Enclosure II

Shree Manibhai Virani and Smt.Navalben Virani Science College, Rajkot
(Autonomous)
Affiliated to Saurashtra University, Rajkot

B.Sc. BIOCHEMISTRY

Semester III Syllabus

For Students Admitted From A.Y.2021-2022 and Onwards

Advanced Course For the students admitted from A.Y. 2022-2023& onwards		
Offering Department: **Biochemistry**	Offered to: **B.Sc. Biochemistry**	
Semester – III		
Course Code	Course Title (Ad.)	Course Credit and Hours
21UBCCC301	**Protein Biochemistry**	**4 Credits - 4 hrs/wk**

Course Description:

The course covers the physical and chemical properties of amino acids. Various elements of peptide bond, protein structure andfunctions. The course also offers to understand the applications of different techniques like centrifugation, homogenization, chromatography and electrophoresis used for protein isolation and characterization.

Course Purpose: The objective of the course is to provide comprehensive knowledge in the areasof protein chemistry,structure and function relationships, physicochemical properties of proteins and methodologies for characterization of proteinsrequired to understand regulation of cellular and molecular transformations in biological systems.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	**CO Statement**	**Blooms taxonomy Level (K_1 to K_6)**
CO_1	Classify, compare and evaluate the structural and functional differences of amino acids and various biologically important peptides	K1, K2, K3
CO_2	Describe, compare and predict structural forms of proteins and illustrate peptide bond formation	K1, K2, K3, K4

CO_3	Identify and recognize the physiological roles of proteins. Understand, compare the roles of protease enzymes applied in protein sequencing	K1, K2, K3, K4
CO_4	Describe, compare and apply the knowledge of various homogenization and chromatographic techniques used in protein purification.	K1, K2, K3, K4
CO_5	Draw and evaluate electrophoretographs of protiens separated by different electrophoresis; explain and classify immunoglobulins.	K1, K2, K3, K4

Course Content	**Hours**
Unit-I :Introduction to Amino acids, peptides and proteins	**12hrs**
● Structure and classification of amino acids. ● Physical, chemical and optical properties of amino acids. ● Physicochemical characteristics of proteins ● Biologically important amino acids and peptides - hormones, antibiotics and growth factors.	
Unit-II: Protein structure	**12 hrs**
● Nature of stabilizing bonds - covalent and non covalent. ● The peptide bond – Formation, Bond angles and bond lengths. ● Primary, Secondary, Tertiary and quaternary structures of protein ● Overview of protein folding (Role of molecular chaperons) ● Structures and functions of globular (myoglobin/ hemoglobin)and fibrous proteins(collagen/ keratin).	
Unit-III: Classification and Sequencing of Proteins	**12 hrs**
● Nutritional Classification of protein ● Functional classification and diverse biological functions of proteins. ● Chemical classification: Multimeric proteins, conjugated proteins and metallo proteins and their properties. ● N-terminal and C-terminal amino acid analysis. ● Sequencing techniques – Edman's degradation, Sanger's method and Automation. ● Generation of overlap peptides using different enzymes and chemical reagents. Disulfide bonds and their location.	
Unit-IV: Extraction and Separation techniques of proteins	**12 r s**

● Sources, availability and abundance of different proteins for isolation and separationfrom their cellular and extracellular locations. ● Application of simple homogenization methods: Glass Teflon homogenizer, Grinding, Ultrasonication, French press, Osmotic lysis, and Enzymatic methods. ● Ammonium sulphate fractionation, solvent fractionation, and dialysis. ● Application of Ion-exchange, Molecular sieve and Affinity chromatography for protein purification.	
Unit- V: Analytical techniques and clinical aspects of proteins	**12 hrs**
● Applications of IEF, SDS-PAGE (Native and Reduced) and 2-D electrophoresis to determine purity, molecular weight and subunits of proteins. ● Molecular structure and types of immunoglobulins ● Prions and Prion diseases. ● Haemoglobinopathies- Sickle cell anemia and Overview of types of Thalassemia. ● Collagen and elastin related diseases.	

Text books :

1. Conn Erice, E. and Stumpf Paul, K. (2007).*Outlines of Biochemistry*, [5th Edition]. John Wiley & Sons, New Delhi.(Unit 1 and 2)

2. Jain, J. L. Sunjay Jain and Nitin Jain (2004). *Fundamentals of biochemistry*. S. Chand Publishing, New Delhi.(Unit 3,4 and 5)

Reference books:

1. Nelson, D. L., & Cox, M. M. (2013). *Lehninger Principles of Biochemistry*. [6th edition] Freeman and Company, New York.

2. Berg, J. M., Tymoczko, J. L., Gatto G.J. &Stryer, L., (2015) *Biochemistry*, [8th Revised edition] W H Freeman, New York.

3. Devlin, T. M. (Ed.). (2010). *Textbook of biochemistry: with clinical correlations*. 7th Edition, John Wiley &Sons, New York.

Pedagogic tools:

- Chalk and Board
- Power point presentation
- Seminar

- Videos

Methods of Assessment & Tools:

Components of CIE: 30 marks (Example as below)

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1st 2 units	$1^{1/2}$ hours	5 (Set for 30)	20
	Test 2	All 5 units	3 hours	15 (Set for 70)	
B	Assignment			05	10
C	Class activity			05	
				Grand Total	**30**

Assignment	• Abstract and executive summary • Case study writing • Concept mapping • Student generated handbook • Essay writing etc.
Class activity	• Reaction paper • Quiz • One-minute paper • Situation based question • Application card etc.

Note: Any other assessment tools or methods can be adopted as per requirement of the course.

Advanced Course For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Biochemistry**	Offered to: **B.Sc Biochemistry**	
Semester – III		
Course Code	Course Title (Ad)	Course Credit and Hours
21UBCCC302	**Enzymology**	**4 Credits - 4 hrs/wk**

Course Description:

The course include deepening knowledge in the areas of classification of enzymes and cofactors, kinetics, inhibition and regulation of enzymes and concludes with enzyme applications in industry, therapeutics and diagnosis.

Course Purpose:

Primary goals of this course are to provide the students with detailed knowledge about enzymes, the biological catalysts with remarkable properties that sustain life, so as to develop an understanding of enzyme kinetics, mechanism of enzyme action and their regulation. The course also aims to outline the diverse applications of enzymes in disease diagnosis and therapy as well as in industry.

Acquired theoretical and experimental knowledge will enable students to find appropriate employment in different development, scientific-research laboratories, or to continue their further studies in biochemistry or related disciplines.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level (K_1 to K_6)
CO_1	Explain relationship between the structure and function of enzymes	K1 , K2
CO_2	Interpret and explain significant mechanisms of regulation of enzymatic action	K2 , K3
CO_3	Apply appropriate methods for determination of catalytic parameters and activity of enzymes	K2, K3 and K4
CO_4	Resolve problems considering kinetics and thermodynamics of enzymatic reactions	K2, K3 and K4
CO_5	Analyze options for applying enzymes and their inhibitors in medicine and various industries	K2, K3 and K4

Course Content	Hours
Unit-I : Introduction to enzymes Features of enzyme catalysis	**12 hrs**
• Nature and properties of enzymes - protein and non-protein (ribozyme). • Cofactor and prosthetic group, apoenzyme, holoenzyme. • IUBMB classification of enzymes. • Factors affecting the rate of chemical reactions, collision theory, activation energy and transition state theory. • Fischer's lock and key hypothesis and Koshland's induced fit hypothesis. • Different methods of enzyme assay.	

Unit-II:Enzyme kinetics	**12 hrs**
• Relationship between initial velocity and substrate concentration,steady state kinetics, Equilibrium constant - monosubstrate reactions. • Michaelis-Menten equation, Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot. • Determination and significance of Km , Vmax, Kcat and turnover number. • Effect of pH, temperature and metal ions on the activity of enzyme. • Types of bi bi reactions (sequential – ordered and random, ping pong reactions).	
Unit-III : Role of coenzymes and Mechanism of action of enzymes	**12 hrs**
• Role of coenzymes in enzyme reactions:TPP, FAD, NAD, pyridoxal phosphate, biotin, coenzyme A, tetrahydrofolate, lipoic acid. • Overview of mechanism of enzyme action - proximity and orientation, strain and distortion, acid base and covalent catalysis. • Mechansm of Action of Ribonuclease and Lysozyme. • Metal activated enzymes and metalloenzymes. • Transition state analogues –types and applications.	
Unit-IV : Enzyme inhibition and Regulation of enzyme activity	**12 hrs**
• Reversible (competitive, uncompetitive, non-competitive, mixed and substrate) and irreversible inhibition. • Control of activities of single enzymes (end product inhibition) and metabolic pathways, Feedback inhibition • Introduction to allosteric enzyme and its regulation- Aspartate Transcarbomylase. • Regulation by covalent modification- Glycogen Phosphorylase and Glycogen Synthase • Zymogens- Digestive enzymes, isoenzymes – LDH and Hexokinase. • Multienzyme complex as regulatory enzymes- Pyruvate Dehydrogenase complex.	
Unit- V: Applications of enzymes	**12 hrs**
• Clinical and diagnostics application of enzymes, enzyme applications in therapeutics, enzyme immunoassay (HRPO). • Application of enzymes in industries- Food, Dairy, Detergent, Paper, Textile and Leather Industry • Different methods of enzyme immobilization and their applications.	

Text books (2 textbooks):

- Nicholas C.Price and Lewis Stewens *Fundamentals of Enzymology* (1999) 3rd ed., Oxford University Press Inc. (New York),(Unit 4 and 5)
- Jain, J. L. Sunjay Jain and Nitin Jain (2004). *Fundamentals of biochemistry*. S. Chand Publishing, New Delhi. (Unit 1,2 and 3)

Reference books (2 or 3 reference books):

- Nelson, D.L. and Cox, M.M..Lehninger: *Principles of Biochemistry* (2013) 6th ed., W.H.Freeman and Company (New York).
- Donald, Voet. and Judith G.Voet., *Biochemistry* (2011) 4th ed., John Wiley & Sons Asia Pvt.Ltd. (New Jersey).
- Campbell, N. A., & Reece, J. B. (2016). *Campbell biology*. Boston: Pearson.

Pedagogic tools:

- Chalk and Board
- Power point presentation
- Seminar
- Videos

Methods of Assessment& Tools:

Components of CIE: 40 marks (Example as below)

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1st 2 units	$1^{1/2}$ hours	5 (Set for 30)	20
	Test 2	All 5 units	3 hours	15 (Set for 70)	
B	Assignment			5	10
C	Class activity			5	
				Grand Total	**30**
Assignment	• Abstract and executive summary • Case study writing • Concept mapping • Student generated handbook • Essay writing etc.				
Class activity	• Reaction paper • Quiz • One-minute paper • Situation based question • Application card etc.				

Note : Any other assessment tools or methods can be adopted as per requirement of the course.

Applied Course For the students admitted from A.Y. 2021-2022 & onwards	
Offering Department: Biochemistry	**Offered to: B.Sc Biochemistry students**

Semester – III		
Course Code	**Course Title (F)**	**Credits**
21UBCCC303	Core 7: Analytical Biochemistry	**4 Credits- 4 hrs/wk**

Course Description: Analytical biochemistry is a course that is essential for multiple disciplines of biological sciences besides biochemistry; such as plant and animal sciences, medicine, pharmacy and pharmacology, microbiology as well as biotechnology. It deals with various analytical techniques highly useful in better understanding of biomolecules and applying the bioanalytical instruments for analysis of wide range of biochemical substances.

Course Purpose:

The course aims to make students relate and apply basic concepts of biophysics and various analytical techniques such as UV-Visible spectroscopy, Centrifugation techniques, chromatography and electrophoresis in evaluation of wide range of substances encountered in biochemistry. It also expected to help analyze higher order structures of proteins, DNA and other macromolecules and compare them with their functions.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level (K_2 to K_6)
CO_1	Apply the basic concepts of various analytical techniques to distinguish, characterize and analyze different biomolecules.	K_2 , K_3 , K_4
CO_2	Relate working principle, instrumentation and applications of various bio-analytical instruments.	K_2 , K_3 , K_4
CO_3	Illustrate and apply the principles and functioning of various analytical instruments to elucidate interpret and analyze properties of different Biomolecules (proteins and nucleic acids) such as their structures, molecular weight, solubility, etc.	K_2 , K_3, K_4, K_5, K_6
CO_4	Apply various analytical techniques in identification and characterization of wide range of known as well as unknown chemical and biological substances and relate their functions with their properties.	K_2 , K_3, K_4, K_5, K_6

CO_5	Design methodologies and plan experiments to analyze, separate or purify wide range of molecules from biological samples on the basis of differences in their physicochemical properties.	K_2 , K_3, K_4, K_5, K_6

Course Content	**Hours**
Unit 1: Spectroscopic Techniques	**12 hrs**
• Descriptions of different terminologies; light, colour, wavelength, frequency energies of photons etc. Wavelength ranges of different electromagnetic radiations and their important characteristics. • UV-Visible absorption spectra, identification of unknown substances based on absorption spectra and absorption maxima. How do absorption spectra arise? Chromospheres and Chromophoric groups. • Quantitative aspects of light absorption; Beer-Lamberts laws of light absorption with their limitations. Extinction coefficients- (molar and percent extinction coefficients). • Instrumentation, principles, components and working of single and double beam colorimeter and spectrophotometers. • Advantages of double beam instruments over single beam instruments. Basic and advanced applications of UV-Visible spectroscopy in biochemistry.	
Unit 2: Centrifugation Techniques	**12 hrs**
• Sedimentation Principle - the concepts of Centrifugal force (F) and Relative centrifugal force (RCF). Relationship between F and RCF. • Over view of different types of rotors (swing out type rotors, angle head rotors, vertical rotors etc) and centrifuges (clinical centrifuges, high speed centrifuges and ultra centrifuges). • Preparative and analytical centrifugation –principles, instrumentation, techniques, and their applications. • Overview of different homogenization methods. Differential centrifugation and its applications in isolation of cell organelles. Significance of use of low temperatures and isotonic medium in differential centrifugation. • Principle of density gradient centrifugation, materials used to prepare density gradients and various applications of density gradient centrifugation.	
Unit 3: Radioisotope techniques	**12 hrs**
• Radioactive decay by emission of alpha, beta and gamma radiations with suitable examples. • Half life of radio isotopes. Types of radioisotopes commonly used in biochemistry, units of radioactivity. • Techniques for measurement of radioactivity (gas ionization and liquid scintillation counting). Overview of GM counter, Liquid Scintillation counter and gamma counters. • Applications of radioisotopes. • Biological hazards of radiation and safety measures in handling radioisotopes.	

Unit 4: Chromatographic techniques	**12 hrs**
General principles, materials, methods and applications of the following techniques: • Paper and thin-layer chromatography techniques. • Ion exchange chromatography. • Molecular sieve chromatography. • Affinity chromatography • Gas-Liquid chromatography (GLC) • High performance liquid chromatography (HPLC)	
Unit 5: Electrophoresis	**12 hrs**
• Basic principles of electrophoresis and factors affecting electrophoretic mobility: sample itself, electrical field strength, buffer, and supporting medium. • Principle, materials, apparatus used and applications of Agarose and Polyacrylamide gel electrophoresis (PAGE). • Overview of various applications of gel electrophoresis in molecular biology. • Principle and applications of SDS PAGE, Native v/s SDS PAGE. Using these techniques in determination of protein structure. • Basic principle and applications of Isoelectric focusing and 2D Gel electrophoresis.	

Text books (2 textbooks):
1. Upadhyay, A., Upadhyay, K., & Nath, N. (2009). Biophysical chemistry (principles and **techniques). Mumbai: Himalaya Pub. House.** **2.** Wilson K. and Walker J. (2018). *Principles and Techniques of Biochemistry and Molecular Biology.* Cambridge University Press - ISBN: 9781316677056
Reference books: 1. Conn Erice, E. and Stumpf Paul, K. (2007).Outlines of Biochemistry, [5th Edition]. John Wiley & Sons, New Delhi. 2. Freifelder, D. (1986). Physical biochemistry: Applications to biochemistry and molecular biology. San Francisco: W.H. Freeman. 3. Van Holde, K. E., Johnson, W. C., & Ho, P. S. (2006). Principles of physical biochemistry. Prentice-Hall.
Pedagogic tools: ● Chalk and Board ● Power point presentation ● Seminar ● Videos

Methods of Assessment & Tools:
Components of CIE:30 marks (Example as below)

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1st 2 units	$1^{1/2}$ hours	5 (Set for 30)	20
	Test 2	All 5 units	3 hours	15 (Set for 70)	
B	Assignment			05	10
C	Class activity			05	
				Grand Total	**30**

Assignment	● Abstract and executive summary ● Case study writing ● Concept mapping ● Student generated handbook ● Essay writing etc…
Class activity	● Reaction paper ● Quiz ● One-minute paper ● Situation based question ● Application card etc..

Note : Any other assessment tools or methods can be adopted as per requirement of the course.

Advanced Course For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Biochemistry**	Offered to: **B.Sc Biochemistry**	
Semester – III		
Course Code	Course Title (Ad)	Course Credit and Hours
21UBCC304	**Enzymology and Bioanalytical Practicals**	**3 Credits - 6 hrs/wk**

Course Description:

This laboratory course compliments the theory core courses by providing students with hands on experiences on Enzyme assay and Kinetics . Course also includes various analytical techniques such as UV-Visible spectroscopy, centrifugation techniques, chromatography and electrophoretic techniques.

Course Purpose:

To integrate the practical aspects of enzymology to provide an overview of the effects of various factors affecting enzyme activity, and applications of various bioanalytical techniques to purify and evaluate protein structure and functions through which students can confidently and competently work in both academia and industry.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	**CO Statement**	**Blooms taxonomy Level (S_1 to S_6)**
CO_1	Describe, apply and execute the enzyme assay from homogenate	**S1, S2, S3, S4**
CO_2	Compare and identify the differences in electrophoretic patterns of various proteins	**S2, S4**
CO_3	Perform bioassay for protein estimations and calculate the concentration of unknown biological samples	**S2, S3**
CO_4	Illustrate and draw the graphs to evaluate the effects of various factors like pH, temperature and substrate concentration on enzyme activity	**S1, S2, S3, S4**
CO_5	Identify and characterize the amino acids from the mixture by applying TLC and paper chromatography technique	**S1, S3**

Suggested laboratory experiments:

1. Qualitative analysis of proteins
2. Estimation of proteins by Lowry method.
3. Isolation of casein from milk.
4. Isoelectric pH of casein.
5. Molecular weight and subunit determination of proteins by native PAGE and SDS-PAGE. (Dry lab)
6. An introduction to practicals in enzymology.
7. Assay of enzyme Acid Phosphatase.
8. Enzyme curve of Acid Phosphatase.
9. Substrate curve of Acid Phosphatase.
10. pH curve of Acid Phosphatase

11. Temperature Curve of Acid Phosphatase.
12. Determination of Specific activity of enzyme.
13. Determination of absorption spectrum and absorption maxima of given compound.
14. Verification of Beer's Law of light absorption using colored solutions.
15. Introduction to principle and working of centrifuge.
16. Separation of amino acids using paper chromatography. Determination of Rf values and identification of amino acids from mixtures.
17. Separation of lipids by thin layer chromatography.
18. Separation of compounds using column chromatography.
19. Separation of Dyes using chalk chromatography.
20. Agarose Gel electrophoresis of DNA.

Pedagogic tools:

- Chalk and Board
- Laboratory Hands on training
- PowerPoint Presentation and Videos.
- Virtual Lab

Text books – Not applicable

Reference Books:

- Sadasivam, S. and Manickam, A. 2010. *Biochemical Methods*. [Third Edition]. New Age International (P) Ltd., New Delhi.
- Jayaraman, J. 2008. *Laboratory Manual in Biochemistry*. [First Edition Reprint]. New Age International (P) Ltd., New Delhi

Laboratory Manual/ Book

- Manual of Biochemistry Department, Shri M. & N. Virani Science College (Autonomous), Rajkot

Suggested reading / E-resources

- Not Applicable

Suggested MOOCs

- Not Applicable

Methods of assessing the Course Outcomes The COs of the course will be assessed through
● CIA (Test, Performance, Record book, Viva Voce) ● SEE

CIA Components	**Marks**
Test (After completion of 70-80% of accessible Practicals)	30
Performance and Record book	10
Grand Total	**40**

Sr. No.	**SEE Component**	**Content**	**Duration (if any)**	**Marks**	**Sub Total**
A	Test	After completion of course	6 hours	60	60
				Grand Total	**60**