Kurukshetra University, Kurukshetra

(Established by the State Legislature Act-XII of 1956)
("A^{++}" Grade, NAAC Accredited)

Syllabus
for
Post Graduate Programme
M.Sc. Biochemistry

as per NEP 2020
Curriculum and Credit Framework for Postgraduate Programme

With Multiple Entry-Exit, Internship and CBCS-LOCF
With effect from the session 2024-25 (in phased manner)

DEPARTMENT OF BIOCHEMISTRY
FACULTY OF LIFE SCIENCES

KURUKSHETRA UNIVERSITY, KURUKSHETRA -136119

HARYANA, INDIA

Officiating CHAIRMAN
Department of Biochemistry
Kurukshetra University
KURUKSHETRA-136119

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Session: 2024-25			
Part A – Introduction			
Name of Programme	**M. Sc. Biochemistry**		
Semester	**Semester- I**		
Name of the Course	**Structure and Function of Biomolecules**		
Course Code	**M24-BCH-101**		
Course Type	**CC-1**		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO1: have an overview of importance of biomolecules starting from the simplest molecule, water and structure and functions of carbohydrates CLO 2: understand the structure, properties and functions of lipids and amino acids CLO 3: understand the structure and conformation of proteins CLO 4: understand the structure and functions of nucleic acids and porphyrins		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Water and Buffers:** Structure and physicochemical properties of water, ionization of water, weak acids and bases, pH, pka, Henderson – Hasselbalch equation and its significance. **Carbohydrates:** Occurrence, characteristics, and classification of carbohydrates, structure and functions of monosaccharides, disaccharides, and polysaccharides; Different conformation of sugar, stereoisomerism, optical isomerism, mutarotation, sugar derivatives, structural polysaccharides, storage polysaccharides and blood group polysaccharides	15
II	**Fats and Lipids:** Structure and properties of fatty acids, Nomenclature, Classification and functions of lipids, plasmalogens, phospholipids, sphingolipids, glycolipids, steroids, prostaglandins and eicosanoids, and	15

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	thromboxanes, bile acids, characterization of lipids (saponification value, iodine number, acid value, Reichart-Meissl number) **Amino acids:** Nomenclature, classification, and structure of standard amino acids, physico- chemical properties of amino acids, stereoisomerism and optical properties of amino acids; non-natural amino acids; Titration curve of amino acids and isoelectric point, amino acid as zwitter ion	
III	**Proteins: Primary structure of proteins**, nature of peptide bond, Ramachandran plot, hierarchy of protein structure; **Secondary and tertiary structure of proteins:** α-helix, β-structure; collagen helix, super secondary structures, domains, **Ouaternary structure of proteins** with example of haemoglobin, Forces stabilizing the different level of protein structure, denaturation and renaturation of proteins Determination of primary structure of proteins, determination of amino acid composition, N- terminal and C-terminal residues and disulfide bonds	15
IV	**Nucleotides and Nucleic acids:** Structure of purines and pyrimidines, nucleosides and nucleotides, Structure and functions of DNA and RNA, Forces stabilizing DNA structure, structural polymorphism of DNA (A, B and Z-DNA), Structure of different types of RNA, C-value paradox, denaturation and renaturation of DNA Porphyrins: Basic structure of porphyrins, Classification of porphyrins, Naturally occurring porphyrins, Some important metallo-porphyrins	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Lehninger: Principles of Biochemistry, 7th edition, by David L. Nelson and M M Cox (2017), Macmillan / Worth publishers/ W H Freeman and Company.
2. Biochemistry (2004) by J David Rawn, Panima Publishing Corporation, New Delhi.
3. Biochemistry, 6th edition, by R H Garrett and C M Grisham (2017), Saunders College Publishing, New York.
4. Biochemistry, 7th edition, by Jeremy M. Berg (2015), W H Freeman and Co., New York.
5. Fundamentals of Biochemistry, 2nd ed., by Donald Voet, Judith G. Voet and Charlotte W Pratt (2006), John Wiley and Sons, INC.
6. Textbook of Medical Physiology, 13th ed., A C Guyton and J E Hall (2015) Elsevier.
7. Biochemistry, 4th ed. Zubay, G., (2009). Wm.C Brown Publishers, Saunders and Company, Philadelphia.

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Session: 2024-25			
Part A – Introduction			
Name of Programme	**M. Sc. Biochemistry**		
Semester	**Semester- I**		
Name of the Course	**Cell Biochemistry and Cell Signaling**		
Course Code	**M24-BCH-102**		
Course Type	**CC-2**		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: acquire detailed information regarding bio-membranes and membrane transport CLO 2: get an insight into the structure and functions of various cellular organelles and a detailed account of the cytoskeleton CLO 3: explain the communications of cells with other cells and to the environment CLO 4: have a conceptual understanding of the molecular basis of cell signaling		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Plasma membrane**: An overview of membrane functions; Chemical composition of membranes: membrane lipids: phospholipids, sphingolipids, cholesterol, liposomes, lipid rafts, lipid droplets, membrane carbohydrates: Blood group antigens, Glycocalyx, membrane proteins: integral proteins, peripheral proteins, lipid anchored proteins, mobility of membrane proteins: Cell fusion experiment and FRAP **Membrane transport of small molecules:** Basic mechanisms of movement of substances across cell membranes, Passive diffusion, Facilitated diffusion and carrier proteins, ion channels; patch clamp technique; ion selectivity of Na^+ and K^+ channels; gated channels, Active transport driven by ATP hydrolysis: Na^+-K^+ pump, ABC	15

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	transporters, Active transport driven by ion gradients, methods of introducing a membrane-impermeant substance into a cell	
II	**Endoplasmic reticulum:** Structurally and functionally diverse ER, microsomes, Isolation of purified rough and smooth microsomes from ER, RER and protein secretion, SER and lipid synthesis. **Golgi apparatus:** Organization of the Golgi complex, protein glycosylation within the Golgi complex, purpose of glycosylation, lipid and polysaccharide metabolism in the Golgi **Lysosomes:** Lysosomal acid hydrolases, role of lysosomes in phagocytosis and autophagy **The Cytoskeleton:** Microfilaments: assembly and disassembly of actin filaments; actin binding proteins; organization of actin filaments, Muscle contraction; Sarcomere, structure of myosin; role of Ca^{2+} in muscle contraction, Intermediate filaments- Intermediate filament proteins; assembly of intermediate filaments; functions of keratins and neurofilaments, Microtubules: structure and dynamic organization of microtubules, Microtubule organizing centers: centrosomes and basal bodies; Microtubule motor proteins: Dynein and kinesin, Cilia and flagella: structure and functions	15
III	**Extracellular matrix and Cell-matrix interactions:** Matrix structural proteins, matrix polysaccharides, matrix adhesion proteins, Interactions of cells with extracellular matrix: integrins, focal adhesions and hemidesmosomes; Interactions of cells with other cells: Adhesion junctions, Tight junctions, Gap junctions and Plasmodesmata. **Mitochondria:** Organization and function of mitochondria, critical roles of mitochondria in cell metabolism besides ATP production. **Chloroplast and other plastids**: structure and functions of chloroplast, molecular organization of thylakoids, different types of plastids **Peroxisomes:** structure of peroxisomes and their involvement in photorespiration.	15
IV	**Cell signaling:** General principles of cell communication, modes of cell-cell signaling, Steroid hormones and the nuclear receptor superfamily, nitric oxide and carbon monoxide, neurotransmitters, peptide hormones and growth factors, eicosanoids, plant hormones Functions of cell surface receptors: G-protein coupled receptors, regulation of G-proteins, Receptor protein-tyrosine kinases, Cytokine receptors and nonreceptor protein-tyrosine kinases, receptors linked to other enzymatic activities **Pathways of intracellular signal transduction**: The cAMP pathway, cyclic GMP, phospholipids and Ca^{2+} ions, function of calmodulin, The PI3-kinase/Akt and mTOR pathways, regulation of FOXO, MAP kinase pathways: activation of ERK MAP kinases, regulation of Ras proteins, Ras activation, induction of immediate early genes by ERK, The JAK/STAT and TGF-β/Smad pathways, NF-κB signaling	15
	Total Contact Hours	60
	Suggested Evaluation Methods	

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Internal Assessment: 30		End Term Examination: 70	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Cell and Molecular Biology- Concepts and experiments, 5th ed. (2008) Gerald Carp- Wiley & Sons.
2. The Cell: A Molecular Approach, G.M. Cooper & R.E. Hausman (2007), 4th ed. ASM Press.
3. Molecular Biology of the Cell (2008) 5TH ed. Alberts *et al.* Garland Science, Taylor and Francis Group.
4. Molecular Cell Biology (2008) 6th ed. Lodish *et al.,* W.H. Freeman & Company.
5. Cell and Molecular Biology, 8th ed. E.D.P. De Robertis & E.M.F. De Robertis (2001), Lippincott, Williams and Wilkins.

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Session: 2024-25			
Part A – Introduction			
Name of Programme	**M.Sc. Biochemistry**		
Semester	**Semester- I**		
Name of the Course	**Bioenergetics and Metabolism-I**		
Course Code	**M24-BCH-103**		
Course Type	**CC-3**		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: understand the concept of free energy change, coupled reactions, high energy compounds and redox reactions and its application to the study of metabolism. CLO 2: describe various anabolic and catabolic pathways like glycolysis, Kreb's cycle, HMP shunt, glycogen metabolism etc. and their regulation for better understanding of physiology and therapeutic applications. CLO 3: comprehend reactions and regulation of pathways involved in the metabolism of lipids and correlate with the metabolic disorders at molecular level. CLO 4: have an insight of electron transport chain and mechanism of ATP synthesis during catabolism of molecules.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Bioenergetics:** Concept of Free energy; standard Free energy; Relationship between standard free-energy change and equilibrium constant; Coupled reactions; High-energy compounds. Biological oxidation: Oxidation & reduction; Oxidation-reduction half reactions; Nernst equation, measurement of standard reduction	15

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	potentials; Calculation of ΔG from standard reduction potentials; Enzymes involved in oxidation and reduction (oxidases, dehydrogenases, hydroperoxidases and oxygenases). Introduction to Metabolism and Experimental approaches for studying metabolism.	
II	**Carbohydrate Metabolism:** Reactions, energetics and regulation of glycolysis; Feeder pathways for glycolysis; Fate of pyruvate under aerobic and anaerobic conditions; Pasteur effect; Pyruvate dehydrogenase complex and its regulation; Reactions, regulation and amphibolic nature of TCA Cycle; Anaplerotic reactions; Glyoxalate cycle; Pentose Phosphate Pathway; Gluconeogenesis; Cori cycle; Biosynthesis of lactose and sucrose; Glycogenesis and Glycogenolysis; Control of glycogen metabolism; Maintenance of blood glucose levels.	15
III	**Lipid Metabolism:** Mobilization and hydrolysis of triacylglycerols; Fatty acid oxidation: Franz Knoop's experiment; β-oxidation of saturated, unsaturated and odd-chain fatty acids; Peroxisomal β-oxidation; Minor pathways of fatty acid oxidation (α- and ω-oxidations); Formation and utilization of Ketone bodies; Biosynthesis of saturated fatty acids; Elongation and desaturation of fatty acids; Biosynthesis of triacylglycerols; Regulation of fatty acid metabolism; Cholesterol biosynthesis and its regulation; Biosynthesis of glycerophospholipids and sphingolipids; Breakdown of sphingolipids by lysosomal enzymes; Formation of prostaglandins, prostacyclins, thromboxanes and leukotrienes from arachidonic acid.	15
IV	**Mitochondrial Electron Transport Chain and Oxidative Phosphorylation:** Mitochondrial Transport Systems; Nature, order and organization of the components of electron transport chain; electron flow from NADH and $FADH_2$ to O_2; sites of ATP production; inhibitors of electron transport chain; Coupling between oxidation and phosphorylation; Chemiosmotic hypothesis of oxidative phosphorylation; Mechanism of ATP synthesis: Structure of proton-translocating ATP synthase; Binding Change Mechanism for proton-driven ATP synthesis; Uncoupling of oxidative phosphorylation; Control of oxidative phosphorylation.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Lehninger: Principles of Biochemistry, 4th edition, by David L. Nelson and M.M. Cox (2005) Maxmillan/ Worth publishers/ W. H. Freeman & Company.

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2. Fundamentals of Biochemistry, 3rd edition ,by Donald Voet and Judith G Voet (2004) , John Wiley & Sons, NY
3. Biochemistry, 2nd edition, by R .H. Garrett and C. M. Grisham (1999). Saunders College Publishing, NY.
4. Biochemistry, 6th edition, by Jeremy M. Berg (2007). W.H. Freeman & Co., NY.
5. Harper's Biochemistry, 26th edition, by R.K. Murray, P.A.Hayes, D.K.Granner, P.A. Mayes and V. W. Rodwell (2003). Prentice Hall International.
6. Biochemistry, 3rd edition, by C.K. Mathews, K.E. vans Holde and K.G. Ahern (2000). Addison-Wesley Publishing Company.
7. Biochemistry (2004) by J. David Rawn, Panima Publishing Corporation, New Delhi.

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Session: 2024-25			
Part A – Introduction			
Name of Programme	**M.Sc. Biochemistry**		
Semester	**Semester – I**		
Name of the Course	**Plant Biochemistry**		
Course Code	**M24-BCH-104**		
Course Type	**CC-4**		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: understand the light phase of photosynthesis and pathways of CO_2 assimilation in C_3, C_4 and CAM plants. CLO 2: get an insight about the Sucrose and starch metabolism in plants and Electron transport chain in plant mitochondria. CLO 3: explain the various plant processes viz. nitrate assimilation, biological nitrogen fixation and sulphate assimilation in plants. CLO 4: understand biochemical defense mechanisms against pathogens and molecular mechanism of action of different plant hormones that can facilitate their research abilities in the field of plant sciences.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Chemical and physical composition of higher plant cell wall. **Light reactions of Photosynthesis:** Photosynthetic pigments, chlorophyll excitation by absorption of light energy and its return to the ground state, Requirement of an antenna to capture light, van Niel equation, Hill equation, Cyclic electron transport in purple photosynthetic bacterium, Red drop and Emerson enhancement effect, Photosystem I & II, Non-cyclic, cyclic and pseudocyclic photosynthetic electron transport,	15

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	Inhibitors of non-cyclic electron transport, Regulation of energy distribution between PS I and PS II, Photophosphorylation: coupling between electron transport and phosphorylation, chemiosmotic hypothesis, chloroplast ATP synthase, binding change mechanism of ATP synthesis and uncouplers of photophosphorylation.	
II	Pathway and regulation of CO_2 assimilation in C_3, C_4 & CAM plants. Photorespiration: pathway and significance. Metabolism of Sucrose and Starch: Biosynthesis and degradation of starch and sucrose; role of fructose 2, 6- bisphosphate in carbon partitioning between sucrose and starch. **Electron transport in plant mitochondria:** Electron transport complexes and pathway of electron flow in plant mitochondria; cyanide - resistant respiratory pathway.	15
III	**Nitrogen Metabolism:** Nitrogen Cycle; Nitrate Assimilation: nitrate uptake, nitrate & nitrite reduction and regulation of nitrate assimilation. **Biological nitrogen fixation**: Nitrogen fixing organisms, structure and mechanism of action of nitrogenase, Legume- Rhizobium symbiosis (A brief account), Leghaemoglobin, Strategies for protection of nitrogenase against the inhibitory effect of oxygen, Uptake hydrogenase, Ammonia assimilation, *nif* genes of *Klebsiella pneumoniae* and their regulation, and synthesis of amides and ureides. **Sulphate assimilation**: sulphate uptake and its assimilation into cysteine.	15
IV	Biochemical defense mechanisms in plants against pathogens; **Plant hormones:** Physiological effects and molecular mechanism of action of auxins, gibberellins, cytokinins, ABA and ethylene. Phytochromes as light sensors.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Biochemistry and Molecular Biology of Plants by Bob, B. Buchanan, W. Gruissen and R. L. Jones (2000). Published by American Society of Plant Physiologists and distributed by Panima Educational Book Agency, New Delhi.
2. Plant Biochemistry & Molecular Biology, 3rd ed., by Hans–Walter Heldt (2005), Academic Press
3. Introduction to Plant Biochemistry, T. W. Goodwin and E. I. Mercer (1983). Pergamon Press, Oxford
4. Plant Physiology, 2nd edition, by L. Taiz and E Zeiger (1998), Sinauer Associates, Inc., Publishers

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Session: 2024-25			
Part A – Introduction			
Name of the Programme	**M.Sc. Biochemistry**		
Semester	**Semester – I**		
Name of the Course	**PC-1 (Qualitative and quantitative analysis of Biomolecules)**		
Course Code	**M24-BCH-105**		
Course Type	**PC-1**		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: get an insight/awareness about the safe laboratory practices. CLO 2: get more acquainted with the basic practical techniques related to various biomolecules. CLO 3: standardize and qualitatively & quantitatively estimate various biomolecules including carbohydrates, lipids and proteins in the biological samples.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B- Contents of the Course

Practicals	Contact Hours
1.To study biochemistry laboratory safety rules and guidelines 2. Determination/calculation of normality and molarity of solutions 3. Standardization of pH meter and preparation of buffers 4. Qualitative estimation of carbohydrates 5. Qualitative estimation of proteins/amino acids 6. Qualitative estimation of lipids 7. Quantitative estimation of proteins by Lowry's method 8. Quantitative estimation of proteins by Bradford method 9. Quantitative estimation of total sugars 10. Quantitative estimation of reducing sugars by Nelson-Somoygi's method 11. Solubility test for lipids 12. To detect the presence of glycerol in given sample by acrolein method 13. Characterization of lipids (Acid value, Saponification value and Iodine number) 14. Extraction of lipids from tissues using Soxhlet's apparatus 15. To determine pka of acetic acid/glycine 16. Cell counting by hemocytometer and identification of blood cell types	120

Suggested Evaluation Methods

Internal Assessment: 30		End Term Examination: 70	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	15		

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Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Introductory Practical Biochemistry by Sawhney, S.K. and Singh, R. (2000), Narosa Publishing House, India
2. Principles and Techniques of Practical Biochemistry, 6th edition by Keith Wilson and John Walker (2000), Cambridge University Press.
3. Physical Biochemistry, 2nd edition, by D Friefelder (1983), W H Freeman and Co., USA.
4. Biophysical Chemistry: Principles and Techniques, 2nd edition by A Upadhyay, K Upadhyay and N Nath (1998), Himalaya Publishing House, Delhi.
5. Physical Biochemistry, 2nd edition, by K. E Van Holde (1985), Prentice Hall Inc, New Jersey.

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Session: 2024-25			
Part A – Introduction			
Name of the Programme	**M.Sc. Biochemistry**		
Semester	**Semester – I**		
Name of the Course	**PC-2 (Practicals of Basic Biochemistry and Plant Biochemistry)**		
Course Code	**M24-BCH-106**		
Course Type	**PC-2**		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: appreciate and illustrate the biochemistry of plant related processes and its relation to the stressed environment CLO 2: develop skills and knowledge to conduct basic research work in the field of Plant Biochemistry. CLO 3: correlate the applications of enzymes of plant origin (β-amylases) in various industrial processes such as food, fermentation, and pharmaceutical industries.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B- Contents of the Course

Practicals	Contact Hours
1. Estimation of phenols in plant tissues 2. Estimation of chlorophyll content in the leaves 3. Quantitative estimation of starch in the given plant tissue 4. Quantitative determination of free amino acid content in germinating moongbean seeds 5. Estimation of proline in stressed plant tissues 6. To determine the activity of malate dehydrogenase in the given plant tissue 7. Determination of β-amylase activity in germinating barley seeds 8. Estimation of ascorbic acid in lemon juice 9. To determine the activity of polyphenol oxidases 10. To estimate titrable acidity in fruits 11. Estimation of nitrate reductase activity from plant tissue	120

Suggested Evaluation Methods

Internal Assessment: 30		End Term Examination: 70	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Introductory Practical Biochemistry by Sawhney, S.K. and Singh, R. (2000), Narosa

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Publishing House, India
2. Principles and Techniques of Practical Biochemistry, 6th edition by Keith Wilson and John Walker (2000), Cambridge University Press.
3. Physical Biochemistry, 2nd edition, by D Friefelder (1983), W H Freeman and Co., USA.
4. Biophysical Chemistry: Principles and Techniques, 2nd edition by A Upadhyay, K Upadhyay and N Nath (1998), Himalaya Publishing House, Delhi.
5. Plant Biochemistry & Molecular Biology, 3rd ed., by Hans–Walter Heldt (2005), Academic Press

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Session: 2024-25	
Name of the Programme	**M.Sc. Biochemistry**
Semester	**Semester – I**
Name of the Course	**Seminar**
Course Code	**M24-BCH-107**
Course Type: (CC/DEC/PC/Seminar/CHM/OEC/EEC)	Seminar
Level of the course	400-499
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: work independently, critically analyze research literature and use different digital sources to explain the concepts of Biochemistry. CLO 2: demonstrate latest scientific developments from disciplinary perspective to its professional and everyday use.
Credits	Seminar
	2
Teaching Hours per week	2
Max. Marks	50
Internal Assessment Marks	0
End Term Exam Marks	50
Examination Time	1 hour
Instructions for Examiner: Evaluation of the seminar will be done by the internal examiner(s) on the parameters as decided by staff council of the department. There will be no external examination/viva-voce examination.	

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Session: 2024-25			
Part A – Introduction			
Name of Programme	**M.Sc. Biochemistry**		
Semester	**Semester- II**		
Name of the Course	**Metabolism–II**		
Course Code	**M24-BCH-201**		
Course Type	**CC-5**		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: get an insight into the pathways involved in the catabolism and biosynthesis of amino acids, porphyrins and nucleotides. CLO 2: acquire knowledge about the chemical nature and metabolism of secondary metabolites produced by plants such as isoprenoids, phenylpropanoids, alkaloids etc. CLO 3: understand the integration of metabolism CLO 4: understand the organ specific metabolic profiles, metabolic changes during starvation and food intake, and ethanol metabolism in liver.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Amino acid degradation:** General reactions of amino acid metabolism: Transamination; Oxidative, non-oxidative deamination and decarboxylation reactions; Role of glutamine in ammonia transport; Glucose-Alanine Cycle; Urea Cycle; Metabolic breakdown of individual amino acids (both essential and non-essential).	15
II	**Amino acid biosynthesis:** Biosynthesis of non-essential and essential amino acids; Regulation of amino acid biosynthesis; Amino acids as biosynthetic precursors of phosphocreatine, glutathione, dopamine, non-epinephrin and epinephrin, GABA, histamine, serotonin, polyamines (spermine and spermidine), and indole-3-acetic acid. Porphyrins: Structure of porphyrins; Important porphyrins occurring in nature; Detection of porphyrins spectrophotometrically and by fluorescence; Biosynthesis of heme and its regulation; Degradation of heme; Regulation of heme biosynthesis; Chlorophyll biosynthesis.	15

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III	**Nucleotide metabolism:** *De novo* biosynthesis and regulation of purine and pyrimidine nucleotides; Salvage pathways of purines and pyrimidines; Ribonucleotide reductase and formation of deoxyribonucleotides (dNTPs) from ribonucleotides (NTPs); Catabolism of purine and pyrimidine nucleotides; Chemotherapeutic agents as inhibitors of enzymes in nucleotide biosynthetic pathways; Biosynthesis of nicotinamide coenzymes, flavin coenzymes and coenzyme A. Integration of metabolism: basic strategy of catabolic metabolism; Recurring motifs in metabolic regulation; Major metabolic pathways and control sites; Key junctions in metabolism (glucose-6-phosphate, pyruvate and acetyl CoA); Organ specific metabolic profile; Metabolic changes induced by food intake and starvation; Ethanol metabolism in the liver.	15
IV	**Secondary plant metabolism:** Primary and secondary metabolites; Isoprenoids: introduction, different classes with examples; biosynthesis of carotenoids (Limonene, Lycopene and β-Carotene); Alkaloids: definition, classification according to their heterocycles with examples; physiologically active alkaloids (used in medicine and plant chemical defense); Phenylpropanoids: Introduction; overview of products of the phenylpropanoid metabolism; Biosynthesis of lignin; Flavonoids: nature; classification of aglycons with examples; functions of flavonoids; Nature of Tannins, Cyanogenic glycosides and Glucosinolates.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Lehninger: Principles of Biochemistry, 4th edition, by David L. Nelson and M.M. Cox (2005) Maxmillan/ Worth publishers/ W. H. Freeman & Company.
2. Fundamentals of Biochemistry, 3rd edition, by Donald Voet and Judith G Voet (2004), John Wiley & Sons, NY
3. Biochemistry, 6th edition, by Jeremy M. Berg (2007). W.H. Freeman & Co., NY.
4. Harper's Biochemistry, 26th edition, by R.K. Murray, P.A.Hayes, D.K.Granner, P.A. Mayes and V. W. Rodwell (2003). Prentice Hall International.
5. Biochemistry (2004) by J. David Rawn, Panima Publishing Corporation, New Delhi
6. Plant Biochemistry & Molecular Biology, 3rd ed., by Hans –Walter Heldt (2005), Academic Press
7. Biochemistry and Molecular Biology of Plants by Bob, B. Buchanan, W. Gruissen and R.L.Jones (2000). Published by American Society of Plant Physiologists and distributed by Panima Educational Book Agency, New Delhi.

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Session: 2024-25			
Part A – Introduction			
Name of Programme	**M.Sc. Biochemistry**		
Semester	**Semester – II**		
Name of the Course	**Biochemical and Biophysical techniques**		
Course Code	**M24-BCH-202**		
Course Type	**CC-6**		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: know the radio-isotopic techniques and centrifugation and their applications in biological science research. CLO 2: understand the basic principles and techniques of chromatography and protein purification and their applications CLO 3: gain insight knowledge of the principle of electrophoresis and the various electrophoretic techniques for proteins and nucleic acids CLO 4: understand spectroscopy to elucidate the chemical structure of molecules and acquire knowledge of microscopy and its applications in various fields of research.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Radioisotope techniques:** Basic concepts (types of radioactive decay, rate of radioactive decay, radioactive isotopes and their half-lives and units of radioactivity); GM and scintillation counter; autoradiography; specific activity of a radioisotope; safety aspects; applications of radioisotopes in biological sciences. **Centrifugation:** Basic principle of sedimentation, factors affecting sedimentation; different types of centrifuges; types of rotors; analytical and preparative ultracentrifugation	15

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II	**Chromatography:** Principles and applications of paper, thin layer chromatography, ion-exchange chromatography, affinity chromatography, gel filtration chromatography, Determination of molecular weight using gel filtration chromatography, gas liquid chromatography and High-performance liquid chromatography **Protein purification techniques:** Selection of source, criteria of purity and monitoring protein purification, use of chromatography techniques for protein purification	15
III	**Electrophoretic techniques:** Isolation of DNA and RNA, purification and quantification of nucleic acids, Principle of electrophoretic separation, Native and SDS-PAGE, Determination of molecular weight and subunits using SDS-PAGE, Detection and quantification of proteins in gels; Recovery of proteins from gels. Iso-electric focusing (IEF), Western blotting Electrophoresis of nucleic acids: agarose gel electrophoresis, pulse field electrophoresis; capillary electrophoresis; microchip electrophoresis	15
IV	**Spectroscopy:** Nature of electromagnetic radiations; Principles and applications of UV, Visible, Infrared, Raman, Fluorescence and NMR spectroscopy; ORD and CD, Atomic absorption spectroscopy **Microscopy:** Resolving power and magnification power, principle and applications of Phase contrast, Fluorescence microscopy and Electron microscopy (Scanning electron microscopy and Transmission electron microscopy)	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Principles and Techniques of Practical Biochemistry, 6th edition by Keith Wilson and John Walker (2000), Cambridge University Press.
2. Physical Biochemistry, 2nd edition, by D Friefelder (1983), W H Freeman and Co., USA.
3. Biophysical Chemistry: Principles and Techniques, 2nd edition by A Upadhyay, K Upadhyay and N Nath (1998), Himalaya Publishing House, Delhi.
4. Physical Biochemistry, 2nd edition, by K. E Van Holde (1985), Prentice Hall Inc, New Jersey.
5. Instrumental Methods of Analysis, 7th edition by H.H.Willard, L L Merritt Jr., J A Dean and F A Settle Jr. (1996), CBS Publishers and Distributors, New Delhi.
6. Kuby Immunology, 4rd ed. by R A Goldsby et al, W H Freeman and Co.

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Session: 2024-25			
Part A – Introduction			
Name of Programme	**M.Sc. Biochemistry**		
Semester	**Semester – II**		
Name of the Course	**M24-BCH-203**		
Course Code	**Enzymology**		
Course Type	**CC-7**		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: distinguish the fundamentals of enzyme properties, nomenclature, characteristics and mechanism. CLO 2: study of factors affecting enzymatic reactions, application of biochemical calculations for enzyme kinetics and plotting graphs based upon kinetic data CLO 3: describe the concept of enzyme inhibition. Students will know how to construct enzyme inhibitors. CLO 4: conceptualize the co-operative behavior of enzyme, allosteric enzyme and understanding of regulatory mechanism of enzyme action.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Introduction:** General characteristics of enzymes; Nomenclature and classification; Introduction to the following terms with examples – Holoenzyme, apoenzyme, cofactors, coenzymes, prosthetic groups, metalloenzymes, metal dependent enzymes, turnover number, enzyme activity units (I.U. and Katal), and specific activity. **Enzyme specificity:** Types of enzyme specificity; three-point attachment theory, Lock-and-key hypothesis, Induced- fit theory, Strain and distortion theory, transition-state theory, Common features of active sites, reaction co-ordinate diagram, Multienzyme systems, multifunctional enzymes, Isoenzymes, Ribozymes, Pseudoenzymes, Synthetic artificial enzymes, Abzymes **Enzyme Catalysis:** Proximity & orientation, acid-base catalysis, covalent catalysis; Mechanism of action of chymotrypsin,	15

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	ribonuclease and lysozyme. Role of $NAD^+/NADP^+$, FMN/FAD, coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, lipoic acid, biotin, Vitamin B12 Coenzyme, and tetrahydrofolate in enzyme catalysis	
II	**Enzyme Kinetics:** Factors affecting enzyme activity; Arrhenius plot; kinetics of single-substrate reaction, rapid equilibrium and steady state approach, Derivation of Michaelis-Menten equation, kinetic parameters of enzymes (Km, V_{max}, K_{cat}, K_{cat}/K_m) and their significance, Linear transformations of MM equation to determine Km and V_{max} (Lineweaver-Burk plot, Eadie-Hofstee plot and Hanes plot) **Kinetics of Bi-substrate reactions:** Sequential and ping-pong mechanisms with examples and determination of K_m for each substrate (derivation excluded); Use of initial velocity studies, product-inhibition studies and isotope exchange at equilibrium to determine kinetic mechanisms of bi-substrate reactions	15
III	**Enzyme inhibition:** Reversible enzyme inhibitors (determination of kinetic parameters in the presence of competitive, non- competitive, and uncompetitive inhibitors), Irreversible enzyme inhibitors (affinity labels and suicide inhibitors) **Investigation of active site of enzymes:** Methods for identification of binding and catalytic sites- Trapping the enzyme-substrate complex, use of substrate analogues, chemical modification of amino acid side chains in enzymes, Modification by proteases and effect of changing pH	15
IV	**Enzyme regulation:** Coarse and fine control of enzyme activity; Enzyme induction & Repression; Feedback regulation of enzyme activity; Reversible and irreversible covalent modification of enzymes **Allostery of enzyme action:** Sigmoidal kinetics, Allosteric enzymes, Allosteric regulation with aspartate transcarbamoylase as an example, Positive and Negative Cooperativity Concerted and sequential models for action of allosteric enzymes, Hill plot, Scatchard plot	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

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Recommended Books/e-resources/LMS:

1. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry by Trevor Palmer (2007). Horwood Publishing.
2. Fundamentals of Enzymology, 3rd edition, by Nicholas C. Price and Lewis Stevens (1999) Oxford University Press.
3. Principles of Enzymology for Food Science by J.R. Whitaker (2018). Marcel Dekkar Publishers.
4. Structure and Mechanism in Protein Science, 2nd edition, by Alan Fersht (1999). W.H. Freeman and Co., NY.
5. Lehninger: Principles of Biochemistry, 7th edition, by David L. Nelson and M.M. Cox Maxmillan/ Worth publishers/ W.H. Freeman & Company.

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Session: 2024-25			
Part A – Introduction			
Name of Programme	**M. Sc. Biochemistry**		
Semester	**Semester – II**		
Name of the Course	**Molecular Biology**		
Course Code	**M24-BCH-204**		
Course Type	**CC-8**		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: acquire knowledge about central diagram of molecular sinology. CLO 2: learn about DNA, RNA and protein synthesis. CLO 3: get an insight about DNA damages and various repair mechanism. CLO 4: understand molecular mechanisms behind protein targeting.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Basic Concepts of Genetic Information:** Nucleic acids as the genetic material - experimental evidences; Chargaff's rules, DNA topology, topological and geometric properties, DNA supercoiling, Topoisomerases in prokaryotes and eukaryotes, DNA organization in prokaryotes and eukaryotes, C-value paradox, various classes of DNA: highly repetitive, moderately repetitive and unique sequence	15
II	**DNA replication:** Possible modes of DNA replication, Meselson-Stahl experiment, DNA polymerases and other enzymes involved in DNA replication, Okazaki fragments, Mechanism of replication in prokaryotes and eukaryotes, inhibitors of DNA replication	15
III	**Transcription and post-transcriptional modifications:** RNA polymerase/s in prokaryotes and eukaryotes, DNA footprinting technique, initiation, elongation and termination of transcription in prokaryotes and eukaryotes, inhibitors of transcription, RNA replicase, reverse transcriptase, post-transcriptional modifications: different types of introns and their splicing mechanisms, processing of mRNA, rRNA and tRNA precursors, overlapping genes and split genes.	15

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IV	**Protein synthesis, targeting and degradation:** Characteristics of the genetic code, biological significance of degeneracy, decoding the code, Wobble hypothesis, ribosomes structure and function in prokaryotes and eukaryotes, Aminoacyl tRNA-synthetases, various factors and steps involved in protein synthesis in prokaryotes and eukaryotes, polyribosomes, post-translational processing, signal hypothesis and protein targeting to lysosomes, Plasma membrane, extracellular matrix and different compartment of mitochondria and chloroplast, protein degradation.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Molecular Cell Biology, Lodish et al, 7th edition (2012), W H Freeman and Company.
2. Lewin's Genes XI, Krebs et. al., 11th edition (2012), Jones and Bartlett Publishers.
3. Freifelder's Essentials of Molecular Biology, D Freifelder, 4th edition, (2008), Narosa publishing house.
4. Principle of Biochemistry, Moran et. al., 5th edition (2013) Neil Patterson Publishing.
5. Fundamentals of Biochemistry, Voet et. al, 4th edition (2012), John-Wiley & sons.
6. Biochemistry, Berg et al. 8th edition, (2015), W H Freeman & Co. N York.
7. Lehninger's Principles of Biochemistry, Nelson and Cox 6th edition, (2013) W H Freeman & Co. N York.
8. Molecular Biology of the Gene, Watson et al, 7th Edition, (2013) Pearson Education International.

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Session: 2024-25			
Part A – Introduction			
Name of the Programme	**M.Sc. Biochemistry**		
Semester	**Semester – II**		
Name of the Course	**PC-3** (Practical skills in Biotechniques)		
Course Code	M24-BCH-205		
Course Type	**PC-3**		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: well acquainted with the titration and spectrophotometric estimation of biomolecules CLO 2: understand the different chromatographic techniques and their applications in purifications and separations of biomolecules CLO 3: develop skills of using various equipment involved in biomolecules purification and separation CLO 4: develop skills in carrying out research projects by employing basic biochemical techniques		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B- Contents of the Course

Practicals	**Contact Hours**
1. Subcellular fractionation of organelles from animal/plant tissue 2. To demonstrate light microscopy 3. Verification of Beer-Lambert's law and determination of absorption coefficients 4. Separation of amino acids of a mixture by Paper chromatography 5. Separation of amino acids of a mixture by thin layer chromatography 6. Separation of carbohydrates of a mixture by Paper chromatography 7. Separation of proteins using gel filtration chromatography 8. Separation of proteins using ion-exchange chromatography 9. Separation of proteins using Native PAGE 10. Separation of proteins using SDS PAGE 11. Determination of molecular weight using SDS-PAGE 12. Determination of molecular weight using gel filtration chromatography 13. Separation of DNA on agarose gel electrophoresis	120

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10		

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• Mid-Term Exam:	15	execution of the practical

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Introductory Practical Biochemistry by Sawhney, S.K. and Singh, R. (2000), Narosa Publishing House, India
2. Principles and Techniques of Practical Biochemistry, 6th edition by Keith Wilson and John Walker (2000), Cambridge University Press.
3. Physical Biochemistry, 2nd edition, by D Friefelder (1983), W H Freeman and Co., USA.
4. Biophysical Chemistry: Principles and Techniques, 2nd edition by A Upadhyay, K Upadhyay and N Nath (1998), Himalaya Publishing House, Delhi.
5. Modern Experimental Biochemistry, 3rd edition by Boyer, R. (2002), Pearson India

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Session: 2024-25			
Part A – Introduction			
Name of the Programme	**M.Sc. Biochemistry**		
Semester	**Semester – II**		
Name of the Course	**PC-4 (Practicals based on Enzymology and Molecular Biology)**		
Course Code	**M24-BCH-206**		
Course Type	**PC-4**		
Level of the course	400-499		
Pre-requisite for the course (if any)			
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 1: learn about use of instrumentation in design, execution and critical interpretation of experiments CLO 2: learn appropriate concepts, quantitative analysis and laboratory techniques CLO 3: develop the skills of extraction, purification assay of enzymes from plant and animal tissue. CLO 4: demonstrate the proficiency in concepts, manipulations and biochemical calculations		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B- Contents of the Course

Practicals	Contact Hours
1. Estimation of DNA by diphenylamine reaction 2. Estimation of RNA by orcinol reaction 3. Assay of acid phosphatase enzyme from plant/animal tissue and calculation of specific activity 4. Assay of alkaline phosphatase enzyme from plant/animal tissue and calculation of specific activity 5. Effect of substrate concentration on enzyme activity of acid/alkaline phosphatase 6. Effect of enzyme concentration on enzyme activity of acid/alkaline phosphatase 7. Effect of temperature on the activity of acid/alkaline phosphatase and calculation of Ea. 8. Effect of pH on the activity of acid/alkaline phosphatase 9. Determination of K_m, and V max 10. Determination of pH optima of an enzyme 11. Separation of enzymes by acetone precipitation method 12. Time course of enzyme activity	120

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and	

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• Seminar/Demonstration/Viva-voce/Lab records etc.:	10	execution of the practical
• Mid-Term Exam:	15	

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Introductory Practical Biochemistry by Sawhney, S.K. and Singh, R. (2000), Narosa Publishing House, India
2. Principles and Techniques of Practical Biochemistry, 6th edition by Keith Wilson and John Walker (2000), Cambridge University Press.
3. Physical Biochemistry, 2nd edition, by D Friefelder (1983), W H Freeman and Co., USA.
4. Biophysical Chemistry: Principles and Techniques, 2nd edition by A Upadhyay, K Upadhyay and N Nath (1998), Himalaya Publishing House, Delhi.
5. Modern Experimental Biochemistry, 3rd edition by Boyer, R. (2002), Pearson India

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