MOTHER TERESA WOMEN'S UNIVERSITY
KODAIKANAL-624 101

DEPARTMENT OF BIOTECHNOLOGY

M.Sc. BIOCHEMISTRY
Curriculum Framework, Syllabus, and Regulations
(Based on TANSCHE Syllabus under choice Based Credit System – CBCS)

(For the candidates to be admitted from the Academic Year 2023-2024)

M.Sc. BIOCHEMISTRY

1. About the Programme:

M.Sc. Biochemistry is a 2-year Postgraduate programme that is divided into 4 semesters. The programme offers in-depth knowledge of biological-chemistry with regard to Pharmaceutical Biochemistry, Immunology, Clinical biochemistry and Enzymology. The main aim of the program is to make students understand the dynamics and mechanism of the biological activities taking place both in Microbes, Plants and Animals. M.Sc. Biochemistry degrees provide job opportunities for the eligible applicants to work as Research Fellow, Analytical Chemist, Pharma Associate, Clinical Biochemist, Food Safety Analyst, etc.

Programme:	**M.Sc BIOCHEMISTRY**
Programme Code:	**P23BC**
Duration:	**02 years**
Programme Outcomes:	**PO1.** To make students understand the importance of biochemistry as a subject that deals with life processes, as well as the concepts, theories and experimental approaches followed in biochemistry, in order to pursue a research career, either in an industry or academic setting. **PO2.** To develop analytical and problem-solving skills **PO3**. To create an awareness among the students on the interconnection between the interdisciplinary areas of biochemistry. **PO4**. To give the necessary practical skills required for biochemical techniques and analysis. **PO5**. To develop ~~a~~ communication and writing skills in students. **PO6**. To develop leadership and teamwork skills **PO7**. To emphasiz**e** the importance of good academic and work ethics and their social implications. **PO8**. To emphasize the importance of continuous learning and to promote lifelong learning and career development. **PO9**. To teach students how to retrieve information from a variety of sources, including libraries, databases and the internet. **PO10.** To teach students to identify, design and execute a research problem, analyze and interpret data and learn time and

	resource management.
Programme Specific Outcomes:	**Programme Specific Outcomes (PSO)** **On successful completion of this course, students should be able to**: **PSO1.** Understand the principles and methods of various techniques in Biochemistry, Immunology, Microbiology, Enzyme kinetics and Molecular Cell Biology. Based on their understanding, the students may would be able to design and execute experiments during their final semester project, and further research programs. **PSO2.** Insight on the structure-function relationship of biomolecules, their synthesis and breakdown, the regulation of these pathways, and their importance in terms of clinical correlation. Students will also acquire knowledge of the principles of nutritional biochemistry and also understand diseases and their prevention. **PSO3**. To understand the concepts of cellular signal transduction pathways and the association of aberrant signal processes with various diseases. Acquire insight into the immune system and its responses, and use this knowledge in the processes of immunization, vaccine development, transplantation and organ rejection. **PSO4.** To visualize and appreciate the central dogma of molecular biology, regulation of gene expression, molecular techniques used in rDNA technology, gene knock-out and knock-in techniques. **PSO5.** To create awareness in students about the importance of good laboratory practices and the importance of ethical and social responsibilities of a researcher. Teach them how to review literature and the art of designing and executing experiments independently and also work as a part of a team.

Eligibility:

A graduate who possess Degree in any one of the Life Sciences (Biotechnology / Botany / Zoology / Microbiology / Biochemistry / Environmental Science / Food Science and Herbal Sciences) and other relevant Subjects. Candidate should have secured at least 55% in the above subject from any recognized university.

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks
Methods of Assessment		
Recall(K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend(K2)	MCQ, True/False, Short essays, Concept explanations, Short summary or overview	
Application (K3)	Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain	
Analyze(K4)	Problem-solving questions, Finish a procedure in many steps, Differentiate	
	Between various ideas, Map knowledge	
Evaluate(K5)	Longer essay/Evaluation essay, Critiqueor justify with pros and cons	
Create(K6)	Check knowledge in specific or off beat situations, Discussion, Debating or Presentations	

- **Question paper pattern for External examination for Core and Elective papers:**

WRITTEN EXAMINATION QUESTION PAPER PATTERN

Theory Paper (Bloom's Taxonomy based)

Intended Learning Skills	**Maximum 75 Marks** **Passing Minimum: 50%** **Duration: Three Hours**
Memory Recall/Example/ Counter Example / Knowledge about the Concepts/Understanding	**Part–A (10x2=20Marks)** Answer ALL questions **Each Question carries 2 marks**
	Two questions from each Unit
	Question 1 toQuestion10
Descriptions/Application (problems)	**Part–B (5x5=25Marks) Answer ALL questions** **Each question carries 5 Marks**
	Either - or Type Both parts of each question from the same Unit
	Question 11 (a) or 11(b) to **Question 15(a) or 15(b)**

Analysis/Synthesis / Evaluation	**Part-C (3x 10 = 30 Marks)** **Answer any THREE questions** **Each question carries 10 Marks**
	There shall be FIVE questions covering all the five units
	Question 16 to Question 20

***Minimum credits required to pass:91**

Project Report

A student should select a topic for the Project Work at the end of the fifth semester itself and submit the Project Report at the end of the sixth semester. The Project Report shall not exceed 75typed pages in Times New Roman font with 1.5linespace.

Project Evaluation

There is a Viva Voce Examination for Project Work. The Guide and an External Examiner shall evaluate and conduct the Viva Voce Examination. The Project Work carries 100 marks (Internal: 25Marks; External (Viva):75 Marks).

Conversion of Marks to Grade Points and Letter Grade (Performance in a Course/Paper)

Range of Marks	Grade Points	Grade	Description
90 –100	9.0 –10.0	O	Outstanding
80-89	8.0 –8.9	D+	Excellent
75-79	7.5 –7.9	D	Distinction
70-74	7.0 –7.4	A+	VeryGood
60-69	6.0 –6.9	A	Good
50-59	5.0 –5.9	B	Average

Attendance

Students must have earned 75% of attendance in each course for appearing for the examination. Students with 71% to 74% of attendance must apply for condonation in the prescribed form with prescribed fee. Students with 65% to 70% of attendance must apply for condonation in the prescribed form with the prescribed fee along with the Medical Certificate. Students with attendance lesser than 65% are not eligible to appear for the examination and they shall re-do the course with the prior permission of the Head of the Department, Principal and the Registrar of the University.

Maternity Leave

The student who avails maternity leave may be considered to appear for the examination with the approval of Staff i/c, Head of the Department, Controller of Examination and the Registrar.

Any Other Information

In addition to the above-mentioned regulations, any other common regulations pertaining to the UG Programmes are also applicable for this Programme.

MOTHER TERESA WOMEN'S UNIVERSITY,KODAIKANAL
M.Sc. BIOCHEMISTRY SYLLABUS
2023-2024

SEMESTER-I								
Course Code	**Course Title**	**Hours**			**Credits**	**CIA**	**ESE**	**Total**
		L	**T**	**P**				
P23BCT11	Core-1 Basics of Biochemistry	4	3		5	25	75	100
P23BCT12	Core-2 Biochemical and Molecular Biology Techniques	4	3		5	25	75	100
P23BCP11	Core – 3- Practical - Biomolecules And Biochemical Techniques			6	4	25	75	100
P23BCE1A/ P23BCE1B	Elective -1: A - Energy and Drug metabolism / B - Biophysical Methodology	3	2		3	25	75	100
P23WSG11	Generic Course I – Women Empowerment	3	2		3	25	75	100
	Total	**30**			**20**	**-**	**-**	**500**
SEMESTER-II								
P23BCT23	Core-4: Enzymology	3	3		5	25	75	100
P23BCT24	Core-5: Clinical Biochemistry	3	3		5	25	75	100
P23BCP22	Core – 6: Practical - Enzymology and Clinical Biochemistry			6	4	25	75	100
P23BCE2A / P23BCE2B	Elective-2: A - Molecular Basis of Diseases and Therapeutic Strategies / B - Bioplastics	2	2		3	25	75	100
P23BCS21	SEC I (NME)- Phytochemistry	2	2		2	25	75	100
P23CSG22	Generic Course II: Cyber Security	2	2		3	25	75	100
	Total	**30**			**22**	**-**	**-**	**600**

SEMESTER-I

Course	**CORE PAPER I**
Title of theCourse:	**P23BCT11 - BASICS OF BIOCHEMISTRY**
Credits:	**5**
Pre-requisites, ifany:	Basic Knowledge of Biochemistry and Biomolecules
Course Objectives	The main objectives of this course are to: **1.** Students will be introduced to the structure of biomolecules. **2.** The significance of carbohydrates in biological processes will be understood. **3.** The structure, properties and biological significance of lipids in the biological system will be studied **4.** Students will learn about the concepts of protein structure and their significance in biological processes and creatively comprehend the role of membrane components with their biological significance. **5.** Students will gain knowledge about the structures and functional roles of nucleic acids in the biological system
Course Outcomes	On successful completion of the course, the students should be able to: **CO1:** Explain the chemical structure and functions of carbohydrates.(K1, K2) **CO2:** Using the knowledge of lipid structure and function, explain how it plays a role in Signalling pathways (K3, K4) **CO3:** Describe the various levels of structural organisation of proteins and the role ofproteins in biological system (K4, K5) **CO4:** Apply the knowledge of proteins in cell-cellinteractions (K3, K4) **CO5:** Applying the knowledge of nucleic acid sequencing in researchand diagnosis (K2, K3, K4)

Units	
	Carbohydrates- Classification, structure (configurations and conformations, anomeric forms),

I	function and properties of monosaccharides, mutarotation, Disaccharides and oligosaccharides with suitable examples. Polysaccharides - Homopolysaccharides (starch, glycogen, cellulose, inulin, dextrin, agar, pectin, dextran). Heteropolysaccharides - Glycosaminoglycans– source, structure, functions of hyaluronic acid, chondroitin sulphates, heparin, keratan sulphate. Glycoproteins - proteoglycans. O- Linked and N-linked glycoproteins. Biological significance of glycan. Blood group polysaccharides. Bacterial cell wall (peptidoglycans, teichoic acid) and plant cell wall carbohydrates.
II	Lipids – Classification of lipids, structure, properties and functions of fatty acids, triacylglycerols, phospholipids, glycolipids, sphingolipids and steroids – Biological importance. Eicosanoids- classification, structure and functions of prostaglandins, thromboxanes, leukotrienes. Lipoproteins – Classification, structure, transport (endogenous and exogenous Pathway) and their biological significance.
III	Overview of Aminoacids - classification, structure and properties of amino acids, Biological role. Non Protein aminoacids and their biological significance .Proteins – classification based on composition, structure and functions. Primary, secondary, super secondary (motifs) (Helix-turn –helix, helix-loop-helix, Beta-alpha-beta motif, Rosemann Rossmann fold, Greek key), tertiary and quaternary structure of proteins. Structural characteristics of collagen and hemoglobin. Determination of amino acid sequence. Chemical synthesis of a peptide, Forces involved in stabilization of protein structure. Ramachandran plot. Folding of proteins. Molecular chaperons – Hsp 70 and Hsp 90 - biological role.
IV	Membrane Proteins - Types and their significance. Cytoskeleton proteins - actin, tubulin, intermediate filaments. Biological role of cytoskeletal proteins. Membrane structure- fluid mosaic model
V	Nucleic acids – types and forms (A, B, C and Z) of DNA. Watson-Crick model - Primary, secondary and tertiary structures of DNA. Triple helix and quadruplex DNA. Mitochondrial and chloroplast DNA. DNA supercoiling (calculation of Writhe, linking and twist number). Determination of nucleic acid sequences by Maxam Gilbert and Sanger's methods. Forces stabilizing nucleic acid structure. Properties of DNA and RNA. C-value, C-value paradox, Cot curve. Structure and role of nucleotides in cellular communications. Major and minor classes of RNA, their structure and biological functions.
Reading List (Print and	1. https://bio.libretexts.org/Bookshelves/Biochemistry/Book%3A_Biochemistry_Online_(Jakubowski)

Online)	2. https://www.thermofisher.com/in/en/home/life-science/protein- biology/protein-biology-learning-center/protein-biology-resource- library/pierce-protein-methods/protein-glycosylation.html 3. https://ocw.mit.edu/courses/biology/7-88j-protein-folding-and- human-disease-spring-2015/study-materials/ 4. https://www.open.edu/openlearn/science-maths- technology/science/biology/nucleic-acids-and-chromatin/content-section- 3.4.2 5. https://www.genome.gov/genetics-glossary/Cell-Membrane https://nptel.ac.in/content/storage2/courses/102103012/pdf/mod3.pdf
Self-Study	1. Classification of Sugars 2. Nutritional classifcation of fatty acids
Recommended Texts	1. David L.Nelson and Michael M.Cox (2012) LehningerPrinciples of Biochemistry (6th ed) W.H. Freeman. 2. Voet.D & Voet. J.G (2010) Biochemistry, (4th ed), JohnWiley & Sons, Inc. 3. Metzler D.E (2003). The chemical reactions of livingcells (2nd ed), Academic Press. 4. Zubay G.L (1999) Biochemistry, (4th ed), Mc Grew-Hill. 5. Lubert Stryer (2010) Biochemistry, (7th ed), W.H.Freeman 6. Satyanarayan, U (2014) Biochemistry (4th ed), ArunabhaSen Books & Allied (P) Ltd, Kolkata.

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**L**	**M**	**S**	**M**	**M**	**M**	**S**	**M**	**M**
CO 2	**S**	**M**	**L**	**S**	**M**	**M**	**M**	**S**	**M**	**M**
CO 3	**S**	**M**	**M**	**S**	**S**	**M**	**L**	**S**	**M**	**M**
CO 4	**S**	**M**	**M**	**S**	**M**	**M**	**M**	**S**	**M**	**M**
CO 5	**S**	**S**	**M**	**S**	**S**	**M**	**M**	**S**	**M**	**M**

S- Strong M-Medium L-Low

Course	**CORE PAPER II**
Title of the Course:	**P23BCT12 - BIOCHEMICAL AND MOLECULAR BIOLOGY TECHNIQUES**
Credits:	**5**
Pre-requisites, if any:	Comprehensive Knowledge of Tools of Biochemistry/Molecular Biology
Course Objectives	Biochemical techniques combine various inter-disciplinary methods in biological research and the course aims to provide students with the following objectives: 1. To understand the various techniques used in biochemical investigation and microscopy. 2. To explain chromatographic techniques.\ and their applications 3. To explain electrophoretic techniques. 4. To comprehend the spectroscopic techniques and demonstrate their applications in biochemical investigations. **5.** To acquire knowledge of radio labelling techniques and centrifugation.
Course Outcomes	After completion of the course, the students should be able to: **CO1.** Attain good knowledge in modern used in biochemical investigation and microscopy and apply the experimental protocols to plan and carry out simple investigations in biological research. (K1, K5) **CO2.** Demonstrate knowledge to implement the theoretical basis of chromatography in upcoming practical course work. (K3, K5) **CO3.** Demonstrate knowledge to implement the theoretical basis of electrophoretic techniques in research work. (K3, K5) **CO4.** Tackle more advanced and specialized spectroscopic techniques that are pertinent to research. (K1, K2 & K5) **CO5.** Tackle more advanced and specialized radioisotope and centrifugation techniques that are pertinent to research work. (K1, K2 & K5)
Units	
I	General approaches to biochemical investigation, cell culture techniques and microscopic techniques. Organ and tissue slice technique, cell distribution and homogenization techniques, cell sorting, and cell counting, tissue Culture techniques. Cryopreservation, Biosensors- principle and applications. Principle, working and applications of light microscope, dark field, phase contrast and

	fluorescent microscope. Electron microscope- Principle, instrumentation of TEM and SEM, Specimen preparation and applications-shadow casting, negative staining and freeze fracturing.
II	Chromatographic Techniques: Basic principles of chromatography- adsorption and partition techniques. Chiral Chromatography and counter current Chromatography. Adsorption Chromatography – Hydroxy apatite chromatography and hydrophobic interaction Chromatography. Affinity chromatography. Gas liquid chromatography- principle, instrumentation, column development, detectors and applications. Low pressure column chromatography – principle, instrumentation, column packing, detection, quantitation and column efficiency, High pressure liquid chromatography- principle, instrumentation, delivery pump, sample injection unit, column packing, development, detection and application. Reverse HPLC, capillary electro chromatography and perfusion chromatography.
III	Electrophoretic Techniques: General principles of electrophoresis, supporting medium, factors affecting electrophoresis, Isoelectric focusing-principle, ampholyte, development of pH gradient and application. PAGE-gel casting-horizontal, vertical, slab gels, sample application, detection-staining using CBB, silver, fluorescent stains. SDS PAGE-principle and application in molecular weight determination principle of disc gel electrophoresis ,2D PAGE. Electrophoresis of nucleic acids-agarose gel electrophoresis of DNA, pulsed field gel electrophoresis- principle, apparatus, application. Electrophoresis of RNA, curve. Microchip electrophoresis and 2D electrophoresis, Capillary electrophoresis.
IV	Spectroscopic techniques: Basic laws of light absorption- principle, instrumentation and applications of UV-Visible, IR, ESR, NMR, Mass spectroscopy, Turbidimetry and Nephelometry. Luminometry (Luciferase system, chemiluminescence). X - ray diffraction. Atomic absorption spectroscopy - principle and applications - Determination of trace elements
V	Radiolabeling Techniques and Centrifugation: Nature of radioactivity-detection and measurement of radioactivity, methods based upon ionisation (GM counter) and excitation (scintillation counter), autoradiography

	and applications of radioactive isotopes, Biological hazards of radiation and safety measures in handling radioactive isotopes. Basic principles of Centrifugation. Preparative ultracentrifugation - Differential centrifugation, Density gradient centrifugation. Analytical ultracentrifugation - Molecular weight determination.
Reading List (Print and Online)	Principles and techniques of biochemistry and molecular biology: https://www.kau.edu.sa/Files/0017514/Subjects/principals%20and%20techiniques%20of%20biochemistry%20and%20molecular%20biology%207th%20ed%
Self-Study	1. Types of rotors 2. Colorimetry – principle and applications
Recommended Texts	1.Keith Wilson , John Walker (2010) Principles and Techniques of Biochemistry and Molecular Biology (7th ed) Cambridge University Press 2.David Sheehan (2009), Physical Biochemistry: Principles and Applications (2nd ed), Wiley-Blackwell 3.David M. Freifelder (1982) Physical Biochemistry: Applications to Biochemistry and Molecular Biology,W.H.Freeman 4.Rodney F.Boyer (2012), Biochemistry Laboratory: Modern Theory and techniques,(2nd ed),Prentice Hall 5.Kaloch Rajan (2011), Analytical techniques in Biochemistry and Molecular Biology, Springer 6. Segel I.H (1976) Biochemical Calculations (2nd ed), John Wiley and Sons 7. Robyt JF (2015) Biochemical techniques: Theory and Practice (1st ed), CBS Publishers & Distributors

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**

CO 1	**S**	**L**	**M**	**S**	**S**	**L**	**L**	**S**	**S**	**M**
CO 2	**S**	**M**	**M**	**S**	**M**	**L**	**M**	**S**	**S**	**L**
CO 3	**S**	**M**	**L**	**S**	**M**	**M**	**M**	**S**	**M**	**L**
CO 4	**S**	**S**	**L**	**S**	**S**	**M**	**M**	**S**	**M**	**M**
CO 5	**S**	**S**	**M**	**S**	**M**	**M**	**M**	**S**	**M**	**M**

S-Strong MS-Strong M-Medium L-Low

Course	**CORE PAPER VII**

Title of the Course:	**P23BCP11** **Laboratory Course on** **BIOMOLECULES AND BIOCHEMICAL TECHNIQUES**
Credits:	**4**
Pre-requisites	Knowledge on basic principles, Instrumentation of Biochemical techniques and metabolic reactions
Course Objectives	1. To instill skill in students enabling them to apprehend the wider knowledge about principles and techniques to be employed for the biomolecules under investigation. 2.To inculcate the knowledge of various isolation and purification techniques of macromolecules like DNA, RNA, Glycogen and Starch, 3. To perform colorimetric estimations to quantify important metabolites like lactate and tryptophan and minerals like calcium and iron from various sources. 4. To achieve training in subcellular fractionation and to identify them by markers. 5 To achieve training in various chromatographic techniques. 6. To perform the isolation and identification of the organelles of a cell using differential centrifugation. 7. To perform phytochemical screening and quantification enabling them to give an insight on phytochemicals this will be useful for future research.
Course Outcomes	**On successful completion of this course, students should be able to:** After completion of the course, the students should be able to: **CO1.**The student will be able to acquire knowledge and skill in the techniques used in the isolation, purification and estimation of different biomolecules that are widely employed in research (K1, K2, K4) **CO2.**The students will get acquainted with Principle, Instrumentation and method of Performing UV absorption studies of DNA, Protein and interpreting the alteration occurred during the process of denaturation (K1,K2, K 3, K4).

	CO3. The student will be fine-tune in handling the instruments like colorimeter, spectrophotometer and will be able to estimate the biomolecules and minerals from the given samples (K1, K2, K4,) **CO4.** The student, in addition to acquiring skill in performing various biochemical techniques can also learn to detect presence of phytochemicals and quantify them in the plant sample. (K1, K2, K3, K4 & K6) **CO5.**The students will develop skill in analytical techniques like subcellular fractionation, Paper, Column and Thin layer Chromatography and the group experiments will enable them to build learning skills like team work, Problem solving, Communication ability. (K1, K2, K3, K4 & K6)
Units	
I	Biochemical studies and estimation of macromolecules 1. Isolation and estimation of glycogen from liver. 2. Isolation and estimation of DNA from animal tissue. 3. Isolation and estimation of RNA from yeast. 4. Purification of Polysaccharides –Starch and assessment of its purity
II	UV absorption 1. Denaturation of DNA and absorption studies at 260nm. 2. Denaturation of Protein and absorption studies at 280nm.
III	Colorimetric estimations 1. Estimation of Pyruvate 2. Estimation of tryptophan.
IV	Estimation of minerals 1. Estimation of calcium 2. Estimation of iron
V	Plant Biochemistry 1. Qualitative analysis Phytochemical screening

	2.Estimation of Flavonoids -Quantitative analysis
VI	Group Experiments 1.Fractionation of sub-cellular organelles by differential centrifugation-Mitochondria and nucleus 2. Identification of the separated sub-cellular fractions using marker enzymes (any one) 3.Separation of identification of lipids by thin layer chromatography. 4.Separation of plant pigments from leaves by column chromatography 5. Identification of Sugars by Paper Chromatography 6.Identification of Amino acids by Paper Chromatography
Reading List (Print and Online)	1.https://www.researchgate.net/publication/313745155_Practical_Biochemistry_A_Student_Companion 2.https://doi.org/10.1186/s13020-018-0177-x 3.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5368116/ 4.https://www.life.illinois.edu/biochem/455/Lab%20exercises/2Photometry/spectrophotometry.pdf 5.https://ijpsr.com/bft-article/determination-of-total-flavonoid-and-phenol-content-in-mimusops-elengi-linn/?view=fulltext 6.https://skyfox.co/wp-content/uploads/2020/12/Practical-Manual-of-Biochemistry.pdf
Self-Study	1. Laboratory Safety Rules, Requirements and Regulations. 2. Preparation of standard solutions and reagent
Books Recommended	1. David Plummer (2001) An Introduction to Practical Biochemistry (3rd ed) McGraw Hill Education (India) Private Ltd 2. Jayaraman, J (2011), laboratory Manual in Biochemistry, New age publishers 3. Varley H (2006) Practical Clinical Biochemistry (6th ed) , CBS Publishers 4. O. Debiyi and F. A. Sofowora, (1978) “Phytochemical screening of medical plants,” Iloyidia, vol. 3, pp. 234–246,

	5. Prof. Sarin A. Chavhan, Prof. Sushilkumar A. Shinde (2019) A Guide to Chromatography Techniques Edition:1 6. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	S	S	S	S	M	S	L	S	M	S
CO 2	S	S	S	S	M	S	L	S	M	S
CO 3	S	S	S	S	M	S	M	S	M	S
CO 4	S	S	S	S	S	S	S	S	S	S
CO 5	S	S	S	S	S	S	S	S	S	S

S-Strong M-Medium L-Low

SEMESTER II

Course	**CORE PAPER IV**
Title of the Course:	**P23BCT23-ENZYMOLOGY**
Credits:	**5**

Pre-requisites	Basic knowledge about catalysis, kinetics and chemical reaction mechanisms.
Course Objectives	1. Students will be introduced to the theory and practice of enzymology. 2. Mechanisms of catalysis and factors affecting catalysis will be understood 3. The kinetics of enzyme catalyzed reactions in the absence and presence of inhibitors will be studied and the options for applying enzymes and their inhibitors in medicine will be analyzed.
	4. Students will learn about the applications of enzymes in research, medicine, and industry, which will prepare them for careers in industrial and biomedical research. 5. The control of metabolic pathways and cellular responses through enzyme regulation will be emphasized.
Course Outcomes	**On successful completion of this course, students should be able to:** **CO1:** Describe the catalytic mechanisms employed by enzymes (K1, K2 & K5) **CO2:** Choose and use the appropriate methods to isolate and purify enzymes and check the purity of the enzyme. (K1, K2 , K3, K4 & K5) **CO3:** Analyze enzyme kinetic data graphically, calculate kinetic parameters, determine the mechanism of inhibition by a drug/chemical and analyze options for applying enzymes and their inhibitors in medicine (K1, K2, K3 &K4) **CO4:** Explain allosterism and cooperativity and differentiate Michaelis-Menten kinetics from sigmoidal kinetics. The role played by enzymes in the regulation of vital cellular processes will be appreciated. (K1, K2, K5, K6) **CO5:** Highlight the use of enzymes in industries and biomedicine (K1, K2 & K3)

Units	
I	Introduction to enzymes and features of catalysis: A short history of the discovery of enzymes and how they became powerful biochemical tools. Holoenzyme, apoenzyme, cofactors, coenzyme, prosthetic groups, Classification and Nomenclature, Specificity of enzyme action-group specificity, absolute specificity, substrate specificity, stereochemical specificity. Active site, Identification of amino acids at the active site-trapping of ES complex, identification using chemical modification of amino acid side chains and by site-directed mutagenesis.

	Mechanisms of enzyme catalysis: acid-base catalysis, covalent catalysis, electrostatic catalysis, metal ion catalysis, proximity and orientation effects, Low barrier H-bonds, Structural flexibility Mechanism of action of chymotrypsin
II	Enzyme techniques: Isolation and purification of enzymes - Importance of enzyme purification, methods of purification- choice of source , extraction, fractionation methods-based on size or mass (centrifugation, gel filtration); based on polarity (ion-exchange chromatography, electrophoresis, isoelectric focusing, hydrophobic interaction chromatography); based on solubility (change in pH, change in ionic strength); based on specific binding sites (affinity chromatography) ,choice of methods, Criteria of purity of enzymes. Enzyme units - Katal, IU. Measurement of enzyme activity - discontinuous, continuous, coupled assays; stopped flow method and its applications. Isoenzymes and their separation by electrophoresis with special reference to LDH
III	Enzyme kinetics I: Thermodynamics of enzyme action, Activation energy, transition-state theory, steady-state kinetics & pre-steady-state kinetics. Single substrate enzyme catalyzed reactions -assumptions, Michaelis-Menten and Briggs-Haldane kinetics, derivation of Michaelis-Menten equation . Double reciprocal (Lineweaver-Burk) and single reciprocal (Eadie -Hofstee) linear plots, their advantages and limitations. Analysis of kinetic data- determination of Km, Vmax, kcat, and their physiological significance, Importance of kcat/Km. Enzyme inhibition: Irreversible inhibition. Reversible inhibition-Competitive, uncompetitive, noncompetitive, mixed and substrate inhibition. Michaelis -Menten equation in the presence of competitive, uncompetitive and non-competitive inhibitors. Graphical analysis - Diagnostic plots for the determination of inhibition type. Therapeutic use of enzyme inhibitors-Aspirin, statins (irreversible inhibitors), Methotrexate (competitive inhibitor), Etoposide (non-competitive inhibitor), camptothecin (uncompetitive inhibitor). Demonstration: Using Microsoft Excel to Plot and Analyze Kinetic Data
IV	Enzyme kinetics II: Allosteric enzymes: Cooperativity, MWC and KNF models of allosteric enzymes, Sigmoidal kinetics taking ATCase as an example. Regulation of amount and catalytic activity by - extracellular signal, transcription, stability of mRNA, rate of translation and degradation, compartmentation, pH, temperature, substrate concentration, allosteric effectors, covalent modification. Regulation of glycogen synthase and glycogen phosphorylase. Feedback inhibition-sequential, concerted, cumulative, enzyme-multiplicity with examples.
	Bi - Substrate reactions: Single Displacement reactions (SDR) (Ordered and Random bi bi mechanisms), Double Displacement reactions (DDR) (Ping pong mechanism), Examples, Cleland's representation of bisubstrate reactions, Graphical analysis (diagnostic plots) to differentiate SDR from DDR.

V	Enzyme technology: Immobilization of enzymes – methods - Reversible immobilization (Adsorption, Affinity binding), Irreversible immobilization (Covalent coupling, Entrapment and Microencapsulation, Crosslinking, Advantages and Disadvantages of each method, Properties of immobilized enzymes. Designer enzymes-ribozymes and deoxyribozymes, abzymes, synzymes. Enzymes as therapeutic agents-therapeutic use of asparaginase and streptokinase. Application of enzymes in industry- Industrial application of rennin, lipases, lactases, invertase, pectinases, papain.
Reading List (Print and Online)	**Enzymes** | MIT OpenCourseWare | Free Online Course Materials https://ocw.mit.edu/high-school/biology/exam-prep/chemistry-of-life/enzymes/ **Enzymology** https://onlinecourses.swayam2.ac.in/cec20_bt20/preview https://mooc.es/course/enzymology/ **The active site of enzymes** https://dth.ac.in/medical/courses/biochemistry/block-1/1/index.php **Enzymes and Enzyme Kinetics** https://www.lecturio.com/medical-courses/enzymes-and-enzyme kinetics.course#/ Mechanistic enzymology in drug discovery: a fresh perspective https://www.nature.com/articles/nrd.2017.219 Enzyme Biosensors for Biomedical Applications: Strategies for Safeguarding Analytical Performances in Biological Fluids https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4934206/
Self-Study	1.Mechanistic enzymology in drug discovery 2. Enzyme Biosensors for Biomedical Applications
Recommended Texts	1.Enzymes: Biochemistry, Biotechnology and Clinical chemistry, 2nd edition, 2007, Palmer T and Bonner P; Affiliated- East West press private Ltd, New Delhi 2.Fundamentals of Enzymology, 3rd edition, 2003, Price NC and Stevens L; Oxford University Press, New York 3.Voet's Biochemistry, Adapted ed, 2011, Voet, D and Voet JG; Wiley, India 4.Lehninger Principles of Biochemistry, 8th edition, 2021, Nelson DL and Cox MM; WH Freeman & Co, New York 5. Biochemistry, Berg JM, Stryer L, Gatto, G, 8th ed, 2015; WH Freeman & Co., New York. 6.Enzyme Kinetics and Mechanism; Cook PF, Cleland W, ;2007; Garland Science, London

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	**S**	**M**	**S**	**L**	**M**	**S**	**L**	**S**	**S**	**M**
CO 2	**S**	**S**	**S**	**S**	**M**	**M**	**L**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**M**	**M**	**M**	**S**	**S**	**S**
CO 4	**S**	**S**	**S**	**S**	**M**	**M**	**M**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**S**	**M**	**L**	**M**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course I	**CORE PAPER – V**
Title of the Course:	**P23BCT24 - CLINICAL BIOCHEMISTRY**
Credits:	**5**
Pre-requisites, if any:	The student should have a basic knowledge of body fluids and their composition and metabolism; anatomy and physiology of vital

	organs.
Course Objectives	1. To understand the need and methods of various biological sample collection. 2. To explicitly understand the etiopathogenesis, symptoms and complications of metabolic and hormonal disorders and the relevant diagnostic markers 3. To emphasize the diagnostic significance of serum enzymes in different pathologies and other Laboratory investigations of diagnostic importance so as to differentiate normal from disease 4. To conceive the role of inherited genes in inborn errors of metabolism and methodologies pertaining to *in utero* diagnosis and post-natal screening. 5. To get updated about electrolyte and hormonal imbalances and the biochemical tests to diagnose them.
Course Outcomes	**CO1.** To appreciate the biological significance of sample collection and awareness of the diagnostic/screening tests to detect common non-communicable diseases so as to understand role of laboratory investigations for biochemical parameters and understand the disorders associated with blood cells **CO2.** To understand the etiology of metabolic diseases like diabetes and atherosclerosis and avoid such lifestyle disorders by healthy eating and correlate the symptoms with underlying pathology based on diagnostic and prognostic markers. **CO3.** To understand the diagnostic application of serum/plasma enzymes to correlate their levels with the organ pathologies associated with specific diseases.

	CO4. To appreciate the role of pre and post-natal diagnosis leading to healthy progeny. **CO5.** To link the serum hormone levels and clinical symptoms with underlying hormonal disturbances. To review the onward transmission of signal via downstream signaling molecules from cell surface to the nucleus by different pathways by comparing and contrasting them and critically evaluate the network between them resulting in the biological outcome.
	Units
I	**Biochemical investigations in diagnosis, prognosis, monitoring, screening:** Specimen collection – blood, (primary /Secondary specimen)., urine and CSF. Preservation of biological specimens - blood, urine, CSF and amniotic fluid. Biological reference ranges; **Disorders of blood cells**: Hemolytic, iron deficiency and aplasticanemia and diagnosis, sickle cell anaemia, thalassemia HBA1C variants. Porphyrias, Thrombocytopenia, Causes of leucopenia, leukemia and leucocytosis. Disorders of blood clotting mechanism - Von willebrand's disease, Hemophilia A, B and C, diagnostic test for clotting disorders, D-dimer and its clinical significance
II	**Diabetes mellitus: pathology and complications:** Acute changes Chronic complications: Diabetic nephropathy, neuropathy, retinopathy and Diabetic foot ulcers, Random/Fasting/PP glucose testing, Impaired glucose tolerance (IGT), Impaired fasting glucose (IFT), Diagnosis-by GTT, Pre-diabetes, Gestational DM, Glycosylated Haemoglobin (HBA1c); Glycated albumin., Hypoglycaemia and critical alert value for glucose. Markers of complications of Diabetes mellitus: Metabolic syndrome, Lipid profile &lipoproteinemia, Atherosclerosis, Diabetic nephropathy, Micralbuminuira, eGFR. Point of care testing for glucose (Glucometers) and continuous glucose monitoring (CGM) : principle and its use. Major groups of anti-diabetic drugs. Diet and life style modifications

III	**Diagnostic Enzymology:** Clinically Important Enzymes and Isoezyme as diagnostic markers: Clinical significance of AST, ALT, ALP, ACP, CK, γ-GT, amylase, pseudocholinesterase and their pattern in Myocardial infarction; Liver disease, Bone disease, Muscle disease, Cancer (tumor markers), GI tract pancreatitis); Enzymes as therapeutic agents. **Pre- and post-natal testing:** Amniocentesis, prenatal detection of inborn errors of metabolism in developing fetus- Autosomal recessive mode of inheritance- cystic fibrosis, X linked recessive inheritance- Duchenne muscular dystrophy. New born screening (NBS) for In born errors of metabolism, Tandem mass spectrometry application in NBS
IV	**Liver function tests:** Liver function test panel, Fatty liver . Plasma protein changes in liver diseases. Hepatitis A, B and C. Cirrhosis and fibrosis. Portal hypertension and hepatic coma. Acute phase proteins - CRP, Haptoglobins, α-fetoprotein, ferritin and transferrin and their clinical significance, Interpreting serum protein electrophoresis. Inflammatory markers (cytokines such as TNF-alpha IL6 and others)
V	**Renal function tests** - tests for glomerular and tubular function-Acute and chronic renal failure-Glomerulonephritis, Nephrotic syndrome, uraemia-urinary calculi-Nephrocalcinosis and Nephrolithiasis-causes, pathology and symptoms. Chronic kidney disease. Dialysis-Hemodialysis and peritoneal dialysis. **Electrolyte disorder :** calcium: hypercalcemia and hypocalcemia; Calcium homoestasis in Blood; phosphate: hyperphosphatemia or hypophosphatemia; Clinical significance: Potassium: hyperkalaemia and hypokalaemia, Sodium: hypernatremia and hyponatremia; Chloride: hyperchloremia, hyporchloremia **Hormonal disorders and diagnostics:** T3, T4 and TSH in the diagnosis of thyroid disorders; Diagnostic methods for disorders associated with adrenal, pituitary and sex hormones - Addison's disease, Cushing's syndrome, pituitary tumour, Hypopituitarism, Hypogonadism

Reading List (Print and Online)	1.**Utility of HIL in Clinical Chemistry:** https://www.aacc.org/science-and-research/clinical-chemistry-trainee-council/trainee-council-in-english/pearls-of-laboratory-medicine/2018/utility-of-hil-in-clinical-chemistry 2. **Pre, Post and Analytical Errors in Clinical Chemistry laboratory** DOI: 10.7860/NJLM/2016/22587:2173 https://doi.org/10.2147/JMDH.S286679 3. **Standards of Medical Care in Diabetes—2022 Abridged for Primary Care Providers** https://diabetesjournals.org/clinical/article/40/1/10/139035/Standards-of-Medical-Care-in-Diabetes-2022 https://doi.org/10.2337/diaspect.16.1.32 http://www.ngsp.org/ 4. Quality control in clinical laboratory https://www.researchgate.net/publication/335830829_Quality_Control_in_a_Clinical_Laboratory https://labpedia.net/quality-control-of-the-clinical-laboratory/ https://journals.sagepub.com/doi/full/10.1016/j.jala.2008.12.001 https://doi.org/10.1016/B978-0-12-407821-5.00004-8 https://www.westgard.com/clia.htm https://www.labroots.com/webinar/bio-rad-unity-solution-molecular-quality-control-data-management
Self-Study	1. **Potential sources of variability in the estimation of the analytes:** Pre-analytical phase: acceptance rejection criteria in terms of haemolysis/icteric/lipemia (HIL) interferences Analytical phase: Linearity, detection limits precision, accuracy, specificity, sensitivity; Total Allowable Error. (Definitions and examples). Post-analytical phase**:** Units of reporting of clinical chemistry parameters-

	2. Interpretation of results in clinical chemistry based on laboratory investigations and quality control: • critical / alert values • American Diabetes Association (ADA) Standards of Medical Care in Diabetes (yearly update); HBA1C testing: NGSP • Case studies to review • Quality control for clinical chemistry in laboratory
Recommended Texts	1. ThomasM.Devlin (2014) Textbook of Biochemistry with Clinical Correlations (7th ed). John Wiley & Sons 2. Montgomery R, Conway TW, Spector AA (1996),Biochemistry: A Case-Oriented Approach (6th ed), Mosby Publishers, USA. 3. Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics (2018) (8th ed), Saunders 4. Dinesh Puri, (2020) Text book of Biochemistry: A clinically oriented approach – 4th Edition, Elsevier. 5. M.N.Chatterjee and Rana Shinde (2012).Textbook of Medical Biochemistry (8th ed), Jaypee Brothers Medical Publishers. 6. Clinical Case Discussion In Biochemistry A Book On Early Clinical Exposure (ECE), Poonam Agrawal, 2021, CBS Publishers & distributors pvt. Ltd

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**S**	**M**	**S**	**S**	**S**	**S**	**M**	**M**	**S**
CO 2	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**M**	**M**	**M**
CO 3	**S**	**S**	**S**	**S**	**S**	**M**	**S**	**S**	**M**	**M**

CO 4	**S**	**M**	**M**	**M**	**S**	**M**	**S**	**S**	**S**	**M**
CO 5	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course	**CORE PAPER -VI**
P23BCP22	**LAB COURSE IN ENZYMOLOGY AND CLINICAL BIOCHEMISTRY**
Credits:	**4**

Pre-requisites	Knowledge on basic principles, Instrumentation of Biochemical techniques and metabolic reactions
Course Objectives	1. To inculcate skill in students enabling them to apprehend the wider knowledge about principles and techniques to be employed for the assayof enzymes under investigation. 2. To inculcate the knowledge of isolation and purification techniques ofenzymes using alkaline phosphatase as an example 3. To perform experiments to study the factors affecting enzyme activity 4. To achieve training in assay of enzymes 5. To achieve training in basic microbiological techniques – preparation ofculture, sterilization and staining methods. 6. To perform the blood grouping test and to prepare blood smear to studydifferent types of blood cells 7. To learn molecular biology techniques like Gel electrophoresis and Blotting techniques 8. To introduce industrial visit so that students may be aware of actual need of the industry and various opportunities available
Course Outcomes	**On successful completion of this course, students should be able to:** After completion of the course, the students should be able to: **CO1.**The student will be able to employ the relevant techniques for isolation and purification of enzymes and gain skill in kinetic studies which is essential for research activity (K1, K2, K4) **CO2.** Student will acquire ability in performing enzyme assay, and explicate the methods that form the basis of enzyme characterization. (K1, K2, K4) **CO3.** Learn the Basic concepts in microbiology and cell biology which will be helpful for interdisciplinary research work. (K1, K3, K4) **CO4.** Students will be trained in separation techniques used in molecular Biology which will be supportive in their future research (K1, K3, K4 & K6) **CO5.** Industrial visits will provide the students with an opportunity to learn practically through interaction, working methods and

	employment practices. Students will have an exposure to Industrial standard and current work practices (K1, K2, K3, K4 & K6)
Units	
I	Enzymology Alkaline Phosphatase a. Isolation of Alkaline Phophatase from goat kidney. b. Purification of alkaline phosphatase c. Checking the purity using SDS-PAGE d. Determination of optimum pH and temperature of alkaline phosphatase. e. Determination of specific activity and Km of alkaline phosphatase. f. Effect of activators and inhibitors on the activity of alkaline phosphatase. Assay of enzymes a. Salivary Amylase b. Acid Phosphatase
II	Clinical Biochemistry Blood analysis • Blood sugar - Azatoor and king's method • Blood urea - Dam method • Blood cholesterol - Zak's method • Blood uric acid - Caraway's method • Creatinine - Picric acid method • Estimation of protein by Biuret method • Calcium and phosphorous

Reading List (Print and Online)	1.https://www.researchgate.net/publication/337146254_Kinetic_studies_with_alkaline_phosphatase 2.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4846332/ 3.https://www.ijsr.net/archive/v3i8/MDIwMTU0MDk=.pdf 4.https://www.researchgate.net/publication/349318898_ABC_of_Periheral_smear 5.https://ncdc.gov.in/WriteReadData/l892s/File608.pdf 6.https://www.ncbi.nlm.nih.gov/books/NBK562156/
Self-Study	1. Preparation of Buffers and pH measurement 2. Michaelis-Menten equation and Lineweaver Burk plot
Books Recommended	1. David Plummer (2001) An Introduction to Practical Biochemistry (3rd ed) McGraw Hill Education (India) Private Ltd 2. Jayaraman, J (2011), laboratory Manual in Biochemistry, New age publishers 3. Fundamentals of Enzymology; 3rd Edn. Nicholas C. Price and Lewis Stevens, Oxford University Press (2012). 4. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland, Wiley-VCH Publishers (2000). 5. ShivanandaNayak B. Manipal Manual of Clinical Biotechnology, Jaypee Brothers, 2013. 6. DrewProvan, Oxford Handbook of Clinical and Laboratory Investigation OUP, Oxford,2018. 7. Practical Enzymology, Second Revised Edtion: Hans Bisswanger, Wiley – Blackwell; 2 edition (2011)

Mapping with Programme Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	**S**	**S**	**S**	**S**	**M**	**S**	**L**	**S**	**M**	**S**

CO 2	**S**	**S**	**S**	**S**	**M**	**S**	**L**	**S**	**M**	**S**
CO 3	**S**	**S**	**S**	**S**	**M**	**S**	**M**	**S**	**M**	**S**
CO 4	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
CO 5	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**

S-Strong M-Medium L-Low

ELECTIVE PAPERS

Course	ELECTIVE PAPER
Title of the Course:	**P23BCE1A - ENERGY AND DRUG METABOLISM**
Credits:	**3**
Pre-requisites	Basic knowledge on biochemical reactions such as addition, deletion, rearrangement, transfer and breaking of bonds
Course Objectives	1. Familiarize on concepts of enthalpy, entropy, free energy, redox system, biological oxidation and high energy compounds 2. Provide an insight into the relationship between electron flow and phosphorylation 3. Inculcate knowledge on processes involved in converting light energy to chemical energy and associated food production by autotrophs 4. Provide a platform to understand the versatile role of Krebs cycle, transport of NADH across mitochondrial membrane and energetics 5. Educate on the various phases of xenobiotic metabolism
Course Outcomes	**On successful completion of this course, students should be able to:** After completion of the course, the students should be able to: **CO1.** Appreciate the relationship between free energy and redox potential and will be able to justify the role of biological oxidation and energy rich compounds in maintaining the energy level of the system (**K1,K2,K3,K4**) **CO2.** Gain knowledge on role of mitochondria in the production of energy currency of the cell **(K1, K2, K5, K6)** **CO3.** Acquaint with the process of photosynthesis **(K1, K2, K5)** **CO4.** Comprehend on the diverse role of TCA cycle and the energy obtained on complete oxidation of glucose and fatty acid **(K1, K2, K4, K5)** **CO5.** Correlate the avenues available to metabolize the xenobiotics **(K1, K2, K4, K5)**
Units	
I	Thermodynamic- principles in biology- Concept of entropy, enthalpy and free energy change. Redox systems. Redox potential and calculation of free energy. Biological oxidation – Oxidases, dehydrogenases, hydroperoxidases, oxygenases. Energy rich compounds – phosphorylated and non-phosphorylated. High energy linkages.
II	Electron transport chain-various complexes of ETC, Q-cycle. Inhibitors of ETC. Oxidative phosphorylation-P/O ratio, chemiosmotic theory. Mechanism of ATP synthesis - role of F0-F1 ATPase, ATP-ADP cycle. Inhibitors of oxidative phosphorylation ionophores, protonophores, Regulation of oxidative phosphorylation

III	Light reaction-Hills reaction, absorption of light, photochemical event. Photo ETC-cyclic and non-cyclic electron flow. Photophosphorylation-role of CF0-CF1 ATPase. Dark reaction- Calvin cycle, control of C3 pathway, and Hatch-Slack pathway (C4 pathway), Photorespiration. Synthesis and degradation of starch
IV	Interconversion of major food stuffs. Energy sources of brain, muscle, liver, kidney and adipose tissue. Amphibolic nature of Citric acid cycle. Anaplerotic reaction. Krebs cycle, Inhibitors and regulation of TCA cycle. Transport of extra mitochondrial NADH – Glycerophosphate shuttle, malate aspartate shuttle. Energetics of metabolic pathways – glycolysis, (aerobic and anaerobic), citric acid cycle, beta oxidation
V	Activation of sulphate ions – PAPS, APS, SAM and their biological role. Metabolism of xenobiotics – Phase I reactions – hydroxylation, oxidation and reduction. Phase II reactions – glucuronidation, sulphation, glutathione conjugation, acetylation and methylation. Mode of action and factors affecting the activities of xenobiotic enzymes.
Reading List (Print and Online)	1.https://chemed.chem.purdue.edu/genchem/topicreview/bp/ch21/gibbs.php 2.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7767752/#:~:text=The%20mitochondrial%20electron%20transport%20chain,cellular%20ATP%20through%20oxidative%20phosphorylation. 3. https://www.researchgate.net/figure/Oxidative-phosphorylation-in-mitochondrial-electron-transport-chain-ETC-and-proton_fig1_230798915 4.https://www.lyndhurstschools.net/userfiles/84/Classes/851/photosynthesis%20light%20&%20dark%20reactions%20ppt.pdf?id=560837 5.https://bajan.files.wordpress.com/2010/05/amphibolic-nature-of-krebs-cycle.pdf 6.https://www.sciencedirect.com/topics/medicine-and-dentistry/xenobiotic-metabolism#:~:text=Xenobiotic%20metabolism%20can%20be%20defined,more%20readily%20excreted%20hydrophilic%20metabolites
Self-Study	1. Calculation of Keq and △ G 2. Interrelationship of carbohydrate, protein, and fat metabolism-role of acetyl CoA
Recommended Texts	1.David L.Nelson and Michael M.Cox (2012) Lehninger Principles of Biochemistry (6th ed), W.H.Freeman 2. Robert K. Murray, Darryl K. Granner, Peter A. Mayes, and Victor W. Rodwell (2012), Harper's Illustrated Biochemistry, (29th ed), McGraw-Hill Medical 3. Metzler D.E (2003). The chemical reactions of living cells (2nd ed), Academic Press. 4. Zubay G.L (1999) Biochemistry, (4th ed), Mc Grew-Hill. 5. Devlin RM (1983) Plant Physiology (4th ed), PWS publishers

	6.Taiz L , Zeiger E (2010), Plant Physiology (5th ed), Sinauer Associates, Inc

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**S**	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**M**
CO 2	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
CO 3	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
CO 4	**S**	**M**	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**L**
CO 5	**S**	**M**	**S**	**S**	**S**	**M**	**S**	**S**	**S**	**S**

S-Strong M-Medium L-Low

Course Code	ELECTIVE PAPER	L	T	P	C
P23BCE1B	BIOPHYSICAL METHODOLOGY	3	2	-	3

Cognitive Level	K1:Recall K2:Understand K3:Apply
Learning objective	➢ To learn the properties of electromagnetic radiation. ➢ To learn the principle and applications of UV, NMR, ESR spectroscopy. ➢ To know about radioactive isotopes and its biological applications. ➢ To understand the instrumentation, principle, types and uses of spectroscopy and microscopy, radioactive isotopes, centrifugation, chromatography.

Unit-I	**Chromatographic techniques**	**12 hours**

Principle, technique and applications of paper, TLC, ion- exchange, molecular sieve and adsorption chromatography. Principle, components, limitations and applications of GC and HPLC. Electrophoresis techniques: Principle and technique of paper, gels –Agarose gel electrophoresis, SDS-PAGE, Native PAGE, Isoelectric focusing.

Unit-II	**Centrifugation techniques**	**12 hours**

Principles and types and applications. Types of Rotors, Sedimentation Co-efficient, Sedimentation Velocity, Relationship between rpm and g. Centrifugal field. Relative Centrifugal Force. Ultracentrifugation – types, optical methods used and applications of preparative and analytical ultracentrifuges.

Unit-III	**Microscopy**	**12 hours**

Basic principles of light microscopy, phase contrast microscopy, fluorescence microscopy. Electron microscopy–Principle, instrumentation and application of SEM and TEM Preparation of Sample. Electron diffraction –principle and application.

Unit-IV	**X – Rays**	**12 hours**

Properties of X rays. X ray diffraction detection and application. Radio isotopes techniques–nature of radioactivity, measurement of radio activity, applications of radioactive and stable isotopes in biological research. Autoradiography.

Unit - V	**Spectroscopy**	**12 hours**

Principles of spectroscopy–Regions of electromagnetic radiation, properties of electromagnetic radiations. Molecular and atomic spectra, types and molecular spectra. Absorption spectroscopy – principle, instrumentation and applications of atomic absorption, UV visible spectroscopy, Infrared spectroscopy, Nuclear Magnetic Resonance Spectroscopy, Electron Spin resonance. Mass spectroscopy–principle, instrumentation and application. Raman Spectroscopy; principles, method, application.

Text Books

1. L. Veerakumari Bioinstrumentation, MJP Publisher, 2019.
2. M.H. Fulekar & Bhawana Pandey, Bioinstrumentation I.K. International Publishing House Pvt. Ltd, 2014
3. John G. Webster Bioinstrumentation by, Wiley,2018.
4. Terence Allen, Microscopy: A Very Short Introduction, Publisher Oxford University Press,2015

References

1. M. J. Reilly Bioinstrumentation by, CBS Publishers & Distributers, 2016.

2. Keith Wilson and John Wilson. . Practical Biochemistry. Cambridge University Press, 2018
3. Donald L. Pavia, Introduction to Spectroscopy, Publisher Cengage Learning India Private Limited,2015
4. Hans-Joachim Hübschmann, Handbook of GC-MS: Fundamentals and Applications, Wiley,2015.

E-References link

1.https://www.nature.com/scitable/topicpage/protein-structure-14122136/
2.https://www.hindawi.com/journals/ijpro/2014/147648/
3.https://world-nuclear.org/information-library/non-power-nuclear-applications/radioisotopes-research/radioisotopes-in-medicine.aspx

Course outcome

Upon completion of this course, the students will be able to

CO	Course Outcomes	Knowledge Level
CO1	know the principle and techniques of chromatography.	**K1, K2**
CO2	comprehend about types and applications of centrifuges.	**K1, K2, K3**
CO3	list the types and application of microscopy.	**K1, K2, K3**
CO4	learn about importance of radioactive isotopes.	**K1, K2**
CO5	gain the knowledge on types, principle, instrumentation and applications of spectroscopy.	**K1, K2**

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	M	S	S	S	S	S	S	M	S	M	S
CO2	S	M	S	S	M	M	M	M	S	S	S	M	M
CO3	M	S	S	S	M	S	S	S	M	S	M	S	S
CO4	M	S	M	M	S	S	M	M	S	S	S	S	S
CO5	S	M	S	M	S	S	S	S	S	S	S	S	S

Strongly Correlating (S) - 3 marks ; Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark; No Correlation (N) - 0 mark

Course	ELECTIVE PAPER
Title of the Course:	**MOLECULAR BASIS OF DISEASES AND THERAPEUTIC STRATEGIES**
Credits:	**3**
Pre-requisites, if any:	Knowledge of Human Physiology, Metabolism and Clinical Biochemistry
Course Objectives	1.To understand the concepts of the mechanisms involved in regulation of blood sugar and management of diabetes mellitus 2.To gain in-depth knowledge of the mechanisms of cancer and of tumor metastasis 3.The student will review the basic organization of the central and peripheral nervous system that coordinate the sensory and motor functions of the body. In addition, the student will explore impaired features underlying the major neuropathological complications. 4.To gain knowledge in renal diseases 5.To understand the mechanisms involved in cardiac disorders
Course Outcomes	**On completion of this course the student will be able to understand** **CO1.**Overall view about the complications of diabetes mellitus and its management. **CO2.**Comprehensive understanding of the concepts of cancer biology and implicating the theoretical concepts for further research **CO3**.Understand and appreciate the pathophysiology of conditions affecting the nervous system. **CO4**.A thorough knowledge of renal and cardiac diseases with emphasis related to mechanistic aspects and therapeutic interventions. **CO5.** A thorough knowledge on the experimental models of non-communicable diseases that will be applied for future research or project dissertation. An in-depth knowledge on development of drugs against non-communicable diseases.
Units	
I	Mechanism of blood sugar regulation in human body. Pathophysiology of Type I and II diabetes, Diabetes – investigation methods for the diagnosis of diabetes. Nutritional care. Complications related to diabetes – Diabetic cardiovascular disease, retinopathy, neuropathy and nephropathy. Cellular and molecular mechanism of development of diabetes-Management of Type I and Type II diabetes, drugs for the treatment of diabetes.
II	Biology of cancer: Overview of hallmarks of cancer. Tumorigenesis, Tumor progression and mechanism of Metastasis. Proto-oncogene to oncogene. Oncogene- myc and src family. Tumor suppressor gene-Rb and p53 pathway in cancer. Diagnosis- Non-invasive imaging techniques, Tumor diagnosis, Interventional radiology, New imaging technique, Molecular techniques in cancer diagnosis - treatment of cancer- surgery,

	radiotherapy, chemotherapy, hormonal treatment, and biological therapy. Introduction to personalized medicine.
III	Brain- neuronal network- memory- Neurogenerative diseases- Parkinson and Alzheimer Disease- molecular understanding of the neurodegenerative diseases- treatment modalities.
IV	Acute and chronic renal failure, glomerular diseases– glomerulonephritis, nephritic syndrome, diabetes insipidus, diagnosis of kidney disease.
V	Introduction to cardiovascular diseases, Lipids and lipoproteins in coronary heart disease-cardiac enzymes, Molecular changes during cardiac remodeling – hypertrophy of hearts – heart failure- treatment modalities.
Reading List (Print and Online)	1. The Biochemical basis of disease:2018, **Barr AJ;** Portland Press 2. Biochemical Basis of Diseases 3. https://www.biologydiscussion.com/diseases-2/biochemical-basis-of-diseases/44276
Recommended Texts	1. Wills' Biochemical Basis of Medicine: 2nd edition, Thomas H, Gillham B;Elsevier 2. Molecular Biochemistry of Human Diseases,2021, Feuer G ,de la Iglesia F; CRC Press

Mapping with Programme Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**
CO 1	**S**	**S**	**S**	**M**	**M**	**S**	**S**	**S**	**S**	**S**
CO 2	**S**	**M**	**S**	**L**	**M**	**M**	**M**	**M**	**M**	**S**
CO 3	**S**	**S**	**M**	**L**	**S**	**S**	**M**	**M**	**S**	**M**
CO 4	**S**	**M**	**M**	**M**	**M**	**M**	**S**	**S**	**M**	**S**
CO 5	**S**	**S**	**M**	**M**	**S**	**M**	**M**	**M**	**S**	**S**

S-Strong M-Medium L-Low

Course Code		**ELECTIVE PAPER**	**L**	**T**	**P**	**C**

	BIOPLASTICS	**2**	**2**	**-**	**3**

Cognitive Level	K1:Recall K2:Understand K3:Apply
Learning objective	➢ To learn the properties of Bioplastics and Biodegradation. ➢ To know about a medical and dental devices ➢ To gain knowledge on types of Biomaterials

Unit-I	**Biopolymers**	**12 hours**

Types of Bioplastics (starch based, cellulose based plastics, Aliphatic Polyesters – (PLA, PHB), Polyamides, bio-based composites from soyabean oil and chicken feathers, bioderived polyethylene and genetically modified bioplastics. Environmental impact such as Bioplastics and biodegradation**.**

Unit-II	**Bioplastics and Biocomposites processing and their applications**	**12 hours**

Bioplastics and Biocomposites. Processing of Bioplastics and Biocomposites. Applications of Bioplastics and Biocomposites-Civil Engineering, Biomedical and Auto motive application. Measuring of Biodegradation of polymer- Enzyme assays, Platetest, Respiratory test, Natural environment and Field trial, Gasevolution test (CO2 and CH4). Host tissue reaction.

Unit-III	**Biomaterials in Medical and Dental devices**	**12 hours**

Biomaterials-Material choice implication based on device design. General Biomaterial evolution procedures. Replacement of skeletal hard tissues. Poly Mercedes cosmetic implants, controlled drug delivery system artificial heart valves, bone replacement, artificial organs, dental applications.

Unit-IV	**Surface modification of Biomaterials for Improved Functionality**	**12 hours**

Enhancement of biocompatibility by the use of corona discharge and plasma processes, surface coating silver/ silver oxide silicone, hydro gels, UV curable system, PC coatings heparin loaded systems.

Unit – V	**Characterization and testing of biomaterials**	**12 hours**

Bulk analysis methods applied to the study of biomaterials (XRD, FTIR, DSC, TGA) surface analysis methods applied to the study of biomaterials (SEM, AFM) Mechanical test - Wear, Friction, Flexibility, Fatigue. Application and manufacture of Bioplastics. Use of Biomaterials for manufacture of plastic films, various types of films and application, Usage of Biological friendly plastics in Homes, Industry.

Text Books

1. Srikanthpilla, Hand Book of Bioplastics and Bio composition Engineering Applications, Scrivener Publishing LLC, 2011.
2. Syed Ali Ashter, Introduction to Bioplastics Engineering, Publisher Elsevier, 2016.
3. Publisher: Wiley-Scrivener
4. SrikanthPilla, Handbook of Bioplastics & Biocomposites, Engineering Applications,Publisher Wiley-Scrivener, 2011

References

1. Michael Thielen, Bioplastics: Basics and Applications, Polymedia Publisher GmbH, 2012.
2. Stephan Kabasei, Bio-based plastics: Materials and applications, Publisher Wiley,2013.

3. Robert Murray-Smith. Bioplastics: A Home Inventors Handbook, Publisher: Robert Murray-Smith, 2014.
4. SrikanthPilla, Handbook of Bioplastics and Biocomposites Engineering Applications,John Wiley & Sons,2011

E-References link

1. .https://www.vedantu.com/chemistry/biopolymers
2. https://www.activesustainability.com/environment/what-are-bioplastics/
3. https://matmatch.com/learn/material/biopolymers
4. https://www.researchgate.net/publication/332538701_BiopolymersDefinition_Classification_and_Applications
5. https://ijpsr.com/bft-article/new-advancements-of-bioplastics-in-medical-applications/?view=fulltext
6. https://royalsocietypublishing.org/doi/10.1098/rsfs.2012.0003
7. https://www.sciencedirect.com/topics/materials-science/biomaterials-characterization

Course Outcome

Upon completion of this course, the students will be able to

CO	Course Outcomes	Knowledge Level
CO1	understand the types of bioplastics and their Impacts on environment	**K1, K2**
CO2	illustrate the applications of bioplastics, biocomposites	**K1, K2, K3**
CO3	attain knowledge about Biomaterials in Medical and Dental applications.	**K1, K2**
CO4	understand about Surface modification of biomaterials for enhancement of biocompatibility	**K1, K2**
CO5	know about the characterization method of biomaterials	**K1, K2, K3**

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	M	S	S	S	S	S	S	S	S	S	M	S
CO2	S	S	S	S	S	M	S	S	S	S	S	S	S
CO3	S	S	S	S	M	S	S	S	S	S	S	S	M
CO4	S	M	S	S	S	S	S	S	S	S	S	S	S
CO5	M	S	S	S	S	S	S	M	S	S	M	S	S

Strongly Correlating (S) - 3 marks; Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark; No Correlation (N) - 0 mark

Skill Enhancement Course -I(NME)

Course Code	P23BCS21	PHYTOCHEMISTRY	L	T	P	C
			2	2	-	2
Cognitive Level	K1: Recall K2: Understand K4: Apply					
Learning Objective	• To learn the effective procedures in extraction and purification of bioactive compounds • To understand the structural analysis of bioactive compounds • To gain knowledge on herbal medicine and phyto pharmaceuticals					
Unit 1	**Extraction Methods**					
Polar and Non-polar solvents for extraction. Extraction – purification of bio-active compounds from plants - cold & hot extract. Soxhlet extraction - crude extracts purification by various solvents.						
Unit II	**Bioactive Compounds**					
Isolation of bioactive compounds- chromatographic techniques - thin layer chromatography-liquid chromatography - HPLC and UPLC.						
Unit III	**Structural analysis of bioactive compounds**					
IR spectroscopy - Mass spectroscopy – NMR spectroscopy.						
Unit IV	**Herbal medicine**					
History of herbal medicine - different types of herbal medicine - Ayurveda, Siddha and Unani - Pharmacological action - clinical research and traditional uses of Indian medicinal plants - *Eclipta alba*, *Gymnema sylvestre*, *Ocimum sanctum*, *Curcuma longa*.						
Unit V	**Phytopharmaceuticals**					
Phytopharmaceuticals and their health benefits - anthocyanins, carotenoids, lycopene, isoflavones, polyphenols, omega 3 - fatty acids, biological effects of resveratrol.						
Text Books	1. Shah B. Pharmacognosy and Phytochemistry, Publisher CBS,2019. 2. Vaibhav Darvhekar Rageeb, Lodhi, Vadnere, A Textbook of Pharmacognosy & Phytochemistry, Publisher Everest Publishing House,2019 3. Deep Panhekar, Ms. Trupti P. Sawant, D. P. Gogle, Phytochemicals - Extraction, Separation & Analysis, Publisher Global Education Limited,2019					
References	1. Padmini Shukla, Dr. Shashi Alok, Dr. Prabodh Shukla, Pharmacognosy and Phytochemistry, Publisher Nirali Prakashan, 2019. 2. Kausar Jabeen, Pharmacognosy and Phytochemistry – II, Publisher: SIA Publishers & Distributors Pvt Ltd,2020. 3. Sapna Malviya, Swati Rawat, Pharmacognosy and Phytochemistry, Publisher : Oxford and IBH Publishers,2020.					

E-Reference links	1. https://www.pdfdrive.com/textbook-of-pharmacognosy-and-phytochemistry-d184620437.html 2. https://books.google.co.in/books?id=satDwAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0 3. https://www.pdfdrive.com/trease-and-evans-pharmacognosy-e58233029.html

Course Outcomes

Upon completion of this course the students will be able to		
CO1	know the extraction and purification of bioactive compounds	**K2**
CO2	understand the principles of various chromatographic techniques	**K2**
CO3	acquire knowledge on the structural analysis of bioactive compounds using spectroscopy	**K2**
CO4	compare the medicinal properties of important medicinal plants	**K4**
CO5	know the importance and health benefits of phytopharmaceuticals	**K1**

Mapping of COs with POs & PSOs:

CO	PO								PSO				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**1**	**2**	**3**	**4**	**5**
CO1	S	S	S	S	M	S	M	S	S	S	S	S	M
CO2	S	S	S	S	M	S	M	S	S	S	S	S	S
CO3	S	S	S	S	S	S	M	S	S	S	S	S	S
CO4	S	S	M	M	M	S	M	S	S	M	S	M	M
CO5	S	S	M	M	M	M	M	S	S	M	S	M	S

Strongly Correlating (S) - 3 marks ; Moderately Correlating (M) - 2 marks
Weakly Correlating (W) - 1 mark ; No Correlation (N) - 0 mark