Sant Gadge Baba Amravati University, Amravati

NEP Syllabus

UG Programme

Faculty: Science and Technology

Programme:B.Sc. (Biochemistry)

Programme Outcomes: Students of undergraduate general degree programme at the time of graduation would be able to

- **PO1**-Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
- **PO2-**Effective Communication: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology.
- **PO3-**Social Interaction: Elicit views of others, mediate disagreements and help reach conclusions in group settings.
- **PO4-**Effective Citizenship: Demonstrate empathetic social concern and equity centred national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
- **PO5-**Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
- **PO6-** Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.
- **PO7**- Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes.

Programme Specific Outcomes PSOs: Upon completion of the programme successfully, graduate would be able to –

1. Understand structure, energy value and function of Biomolecules.
2. Prepare buffers of different pH, can perform chromatography of plant pigments and

separate biomolecules by electrophoresis perform structural analysis.

3. Demonstrate a deep understanding of the structures of biomolecules, including proteins, nucleic acids, carbohydrates, and lipids.
4. Apply knowledge of biomolecule metabolism to diagnose various diseases and their root causes.
5. Possess effective communication skills, both written and oral, to convey biomolecular concepts to diverse audiences, including scientists, policymakers, and the general public.
6. Demonstrate the ability to apply biomolecular principles to solve complex problems in areas such as genetics, biochemistry and molecular biology.
7. Integrate knowledge from various scientific disciplines, such as chemistry, biology, and bioinformatics, to address complex issues in biomolecular research.

Employability Potential of the Programme: Biochemistry is the branch of science which deals with study of chemistry of living organisms. Biochemistry focuses on processes happening at molecular level. It focuses on what happening inside our cells, studying components like proteins, lipids, carbohydrates, nucleic acid, vitamins and hormones. The cumulative demand for trained and skilled manpower in the area of Biochemistry requires in depth functional knowledge of modern biology through hands-on training to the students. This structure of syllabus aims to introduce various aspects of Biochemistry and interdisciplinary subjects to the students. The program in Biochemistry as one of the core subjects is designed to cultivate a scientific attitude and interest towards the modern areas of Biochemistry in particular and life science in general. This will help the students to become curious in their outlook. The courses are designed to impart the essential basics in Biochemistry at the initial level of graduation. The basic courses are infused with application in modern life sciences, and awareness on Biochemistry and its influence in human life. The integration of various courses in the program is aimed to develop proficiency in the theory as well

as practical experiments, common equipment, laboratory, along with the collection and interpretation and presentation of scientific data in proper manner. Beside this, the students will be equipped with knowledge in the newer areas of Biochemistry and its application in medical science, agriculture, industry, proteomics, genomics, metabolomics, bioinformatics, nano-biotechnology etc. This will create awareness about Bio-chemistry and contribution of Biochemistry among the society. At the end of the course, the students are expected to have good working knowledge in the field of Bio-chemistry and in addition knowledge gained from courses of interdisciplinary in nature. Students will surely have an urge to continue higher studies in Biochemistry and contribute significantly in the development mankind. The present syllabus is restructured anticipating the future needs of Biochemistry with more emphasis on imparting hands-on skills. The main thrust is laid on making syllabus compatible with developments in Education, Research and Industrial sectors. The Theory and Practical course in new restructured course will lead to impart skill-set essentials to further Biochemistry. Degree program in Biochemistry teaches students how inanimate, lifeless chemicals combine to produce a functional living organism. A significant attraction of the course is the ability to combine in-depth scientific knowledge with practical laboratory skills and the career opportunity in all sectors. After successful completion of three years degree course in Biochemistry, student will be well versed with laboratory skills and transferable skills.

Laboratory Skills:

• Laboratory safety practices
• Accurate weighing and reagent preparation
• Skillful handling of basic and advanced instruments
• Calibration of basic instruments like pH meter, micropipettes etc.

Transferable Skills: During the course student will develop skills other than laboratory skills that are transferable across the number of career areas. These are:

• Analytical skill
• Report writing skill
• Presentation skill
• Time management
• Creative thinking
• Problem solving
• Planning

• Observational skill

Job Opportunities: After successful completion of B.Sc. in Biochemistry, student may continue further studies like M.Sc. in Biochemistry and then Ph.D. in Biochemistry and make career in research field. Students have opportunities in private as well as public sectors.

Private Sector: Biochemist can work in quality control, quality assurance and R & D divisions of companies likeBiotech companies, Pharmaceutical companies, Chemical manufacturing companies, Food and Drink (includes brewing), Health and Beauty Care, Medical Instrument companies, Agricultural companies, Research Companies and Laboratories etc.

Public Sectors: Blood Service, Cancer research institutes, Environmental Pollution Control, Forensic Science, Hospitals, National Blood Services, Overseas Development, Public Health Entities, Public Health Laboratories, Agriculture and fisheries etc.

Government Sector: Syllabus has been design keeping in view that students can apply for various government post filled by Maharashtra Public Service Commission (MPSC), Union Public Service Commission (UPSC), Food Corporation of India, Forensic department, Health department and Food and Drug Administration. These departments recruit successful candidates for the post of Food safety officers in food and drug administration, Assistant Chemical Analyzers in forensic laboratories of Maharashtra and other states all over India, Laboratory Technicians in Clinical pathology laboratories Health department and Food Corporation of India, Sanitary inspectors for schools etc.

Job profiles: Biochemist, Biologist, Biomedical Scientist, Biotechnologist, Chemical Examiners, Chemist, Clinical Scientist, Food Scientist, Forensic Scientist, Laboratory Technician, Microbiologist, Research Associates, Research Officers, and Research Scientist etc. Thus syllabus has been prepared anticipating the requirements of B.Sc. Biochemistry students under NEP. The contents have been drawn to accommodate the widening horizons of the Biochemistry discipline and reflect the changing needs of the students. Hence, Board of Studies in Biochemistry (Including Microbiology and Food Science) in its meeting held on 16/12/2023 resolved to accept the revised syllabus for B. Sc. I Sem. I and Sem II (Bio-chemistry) based on NEP. The detailed syllabus for each paper is appended with a list of suggested reading

Santa Garge Baba Amravati University, Amravati

FACULTY:

Teaching and learning scheme: For the Degree of Bachelor of Science

(Three Years- Six Semesters Bachelor's Degree Programme)

FIRST YEAR : SEMESTER-1

Mode of teaching	Vertical number	The vertical	Type of course	Course code	Course name	Credits	Workload	Vertical workload (Hrs/Week)
Classroom teaching/ lab work(Practical)/ Outdoor/ field	a.	Major Biochemistry 103	Theory 1	103200	Biomolecules	2	2	6
			Lab/ Practical I	103201	Practicals in basic Biochemistry	2	4	
	b.	Major/Minor	Theory 1	--	--	2	2	6
			Lab/ Practical I	--	--	2	4	
	c.	Generic/ Open elective 103	Theory 1	103202	Biochemistry in Health and Disease	2	2	4
			Theory 2	103203	Plant Biotechnology	2	2	
		SEC	Lab/ Practical 3	103204	Application Based Practicals in Biochemistry	2	4	4
		AEC- English	Theory			1	1	6
	e.	AEC-MIL	Theory			1	1	
		IKS-Generic	Theory			2	2	
		VEC	Theory			2	2	
		CC	Outdoor			2	4	4
		Total				22	30	30

Course : B. Sc I Semester I (Biochemistry)

103200 Theory 1: Biomolecules I							
Level	**Sem**	**Course Code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Max Marks**
4.5	I	103200	Biomolecules	2	30	2 Hrs	30

Course Objectives:

- To gain knowledge of the structure of biomolecules, including proteins, nucleic acids, lipids, and carbohydrates.
- To learn about the chemical properties and reactions of biomolecules.
- To explore the functional roles of biomolecules in living organisms.

Course Outcome:

At the end of the course, students would be able to

1. Understand Chemical structure, properties, types of classification and biological Importance of Carbohydrates.
2. Differentiate between saturated and unsaturated fatty acids and suggest good quality edible Oil.
4. Study physiochemical properties, types, classification and biological importance of Proteins.

Unit	Content	Hrs	Weightage of Marks Alloted
Unit-I Carbohydrates	a. Definition, classification, asymmetric carbon, optical isomerism, D & L isomerism, Epimerism, ring structure of pentoses & hexoses, ß anomers, mutarotation, b. Reactions of aldehyde, ketone groups & hydroxyl groups, amino sugars, deoxy sugars, types of glycosidic bonds, c. Structures, sources and functions of disaccharides and oligosaccharides. d. Structureand classificationof polysaccharides, occurrence & biological importance of polysaccharides like starch, glycogen, cellulose & mucopolysaccharides like heparin, hyaluronic acids, chondroitin sulphates.	7	7
Unit-II Lipids	a. Definition and classification of Lipids Fatty acids: introduction, nomenclature, structure & properties of saturated & unsaturated fatty acids, omega fatty acids, cis & trans isomerism, positional isomerism.	8	8

	b. Triacylglycerols; nomenclature, structure & characterization of fats (hydrolysis, saponification value, acid value, rancidity of fats, iodine number) biological significance of fats. c. Structure & functions of lecithins, cephalins, phosphoinositides&spingomyelins, glycolipids cerebrosides, gangliosides d. Steroids: Structure, properties & functions of ergosterol, cholesterol, bile acids		
Unit-III **Proteins**	a. Definition, classification based on solubility, shape, composition & function. Amino acids: classification, structure & isomers of standard amino acids, Zwitter ionic structure and Pi, glucogenic & ketogenic amino acids, non proteinous amino acids (ornithine, citrulline & ß alanine) b. Peptides: structure of peptide bonds, important peptides (structure & functions of glutathione, oxytocin, vasopressin, bradykinin). c. Protein structure: Levels of protein structure, forces stabilizing the tertiary & quaternary structure of proteins. d. Denaturation & renaturation of proteins, salting in and salting out of proteins. Structure & biological functions of fibrous proteins (keratins, collagen, elastins) and globular proteins (haemoglobin& myoglobin)	7	7
Unit-IV **Nucleic acids**	a. Nucleic acids: Structure of nitrogenous bases, nucleosides, nucleotides, Structure of DNA- Watson Crick model, b. Tm of DNA, G+C content of DNA, Types of DNA- A, B & Z-DNA c. RNA-Primary structure,Types- m-RNA, t-RNA and r-RNA Denaturation & annealing of DNA, evidence that DNA is genetic material, gene, genome, chromosomes	8	8

References

1. Lehninger's Principles of Biochemistry (2000) by- Nelson, Cox, M.M. Macmillan, New York. Fundamentals of Biochemistry (1999) by Donald Voet, Judith Voet, Charlotte Pratt, John Wiley & Sons, N.Y. 145 146
2. Biochemistry" by Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer
3. Text Book of Biochemistry by Dr. O. P. Agrawal.
4. Text book of Biochemistry by S.M. Patil and A. B. Patil (NabhPrakashan)
5. Essentials of Biochemistry by Dr. M. C. Pant.
6. Text book of Biochemistry by West and Todd.

7. Practical manual in Biochemistry by Jairaman.
8. Text book of Biochemistry by Sucheta Dandekar.
9. Text book of Biochemistry by U. Sattyanarayan Fundamentals of Biochemistry by J. L. Jain

Model Questions

1. **Short Answer Questions**

Proteins:

1. Define the primary structure of a protein and its significance.
2. Explain the role of hydrogen bonds in protein folding.
3. How does denaturation affect the structure and function of proteins?
4. Give examples of fibrous protein.
5. Give examples of globular protein.
6. Give classes of amino acid.

Carbohydrates:

1. Define the terms monosaccharide, disaccharide, and polysaccharide.
2. Explain the role of carbohydrates in energy storage and structural support.
3. How are glycogen and starch similar, and how do they differ?
4. Give examples of monosaccharide
5. Give examples of disaccharide
6. What is the monosaccharide unit present in starch and glycogen
7. How many asymmetric carbon atoms are present in glucose
8. How many possible diastereomers are possible from glucose?
9. Define epimers
10. What are anomers? Give example.

Lipids:

1. Define saturated and unsaturated fats and their impact on health.
2. Describe the structure of a phospholipid and its role in cell membranes.
3. Explain the concept of amphipathic molecules in the context of lipids.
4. Name any four fatty acids
5. Define waxes
6. Name fat soluble vitamins.

Nucleic Acids:

1) What are the two types of nucleic acids in living organisms?
2) What is the function of DNA polymerase in DNA replication?
3) Which nucleotide base pairs with adenine in DNA?
4) What is the sugar component of RNA?
5) Define transcription in the context of nucleic acids.

2. **Long Answer Questions**

Carbohydrates:

1) Provide an in-depth analysis of the structure and function of carbohydrates.

2) Explain monosaccharides, disaccharides, and polysaccharides, and explain their roles in energy storage and cellular structure.

3) Define anomers? Give examples with structure

4) Discuss the concept of glycogen storage in animals.

5) How is glycogen synthesized and broken down, and how does it serve as a short-term energy reserve in the body?

Lipids:

1) Examine the structure and function of phospholipids in cell membranes.

2) How do phospholipids contribute to the fluidity and selective permeability of biological membranes?

3) Discuss the role of triglycerides in energy storage.

4) How are triglycerides mobilized during periods of energy demand, and what are the metabolic consequences of lipid breakdown?

5) Explore the concept of cholesterol in the human body.

6) What are the functions of cholesterol, and how does its level in the bloodstream impact cardiovascular health?

7) Explain the process of lipogenesis and its significance in the context of energy metabolism.

8) How is excess energy stored as lipids, and what factors regulate lipid synthesis?

9) Discuss the role of lipids in signaling pathways.

10) How do lipid-derived signaling molecules, such as prostaglandins, impact physiological processes in the body?

Proteins:

1) Provide a detailed overview of protein structure, including the levels of organization (primary, secondary, tertiary, and quaternary).

2) How does each level of protein structure contribute to the overall function of a protein?

3) Explore the concept of protein folding and the factors that influence protein stability.

4) How do chaperone proteins assist in the proper folding of newly synthesized polypeptides?

5) Examine the concept of protein denaturation.

6) What are the causes of protein denaturation, and how does it impact the structure and function of proteins?

Nucleic Acids:

1) Discuss in detail the structural differences between DNA and RNA

2) Explain the significance of structural features in the functions performed by DNA and RNA in the cell.

3) Draw structures of adenylate, guanylate, cytidylate

4) Draw and explain hydrogen bonding in nucleotides

3. **Multiple choice question**

1) Which nucleotide base is found in RNA but not in DNA?
- A) Adenine
- B) Thymine
- C) **Uracil**
- D) Cytosine

2) Which of the following is a monosaccharide?
- A) Sucrose
- B) Starch
- C) **Glucose**
- D) Cellulose

3) Which of the following stabilizes the secondary structure of proteins?
- A) Disulfide bonds
- B) **Hydrophobic interactions**
- C) Peptide bonds
- D) Ionic bonds

4) What is a common function of triglycerides in the body?
- A) Enzyme catalysis
- B) Long-term energy storage
- C) Genetic information transmission
- D) **Cell structure support**

5) What is the role of enzymes in biochemical reactions?
- A) Store genetic information
- B) **Speed up chemical reactions**
- C) Provide structural support
- D) Facilitate long-term energy storage

6) What is the quaternary structure of a protein?
- A) Sequence of amino acids
- B) Three-dimensional arrangement of a single polypeptide chain
- C) **Arrangement of multiple polypeptide chains**
- D) Simple protein folding pattern

7) What is a common structural feature of phospholipids?

A) Triglyceride backbone
B) Phosphate head and fatty acid tails
C) Steroid ring structure
D) Amino acid chains

8) Which of the following lipids is a precursor for the synthesis of steroid hormones?
A) Triglycerides
B) Phospholipids
C) Cholesterol
D) Sphingolipids

9) In DNA, which nucleotide pairs with guanine?
A) Adenine
B) Cytosine
C) Thymine
D) Uracil

10) What is the primary function of transfer RNA (tRNA) during protein synthesis?
A) Serve as a template for DNA replication
B) **Carry amino acids to the ribosome**
C) Act as a structural component of ribosomes
D) Facilitate RNA splicing

11) What is the central dogma of molecular biology?
A) DNA replication→ Transcription→Translation
B) Translation → Transcription → DNA replication
C) Transcription → Translation → DNA replication
D) Translation → DNA replication →Transcription

The distribution of marks for the Internal Assessment shall be as follows:

Internal Assessment (Theory)	
Continuous Assessment Tests Three CAT each of 10 marks (MCQs) • Test 1 on completion of 25% syllabus of the course • Test 2 on completion of 50% syllabus of the course • Test 3 on completion of 75% syllabus of the course Total performance in CAT (i.e. 40%) shall be based on the best two out of three in CAT examinations	10 Marks
Any of the following assessment tools/methods Seminar, case study, field work, mini project work, quiz or any innovative method	10 Marks
Total	**20 Marks**

103202 Lab 1- Practicals in Basic Biochemistry							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
4.5	I	103201	Lab1 : Practicals in Basic Biochemistry	2	60	2Hrs	50 (25+25)

Course Objectives:

- To familiarize students with basic laboratory equipment, safety protocols, and common techniques used in biochemistry experiments.
- To develop hands-on skills in performing fundamental biochemistry experiments, including pipetting, dilution, centrifugation, spectrophotome
- To introduce students to the principles of experimental design, hypothesis formulation, and the planning of biochemistry experiments.

Course outcome: At the end of the course, students would be able to

1. Develop basic laboratory skills, including proper handling of equipment, pipetting, dilution techniques, and safety precautions.
2. Understand the principles of experimental design and be able to plan and execute simple biochemistry experiments.
3. Gain proficiency in fundamental biochemistry techniques
4. Recognize the practical applications of biochemistry in solving real-world problems related to health, medicine, and industry.

103202: Lab 1Practicals in Basic Biochemistry	
1	Qualitative test for carbohydrates and Lipids
2	Qualitative test for amino acids , proteins and Nucleic acid
3	Determination of iodine value in edible oils
4	Estimation of sugar by anthrone method
5	Estimation of protein by Biuret method
6	Determination of Acid value of fat.
7	Determination of saponification number of oil.
8	Estimation of ascorbic acid by dye method
9	Estimation of Glycine by formal Titration
10	Isolation of starch from potato

References:

1. Principles and Techniques of Biochemistry and Molecular Biology" by Keith Wilson and John Walker
2. Experimental Biochemistry" by William J. Thompson and Lynnelle K. A. Thompson
3. Biochemistry Laboratory: Modern Theory and Techniques" by Rodney F. Boyer
4. Biochemistry Laboratory: Manual For Students" by T. Satyanarayana and U. Chakrapani
5. Laboratory Techniques in Biochemistry and Molecular Biology" by Raphael Ikan
6. David plummer (2011) An introduction to practical biochemistry
7. Practical Biochemistry for Colleges" by A. C. Deb

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation based on CAT**	
Performance of any two experiments	20 M	Attendance & Students performance	10 M
Viva-voce	05 M	Practical Record Book	05 M
		MCQ/ Spotting (Best 2 out of 3)	10 M
Total	**25 M**	**Total**	**25 M**

Practical lab 3, Skill Enhancement Course (SEC)
103206 - Application Based Practicals in Biochemistry

Level	Semester	Course code	Course Name	Credits	Teaching Hours	Exam Duration	Maximum marks
4.5	I	103204	Application Based Practical's in Biochemistry	2	60	2Hrs	50 (25+25)

Course Objectives:

- To develop fundamental laboratory skills, including accurate pipetting, dilution techniques, and sample preparation.
- To acquire skills in preparing and optimizing buffers for various biochemical assays and experiments.
- To gain proficiency in using common laboratory instruments and equipment used in biochemistry, such as spectrophotometers, centrifuges, pH meter.

Course outcome: At the end of the course, students would be able to..

1) Acquire the ability to prepare and optimize buffers suitable for various biochemical assays and experiments.
2) Measure pH accurately using a pH meter and adjust the pH of solutions with precision.
3) Demonstrate knowledge and practical experience in isolation of carbohydrates and enzymes.
4) Apply spectrophotometric methods for the measurement of absorbance and the determination of λ_{max}

Sr. No	Title of the Practical
1	Preparation of various buffer solution using Handerson Hasselbalch equation
2	Preparation of Normal , Molar and Percentage Solution
2	To determine p^H of sample by various methods
3	Isolation and identification of carbohydrates from various sample
4	Isolation and investigation of saponification value of different oils from various sources
5	Comparison of Acid values of various oils
6	Determination of $\lambda_{max}$of at least two sugars
7	Isolation of caesin from milk
8	Isolation of total lipids from egg yolk
9	To study the titration curves of given amino acids
10	Estimation of amino acid by ninhydrin method
11	Estimation of glucose by glucose oxidase method

References:

1) Principles of Biochemistry" by Donald Voet, Judith G. Voet, and Charlotte W. Pratt
2) Lehninger Principles of Biochemistry" by David L. Nelson and Michael M. Cox
3) Experimental Biochemistry" by William J. Thompson and Lynnelle K. A. Thompson
4) Biochemical Techniques" by Keith Wilson and John Walker
5) Biochemistry Laboratory: Modern Theory and Techniques" by Rodney F. Boyer
6) Biochemistry Laboratory Manual" by Rodney F. Boyer

7) Practical Skills in Biomolecular Science" by Rob Reed, David Holmes, and Jonathan Weyers
8) Experimental Biochemistry: A Hands-on Approach" by Shawn O. Farrell and Lynn E. Taylor
9) Laboratory Techniques in Biochemistry and Molecular Biology" series by Raphael Ikan

Internal Evaluation for SEC	
Attendance	10 M
Practical Performance	20 M
MCQ/Spotting	10 M
Practical Record book	10 M
Total	**50 M**

Sant Gadge Baba Amravati University, Amravati

Teaching and Learning Scheme: for the Degree of Bachelor of Science

(Three Years- Six Semesters Bachelor's Degree Programme)

Programme: B.Sc. (Biochemistry)

Course : B.Sc I Semester II

Mode of Teaching	Vertical No.	The Vertical	Type of Course	Course Code	Course Name	Credits	Workload (Hrs/ Week)	Vertical Workload (Hrs/Week)
Classroom Teaching/ Lab Work (Practical) / Outdoor / Field	a.	Major Biochemistry 103	Theory3	103205	Biophysical and Biochemical techniques	2	2	6
			Lab/Practical-4	103206	Quantitative analysis of Biomolecules	2	4	
		Major /Minor	Theory3	--	--	2	2	6
			Lab/Practical-4	--	--	2	4	
	b.	Generic/ Open Elective 103	Theory 5	103207	Nutritional Biochemistry	2	2	4
			Theory 6	103208	Biochemical Toxicology	2	2	
	c.	VSC	Lab/Practical-5	103209	Biochemical and Cell Biology Techniques	2	4	8
		SEC	Lab/Practical-6	103210	Extraction , Separation and Purification of	2	4	
	d.	AEC - English	Theory			1	1	6
		AEC –MIL	Theory			1	1	
		IKS-Generic	Theory			2	2	
		VEC	Theory			2	2	
	e.	CC	Outdoor			2	4	4
		TOTAL				**24**	**32**	**32**

NEP Syllabus

UG Programme

Programme:B.Sc. (Biochemistry)

Course : **B.Sc I Semester II**

103207- Biophysical and Biochemical techniques							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Max marks**
4.5	II	103205	Biophysical and Biochemical techniques	2	30	2Hrs	30

Course Objective	The objective of the course is to introduce different biophysical techniques to students that are used in biological research for separation, purification and identification from mixture of biomolecules. The emphasis is also on experimental skills in the form of practical exercises so that students can apply this knowledge to improve their understanding of the subject for better utilization of these techniques in research and will also help in their placement.
Course outcomes	After the completion of the course: • Students will acquire knowledge about the principles and applications of separation and purification techniques like centrifugation and chromatography used in a biochemistry laboratory. • .Students will learn about the principles and applications of electrophoresis and spectroscopic techniques involved in estimation and identification of biomolecules. • It will also give them an opportunity to get hands-on experience to develop their experimental skills which are required for biological research lab..

Unit	Content	Workload Allotted in Hours	Weightage of Marks Allotted	Pedagogy
Unit-I Chromatography	General Principles & applications of a. Adsorption chromatography, Ion Exchange chromatography. b. Molecular sieve, Gas liquid chromatography. c. HPLC , Affinity chromatography, d. Paper chromatography, Thin layer chromatography.	8	8	Chalk and board Power point presentation, Videos, Animation etc.
Unit-II Electrophoresis	Protein and nucleic acid Separations: a. PAGE, Non- denaturing PAGE Nonreducing, SDS-PAGE. 2–D electrophoresis, Preparation of pH gradient gel. b. Procedure of preparation of polyacrylamide gels, importance of buffers in electrophoretic separations, importance of stacking and resolving gels, use of denaturing agents and reducing agents in electrophoresis. Applications of electrophoretic techniques in disease diagnosis. c. Staining techniques- Coomassie staining, PAS staining, Silver staining, Fluorescent dye staining, d. Submerged gel electrophoresis for the separation of nucleic acids. Nucleic acid staining techniques. Western, southern & northern blotting techniques.	7	7	Chalk and board Power point presentation, Videos, Animation etc
Unit-III Spectroscopic	a. Beers Lamberts law, Light absorption & its transmittance, determination &	8	8	Chalk and board Power point

techniques:	application of extinction coefficient b. Principles & application of visible & UV spectroscopic techniques. c. Principles & application of NMR, ESR, d. Principles & application of Mass spectroscopy, Fluorometry& flame photometry.			presentation, Videos, Animation etc
Unit-IV Microscopy and Centrifugation	a. Microscopy: Different types of microscopes – electron microscopes – TEM, SEM. Fluorescence and confocal microscopes used in fine structure b. Centrifugation Techniques: Introduction, basic principles, and applications of sedimentation. Centrifuges and their use c. small bench centrifuges, large capacity refrigerated centrifuges, high speed refrigerated centrifuges, d. Continuous flow centrifuges, Preparative ultra- centrifuges, analytical ultracentrifuges, and density gradient centrifugation.	7	7	Chalk and board Power point presentation, Videos, Animation etc
References	• Wilson, K. & Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology, (7th ed.), Cambridge University Press; ISBN 978-0-521-51635-8. • Boyer, R. F. (2012). Biochemistry Laboratory: Modern Theory and Techniques, (6th ed.), Boston, Mass: Prentice Hall; ISBN-13: 978-0136043027. 9 • Plummer, D. T. (1998). An Introduction to Practical Biochemistry (Yd ed.), Tata McGraw Hill Education Pvt. Ltd. (New Delhi); ISBN: 13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0 • Cooper, T.G. (2011). The Tools of Biochemistry (2nd · ed.), Wiley-Interscience Publication (New Delhi); ISBN: 13:9788126530168. • Lehinger's Principles of Biochemistry (2000) by- Nelson, Cox, M. M. Macmillan, New York.			

	• Biochemistry 3rd edition (1994) by Lubert Stryer WH Freeman and Co. San Francisco. • Outline of biochemistry (1987), Conn, Stumpf, Bruencing, Doi, JohnWiley& Sons, N.Y. • Text book of Biochemistry by West and Todd. • Practical manual in Biochemistry by Jairaman. • Physical Biochemistry (2nd Ed. 1985) by Vantolde K.E., Prentice Hall, INC, New Delhi. • Biophysical chemistry by Upadhyay, Upadhyay and Nath. • Chromatography : A Laboratory handbook of chromatography and Electrophoretic Methods (III 1975), BY Erich Haffman, Van Nostrand Reinhold, NY. • Fundamentals of Biochemistry (1999) by Donald Voet, Judith Voet,Charlotte Pratt, John Wiley & Sons,
Model Questions	**Long Questions:** 1. Discuss the diverse applications of chromatography in various scientific fields. 2. Elaborate on the principles of electrophoresis and its applications in molecular biology. 3. Discuss the applications of spectroscopy in the analysis of biomolecules. 4. Discuss the advantages and limitations of electron microscopy compared to light microscopy. **Short Questions** 1. Briefly describe the key differences between gas chromatography and liquid chromatography. 2. Briefly explain the procedure of Polyacrylamide Gel Electrophoresis (PAGE). 3. Why is maintaining a specific pH crucial in electrophoretic separations? 4. What information can be obtained by analyzing a UV-Visible absorption spectrum? 5. Briefly describe the principles of NMR spectroscopy. 6. Explain the principles of density gradient centrifugation. 7. Briefly describe the basic principles of analytical ultracentrifugation. 8. What is the role of the stationary phase in adsorption chromatography? **MCQs:**

	1. In adsorption chromatography, separation is based on: a. Charge differences b. Affinity interactions c. Size exclusion d. Adsorption 2. What distinguishes HPLC from traditional liquid chromatography? a. Higher pressure conditions b. Slower flow rates c. Lower resolution d. Limited sample volume 3. What is a key difference between gel electrophoresis and capillary electrophoresis? a. Presence of a gel matrix b. Speed of separation c. Dependence on voltage d. Use of a buffer system 4. In DNA electrophoresis, which direction do the DNA fragments migrate? a. Towards the anode (positive electrode) b. Towards the cathode (negative electrode) c. Towards the center of the gel d. Randomly in both directions 5. What is the primary advantage of using fluorescence spectroscopy in biomolecular studies? a. High cost-effectiveness b. Low sensitivity c. High sensitivity and selectivity d. Limited wavelength range 6. In mass spectrometry, what is being measured to determine the mass-to-charge ratio? a. Mass and charge separately b. Only mass c. Only charge d. Molecular weight

	7. What is the primary advantage of TEM over scanning electron microscopy (SEM)? a. Higher resolution b. Faster imaging c. Three d. Greater depth of field 8. In continuous flow centrifuges, how is the separation achieved? a. Based on density differences b. Based on charge differences c. Based on molecular size d. Based on magnetic properties

The distribution of marks for the continues assessment test (CAT) shall be as follows:

Internal Assessment (Theory) for 20 marks		
MCQ Test 1 base on 25% syllabus	Consider best 2 out of 3 test (Total performance is not less 40%)	10 Marks
MCQ Test 2 base on 50% syllabus		
MCQ Test 3 base on 75% syllabus		
Assignments /Innovative activities /GD/Seminar/ Poster presentation, quiz etc (any two activity 5 mark each)		10 Marks
Total		20 Marks

103209 Lab Practical : 4 Quantitative analysis of Biomolecules (103209)							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
4.5	II	103206	**Quantitative analysis of Biomolecules**	2	30	2Hrs	50 (25+25)
Course Objective	The objective of the course is to introduce different Biochemical and biophysical techniques to students that are used in biological research for estimation , separation and characterization of biomolecules. The emphasis is also on experimental skills in the form of practical exercises so that students can apply this knowledge to improve their understanding of the subject for better utilization of these techniques in research and will also help in their placement.						
Course Outcomes :	After Completion of this course students will be able to • Estimate carbohydrate ,amino acids , proteins , DNA , RNA, cholesterol, B-carotene , phosphorous content etc from given sample						

Sr No.	**Content of Practical (List of Laboratory Experiments/ Activities etc.)**
1	Determination of Phosphorus content in plant material (Colorimetric method)
2	Estimation of Protein by Lowry Method
3	Quantification of DNA by Diphenylamine Method
4	Determination of RNA By Orcinol Method
5	Estimation of Cholesterol by Zak's Method
6	Estimation of β- carotene in carrots
7	Determination of Protein Concentration by Bradford Method
8	Colorimetric estimation of iron in foodstuffs by ά dipyridyl method
9	Estimation of Total Sugar by Phenol Sulfuric Acid method
10	Verification of Beers law.

References	• Wilson, K. & Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology, (7th ed.), Cambridge University Press; ISBN 978-0-521-51635-8. • Boyer, R. F. (2012). Biochemistry Laboratory: Modern Theory and Techniques, (6th ed.), Boston, Mass: Prentice Hall; ISBN-13: 978-0136043027. 9 • Plummer, D. T. (1998). An Introduction to Practical Biochemistry (Yd ed.), Tata McGraw Hill Education Pvt. Ltd. (New Delhi); ISBN: 13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0 • Cooper, T.G. (2011). The Tools of Biochemistry (2nd · ed.), Wiley-Interscience Publication (New Delhi); ISBN: 13:9788126530168. • Practical manual in Biochemistry by Jairaman. • Chromatography : A Laboratory handbook of chromatography and Electrophoretic Methods (III 1975), BY Erich Haffman, Van Nostrand Reinhold, NY.

The distribution of marks for the practical examination shall be as follows:

External Evaluation		**Internal Evaluation base on CAT**	
Performance of any two	20 marks	Attendance &students performance	05 Marks
Viva-voce	05 marks	Practical Record book	05 Marks
		MCQ/ Spotting (Consider best 2 out of 3 test)	10 Marks
Total	25 Marks	**Total**	25 Marks

103213 VSC -Lab Practical 5: Biochemical and Cell Biology Techniques (103213)

List of Laboratory Experiments/Activities etc.

Level	Semester	Course code	Course Name	Credits	Teaching Hours	Exam Duration	Maximum marks
4.5	II	103209	**Biochemical and Cell Biology Techniques**	2	30	2Hrs	50

Course Objective	The objective of the course is to provide vocational traning of different biochemical and biophysical techniques to students that are used for isolation , separation and study of various properties of biomolecules . The emphasis is also on experimental skills in the form of practical exercises so that students can apply this knowledge to improve their understanding of the subject for better utilization of these techniques in research and will also help in their placement.
Course Outcomes :	After Completion of this course students will be able to • Separate serum and plasma from whole blood using centrifugation • Perform Miotosis investigation in onion root tip • Visualize Mitochondria ,animal and plant cell under microscope • Organic Solvent and ammonium sulfate fractionation of protein • Isolate starch , egg albumin and cellulose

Sr.No.	List of Laboratory Experiments/Activities etc.
1.	Efficient Blood Component Separation: Centrifugation
2.	Mitosis Investigation in Onion Root Tips
3.	Isolation and ammonium salt fractionations of proteins from plant tissues.
4.	Staining and visualization of mitochondria by Janus green stain.
5.	Extraction and solvent precipitation of proteins from plant tissues.
6.	Extraction and solvent precipitation of proteins from animal / insect tissues.
7.	Isolation of Egg Albumin
8.	Visualization of animal and plant cell by methylene blue
9.	Isolation of starch from tubers/roots/cereals.
10.	Isolation of cellulose from plant based samples

References	• Wilson, K. & Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology, (7th ed.), Cambridge University Press; ISBN 978-0-521-51635-8. • Boyer, R. F. (2012). Biochemistry Laboratory: Modern Theory and Techniques, (6th ed.), Boston, Mass: Prentice Hall; ISBN-13: 978-0136043027. 9 • Plummer, D. T. (1998). An Introduction to Practical Biochemistry (Yd ed.), Tata McGraw Hill Education Pvt. Ltd. (New Delhi); ISBN: 13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0 • Cooper, T.G. (2011). The Tools of Biochemistry (2nd · ed.), Wiley-Interscience Publication (New Delhi); ISBN: 13:9788126530168. • Practical manual in Biochemistry by Jairaman. • Chromatography : A Laboratory handbook of chromatography and Electrophoretic Methods (III 1975), BY Erich Haffman, Van Nostrand Reinhold, NY.

Internal Evaluation for VSC	
Attendance	05 Marks
Practical performance	20 Marks
Project based on practical	10 Marks
MCQ/ Spotting	10 Marks
Practical Record book	05 Marks
Total	**50 Marks**

103214 SEC : Lab Practical 6: Extraction, Separation and Purification of Biomolecules							
Level	**Semester**	**Course code**	**Course Name**	**Credits**	**Teaching Hours**	**Exam Duration**	**Maximum marks**
4.5	I	103210	**Extraction , Sepration and Purification of biomolecules**	2	60	2 Hrs	50

Course Objective	The objective of the course is to provide skills of biochemical and biophysical techniques to students that are used for separation and chacterization of biomolecules
Course Outcomes :	After Completion of this course students will be able to • Separate plant pigments using chromatography • Separate proteins using electrophoresis • Separate amino acids ,sugars, proteins. lipids using chromatographical techniques • Perform quantitative analysis of plant pigment

Sr No	List of Laboratory Experiments/Activities etc.
1	Chromatographic Separation: Plant Pigment Analysis
2	Separation of amino acids by paper chromatography.
3	Separation of sugars by paper chromatography.
4	Separation of amino acids by thin layer chromatography.
5	Preparation of cation and anion exchanger column for protein purification.
6	Separation of sugars by silica gel thin layer chromatography.
7	Preparations of various mesh size silica gel column and separation of plant pigments.
8	Qualitative analysis of plant pigments

References	• Wilson, K. & Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology, (7th ed.), Cambridge University Press; ISBN 978-0-521-51635-8. • Boyer, R. F. (2012). Biochemistry Laboratory: Modern Theory and Techniques, (6th ed.), Boston, Mass: Prentice Hall; ISBN-13: 978-0136043027. 9 • Plummer, D. T. (1998). An Introduction to Practical Biochemistry (Yd ed.), Tata McGraw Hill Education Pvt. Ltd. (New Delhi); ISBN: 13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0 • Cooper, T.G. (2011). The Tools of Biochemistry (2nd · ed.), Wiley-Interscience Publication (New Delhi); ISBN: 13:9788126530168. • Practical manual in Biochemistry by Jairaman. • Chromatography : A Laboratory handbook of chromatography and Electrophoretic Methods (III 1975), BY Erich Haffman, Van Nostrand Reinhold, NY.

Internal Evaluation for SEC	
Attendance	05 Marks
Practical performance	20 Marks
Project based on practical	10 Marks
MCQ/ Spotting	10 Marks
Practical Record book	05 Marks
Total	**50 Marks**