) Answer any one of the following** (08)

- i)  
ii)