Sant Gadge Baba Amravati University, Amravati
Part A
Faculty: Science and Technology
Programme: M. Sc. Biochemistry

Programme: M.Sc. Biochemistry under faculty of Science and Technology in accordance with New Education Policy (NEP 23).

Programme information

M.Sc. (Biochemistry)
Programme Outcomes (POs):
Upon completion of M.Sc. (Biochemistry), students will be able to:

PO1 (Domain knowledge): demonstrate knowledge of basic concepts, principles and applications of the specific science discipline.

PO2 (Resource Utilization): cultivate the skills to acquire and use appropriate learning resources including library, e-learning resources, ICT tools to enhance knowledge-base and stay abreast of recent developments.

PO3 (Analytical and Technical Skills): achieve the ability to handle/use appropriate tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations.

PO4 (Critical thinking and Problem solving): identify and critically analyze pertinent problems in the relevant discipline using appropriate tools and techniques as well as approaches to arrive at viable conclusions/solutions.

PO5 (Project Management): demonstrate the knowledge and scientific understanding to identify research problems, design experiments, use appropriate methodologies, analyze and interpret data and provide solutions, exhibit organizational skills and the ability to manage time and resources.

PO6 (Individual and team work): exhibit the potential to effectively accomplish tasks independently and as a member or leader in diverse teams, and in multidisciplinary settings.

PO7 (Effective Communication): communicate effectively in spoken and written form as well as through electronic media with the scientific community as well as with society at large. Demonstrate the ability to write dissertations, reports, make effective presentations and documentation.

PO8 (Environment and Sustainability): analyze the impact of scientific and technological advances on the environment and society and the need for sustainable development.

PO9 (Ethics): exert a commitment to professional ethics and responsibilities.

PO10 (Self-directed and Life-long Learning): develop an ability to engage in life-long learning in the context of the rapid developments in the discipline by their own.

M.Sc. (Biochemistry) Programme Specific Outcomes (PSOs):

At the end of the programme, the students will be able to:

PSO1: Gain disciplinary knowledge and understanding of biochemistry, structure and function of biological molecules and mechanisms, such as the processes and control of bioenergetics, cell biology and physiology.

PSO2: Demonstrate an understanding of the principles and have practical experience of a wide range of biochemical techniques (e.g., analytical methods like spectrophotometry, electrophoresis, the use of standards for quantification, enzyme kinetics; macromolecular purification, etc.).

PSO3: Analyze biochemical data (e.g., in enzyme kinetics, molecular structure analysis and

biological databases) and effectively communicate scientific reasoning and data analysis in both written and oral forms.
PSO4: Explore the knowledge and practical skills for qualitative and quantitative analysis of various constituents in biological fluids for the diagnosis of clinical and genetic disorders.
PSO5: Use various bioinformatics tools and applications of programs for database searching, protein, and DNA sequence analysis.
PSO6: Evaluate the role of different enzymes in clinical diagnosis, vaccine development, food and pharmaceutical industries, research, and agriculture.

Employability Potential of the Programme:

The discipline of Biochemistry involves the study of the structure and function of biomolecules and the vital processes that occur in living organisms. It is regarded as Mother of all Biological Sciences disciplines because it unveils the chemical basis of life in all living organisms including plants, animals, and microorganisms. Biochemistry has contributed enormously to the growth of modern medical and health science and agriculture. Biochemistry has applications in clinical diagnosis, understanding pathology of diseases, treatment of diseases, designing of drugs and understanding their metabolism and manufacture of various biological products like amino acids, proteins, antibiotics, hormones, enzymes, nutrients, etc.

Understanding the biochemical basis of vital processes of plants such as photosynthesis, respiration, hormonal regulation, nutrient assimilation has helped in developing superior varieties of crop plants with better growth attributes and yield. For the estimation of pesticide residues in soil or food grain one has to rely on biochemical tests. The functions and roles of various nutrients are described only by biochemistry. The composition of food materials including the quality-milk and possible adulterations can be checked by biochemical tests. This discipline has played valuable role in farming, fishery, poultry, sericulture, bee keeping and in environmental remediation.

Students can peruse basic research work in research institutes or universities by qualifying various exams for research fellowships.

This programme includes understanding of fundamentals, acquiring practical training and application of the subject knowledge in diversified areas of Biochemistry with a clear perspective that this knowledge will equip the students to make them suitable for various Biotech, Pharma, Medicine, Agri-Biotech, Biochemical related laboratories/industries. After completing the program, candidates can expect numerous jobs in several fields.

It has always been in demand as it promises vast career opportunities to candidates in various employment sectors as it involves the study of biomolecules and biochemical techniques which helps in research and development areas. Increased environmental consciousness and demand for clean energy will lead to opportunities for biochemists focused on discovering alternative energy sources such as biofuels. Growing population and rising food prices call biochemists to advance the development of genetically engineered crops and livestock that produce higher yields.

Students can be employed in pharma-based laboratories and quality control services. They can work in food, chemicals, perfumery, oil industries, distilleries; textile industries. They can expect job opportunities in health care and paramedical laboratories, quality control assistants in analytical laboratories dealing with biochemical/clinical/Food processing/pharma industrial settings. Besides this, our students have marketing entrepreneurial opportunities.

The field of Biochemistry provides large scope in biotech-based industries, Forensic science labs, blood banks, diagnostic labs, drug discovery, medical coding, medical transcription, medical content writing etc. Students can also work as Bio-analysts in various research labs and organizations. Small companies employ biochemists to provide toxicological studies.

The students of biochemistry can also work as food technologists developing new food products or methods of detecting contaminants. Our students are employed in energy development, environmental restoration firms, laboratory technicians at Government and private pathological laboratories.

Through the present curriculum attempt has been made to generate enough interest among students so that they can pursue higher education in Biochemistry to take up the career of teaching, research or to serve the needs of medicine, nutrition, and agriculture related industrial establishments.

Part B

Syllabus Prescribed for First Year PG Programme

Programme: M.Sc. PART I (BIOCHEMISTRY)

M.Sc. PART I (BIOCHEMISTRY) EXAMINATION (Semester –I)
Examination scheme under NEP-2023 for the subject BIOCHEMISTRY

Sr. No	Subjects, Paper number, Title of the Paper	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme							
			Teaching Period Per week				Credits				Maximum Marks					Minimum Passing Marks		
											Theory		Practical					
			L	T	P	Total	L/T	P	Total		Theory Internal	Theory + MCQ External	In	Ex	Total Marks	Mks In	Mks Ex	Grade
0	*Pre-Requisite Course(s) if applicable/MOOC/Internship/Field Work cumulatively If students wish to opt Minor Course ofUG as Major for PG, **balance 12 Credits** Course will have to be completed **(As and when applicable)**	Th-pr								2	15	35			50	06	14	P
1	PAPER:RESEARCH METHODOLOGY AND IPR	RM	4			4	4		4	3	40	60			100	16	24	P
2	PAPER-I [DSC, 1BCM1] GENERAL BIOCHEMISTRY	1BCM1	4			4	4		4	3	40	60			100	16	24	P
3	PAPER-II [DSC, 1BCM2] ADVANCED ENZYMOLOGY	1BCM2	3			3	3		3	3	40	60			100	16	24	P
4	PAPER-III [DSC, 1BCM3] NUTRITIONAL BIOCHEMISTRY	1BCM3	3			3	3		3	3	40	60			100	16	24	P
5	PAPER-IV [DSE1, 1BCM4] BIOENERGETICS AND BIOLOGICAL OXIDATION/ [DSE2 1BCM4] METABOLISM AND ITS REGULATION / MOOC	1BCM4	4			4	4		4	3	40	60			100	16	24	P
6	PRACTICAL-I [LAB-1] GENERAL BIOCHEMISTRY AND ENZYMOLOGY	LAB-I			4	4		2	2	6			50	50	100	50		P
7	PRACTICAL-II [LAB-2] NUTRITIONAL BIOCHEMISTRY	LAB-II			4	4		2	2	6			50	50	100	50		P
8	# On Job Training, Internship/ Apprenticeship, Field projects Related toMajor @during vacations cumulatively		120 Hours cumulatively during vacations of S I and S II						4*									P*
9	Co-curricular Courses: Health and wellness,Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine, Applied/Visual/Performing Arts During Semester I, II, III and IV.		90 Hours Cumulatively From Sem I to Sem IV															
10	Total								**22**						**700+50***			

Total Marks 700, Total minimum and maximum credits 22

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
RM	Research Methodology and IPR	4 periods per week

PAPER-RM
Research Methodology and IPR
Number of periods per week: 4
Number of Credits: 4

Course learning outcomes (COs)

After completion of this course, students will be able to:
CO1: To understand the role of research methodology in Biochemistry
CO2: To understand literature review process and formulation of a research problem.
CO3: To learn various statistical tools for data analysis.
CO4: To learn technical writing skills required for research.
CO5: To create awareness about intellectual property rights and patents.

Unit I Introduction to Research	Meaning, definition, objectives and characteristics of research. Types of research- basic research (fundamental research), applied research, action research, descriptive research, analytical research, evaluation research, historical research, exploratory research, industrial research, development research.	10 periods
Unit II Research Process	Research design, important experimental designs, sample design. Census and sample method; theoretical basis for sampling, methods of sampling, size of sample, merits and limitations of sampling, sampling and non-sampling errors, reliability of sampling. Data and methods of data collection; types of data- primary and secondary data. Primary data collection methods- direct personal investigation, direct oral investigation schedules and questionnaires, pilot study, Information Search, Tools for Web Search.	10 periods
Unit III Scientific Writing	Research resources: reviews, abstracts, books, journal and magazine articles- Exploration and communication; Resources: online and print; Review of literature. Logical format for writing thesis and papers. Essential features of abstract, introduction, review of literature, materials and methods, and discussion. Reference styles, Citation and Acknowledgement, ISBN & ISSN. Peer review. Impact factor and H- index of journals. Understanding Plagiarism: definition, unintentional plagiarism and consequences; Collaborative work.	10 periods
Unit IV: Computer Fundamentals	Basics of Computers, In-put and Out-put devices. Computer graphics. PC based software packages, Computer application in Biology, Educational softwares, Modern computers, personnel computers, hardware, and software, Internet, Modem, freeware, Usenet, file transfer protocol, HTML, Browsers, Home page, URL, Search Engine, IP address.	10 periods
Unit V: Introduction to Biostatistics	a) Statistical application in Biology, Types of statistics used in biology, sample statistics, test statistics, parametric Vs non –parametric. Sample and Sampling: Introduction, selection of sample or sampling, theory-qualitative sample, random sample, nonrandom sample. Graphical distribution of data: Collection of data, classification of data, tabulation of data, graphic representation of data, diagrammatic representation of data. b) Measures of Central tendency: Measures of central	10 periods

	tendency, Mathematical averages, - arithmetic mean, Geometric mean, Average mean- Median and Mode.Test of Significance: Standard error of mean, standard error of standard deviation, student's t-test, chi-square test	
Unit VI: Intellectual Property Rights (IPR)	Patenting – definition of patent. Patenting and fundamental research. Product and process patents, Patent infringement, Copyright infringement and Trademarks, Procedure for patent application, Patenting of life forms – plant, animals, microbes, gene, process and products	10 periods

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
1BCM 1	General Biochemistry	4 periods per week

PAPER-I
[DSC, 1BCM 1]
General Biochemistry
Number of periods per week: 4
Number of Credits: 4.

Course learning outcomes (COs)

After completion of this course students will be able to:
CO1: Understand the physical and chemical properties of water
CO2: Understand the various orders of protein structure, classification, properties, and biological importance of proteins.
CO3: Compare and contrast the structure and functions of the oligo and polysaccharides.
CO4: Evaluate the structure and hierarchical organization of nucleic acids with their biological functions.
CO5: Acquire knowledge on the properties and functions of cholesterol and other steroids

Unit I: Properties of water	Physical and chemical properties of water, ionization and ionic product of water, structure of liquid water and ice. Unusual properties of water. Hydrophilic, hydrophobic and amphipathic molecules in aqueous solution. Effect of solutes on colligative properties of water. Importance of water in biological systems with special reference to the maintenance of native structure of biological molecules. Biological relevance of pH and pKa, determination of pKa of weak acid. Buffers, buffer action, and buffer capacity. Henderson–Hasselbalch equation, preparation of buffers. Importance of buffers in biological systems	10 periods
Unit II: Carbohydrates	Structure, function and properties of carbohydrates, Polysaccharides- Homopolysaccharides and heteropolysaccharides; starch, cellulose, glycogen, hyaluronic acid, chondroitin sulphate, chitin, xylans, bacterial cell-wall polysaccharides, blood group polysaccharides. Importance of glycoproteins and glycolipids, amino sugars, muramic acid, neuraminic acid, Glycoproteins- Glycosidic bond, N- and O-glycosylation, carbohydrates in tissue engineering. Proteoglycans- syndecan and decorin. Pectin and pectic polysaccharides. Lectins – characteristics and functions in biological system	10 periods
Unit III: Proteins	Amino acids and their classification, Structure of peptide bond, Protein classification, structural levels of proteins including primary, secondary (α helix, β pleated sheets) tertiary and quaternary structure), Ramachandran Plot, Modern approach to peptide synthesis, conformation of proteins, factors affecting protein structure, Forces involved in stabilization of protein	10 periods

	structure, Structure of fibrous proteins: K-keratin, silk fibroin and collagen, structural characteristics of myoglobin and chymotrypsin, hemoglobin, folding of proteins- Motifs (super secondary structure – triose phosphate isomerase, concanavalin-A and Rossmann fold), Denaturation and renaturation of proteins, protein sequencing , Isolation methods	
Unit IV: Lipids	a) Lipids- properties, structure, classification and functions, Occurrence, b) Introduction, structure and nomenclature of fatty acids, structure of cholesterol (derivation excluding synthesis), Chemistry of bile acids, bile salts, structural derivation of certain steroidal compounds such as testosterone, progesterone, estrogen and vitamin D, terpenoids, micelles, vesicles, liposome, mixed micelles, trans fatty acids, Eico sanoids- classification, structure and functions of prostaglandins thromboxanes, leukotrienes, lipoproteins- structure, function and mechanism of transport.	10 periods
Unit V: Nucleic acids	Chemical names, structures of Nucleosides and Nucleotides, formation of dinucleotide, and oligonucleotide, histone proteins, nucleosome, solenoid fibre, scaffold, Melting of DNA, Tm, factors affecting Tm, Cot curve, classification of DNA based on cot curve. Chargaff's rule, Watson and Crick model of DNA, A, Z models of DNA structure of RNA. Nucleic acid-isolation, separation assay methods and sequencing	10 periods
Unit VI: Porphyrins	Porphyrins and Metal ions: Role of metal ions like Fe, Cu, Zn in biological systems. Structure, classification and functions of porphyrins, metalloporphyrins and iron-sulphur clusters with suitable examples such as hemoglobin, chlorophyll and cytochrome and their role in biological systems.	10 periods

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
1BCM 2	Advanced Enzymology	3 periods per week

PAPER-II

[DSC, 1BCM 2]
Advanced Enzymology
Number of periods per week: 3
Number of Credits: 3

Course learning outcomes (COs)
After completion of this course students will be able to:
CO1: Analyze the factors that influence enzyme kinetics.
CO2: Evaluate possible catalytic mechanisms of given reaction types.
CO3: Design strategies for the analysis of kinetics mechanism of enzyme catalyzed reactions.
CO4: Elucidate the enzyme inhibitory and regulatory mechanisms.
CO5: Translate the basic concepts of enzymology to industrial and medical applications.

Unit I: Introduction to enzymes	a) Nomenclature and IUB classification of enzymes. Nature of enzymes, localization, isolation, precautionary techniques for purification, characterization of enzymes. Criteria of purity for enzymes. Active site structure. Methods of determining active site, Structure-isolation of ES complex, affinity labeling, chemical modification studies. Active site structure investigation. b) Units of enzyme activity, specificity and specific activity of enzymes. c) Oxygen binding to hemoglobin. Hill equation, homotropic and heterotrophic effectors	07 periods
Unit II: Enzyme Kinetics	Enzyme Kinetics: Rate of reaction, order and molecularity. Michaelis-Menton equation, initial velocity approach, steady state approach. Vmax, Km and their significance. Linear transformation of Michaelis-Menton equation- Line weaver Burk plot, Eadie Hofstee and Hanes- Woolf plot, Turnover number	07 periods
Unit III: Inhibition	Inhibition-Competitive, non-competitive, un-competitive and product inhibition. Irreversible inhibition-suicide inhibition. Determination of Ki. Bi-substrate Reaction- Cleland's notation with examples or ordered, Ping-Pong, and random. General rate equation. Primary and secondary plots, allosteric enzymes and allosteric regulation.	08 periods
Unit IV: Mechanism of Enzyme Catalysis	Nature of Enzyme Catalysis-Transition state theory, proximity and orientation, orbital steering, acid base catalysis, covalent catalysis, metal ion catalysis, nucleophilic Catalysis, intermolecular catalysis, entropy effects. Effect of	08 periods

	temperature and pH on enzyme catalyzed reaction	
Unit V: Coenzymes	Coenzymes and Co factors. Classification of coenzymes. Structure and coenzyme function of CoA, TPP, PLP, NAD/NADP, FAD, FMN, Biotin, folic acid, Vitamin B12 coenzymes. Concept of ES complex, Trypsin, Chymotrypsin, Ribonuclease and Lysozyme.	08 periods
Unit VI: Multi-molecular forms of enzyme	a) Multimolecular Forms-LDH, multifunctional enzyme (DNA polymerase), multi enzyme complex (PDC), feedback regulation. b) Fast Reactions- Stopped flow, temperature jump method with examples of enzymes. c) Immobilization of enzymes, Applications of enzymes in medicine and industries, abzymes d) Mode of hormonal action on enzymes, concept of receptors, agonists and antagonists.	07 periods

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
1BCM 3	Nutritional Biochemistry	3 periods per week

PAPER-III
[DSC, 1BCM 3]
Nutritional Biochemistry
Number of periods per week: 3
Number of Credits: 3

Course learning outcomes (COs)
After completion of this course students will be able to:
CO1: Understand the energy requirements of nutrients and the Recommended Dietary Allowances and their applications for normal health.
CO2: Illustrate the importance of dietary component and their physiological functions.
CO3: Explain consequence of nutritional deficiency or excess in the clinical lab diagnosis of metabolic diseases
CO4: Apply basic nutrition knowledge to obtain an adequate diet for human health.

Unit I: Energy Metabolism	Energy metabolism- energy value of foods, Respiratory quotient, Basal Metabolic Rate (BMR) – factors affecting BMR, Determination of energy metabolism during work, Energy expenditure for various types of activities, Recommended Daily Allowance (RDA) for infants, children and pregnant women, Specific Dynamic Action (SDA) of foods.	07 periods
Unit II: Nutritional aspects of Food	a) Nutritional aspects of Food Nutritional aspects of carbohydrates, lipids, proteins and fiber – sources, requirement, absorption and functions. b) Vitamins-Sources, requirements, functions and deficiency symptoms of Vitamin-C, Thiamine, Riboflavin, Pyridoxine, Folic acid, Vitamin B12. Absorption of fat-soluble vitamins-A, D, E and K. Micronutrients: Source, Daily requirement, functions and deficiency disease symptoms of Macro-minerals (Ca, P, and Cl) and micro minerals/trace elements (I, Fe, Zn and Se) Free radicals and Antioxidants.	07 periods
Unit III: Biochemical aspects of Diet	Balanced diet formulation, Determination of nutritive value of proteins, Biological value of proteins (BV), Protein efficiency ratio (PER), Digestibility coefficient, Net protein utilization, Net Protein Ratio (NPR)	08 periods
Unit IV: Diet related Diseases	Protein energy malnutrition – Kwashiorkor, Marasmus. Life Style diseases – Risk factors, Molecular pathogenesis, Biochemical and clinical features, diagnosis and treatment of Atherosclerosis, Diabetes, Cancer, Inflammatory arthritis,	08 periods

	Obesity.	
Unit V: Diseases related to absorption and digestion of foods	Diseases related to absorption and digestion of foods –LDL Hypercholesterolemia, hyperlipoproteinemia, hypertriglyceridemia, Gastritis and gastric atrophy (hyperacidity), Achlorhydria (hypochlorhydria), Ulcers – Peptic ulcer, Pancreatitis, Lactose intolerance, Monosaccharide malabsorption, Steatorrhea, Chyluria, Cholelithiasis, Sprue. Liver Diseases- Jaundice, Hepatitis.	08 periods
Unit VI: Dietetics and Diet Therapy	Introduction. Food pyramid. Diet planning and introduction to diet therapy. Nutritional requirements for different age groups, anemic child, expectant mother and lactating women. Diet planning for prevention and cure of nutritional deficiency disorders. Diet therapy: Anthropometric measurements, Prevention and correction of obesity, underweight, and metabolic diseases by diet therapy. Dietary interventions to correct and or manage the gastrointestinal diseases (indigestion, peptic ulcer, constipation, diarrhea, steatorrhea, irritable bowel syndrome. Functional foods-based diet therapy for diabetes, cardiovascular disease and cancer.	07 periods

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
1BCM 4	Bioenergetics and Biological Oxidation	4 periods per week

PAPER-IV
[DSE1, 1BCM 4]
Bioenergetics and Biological Oxidation
Number of periods per week: 4
Number of Credits: 4

Course learning outcomes (COs)
After completion of this course students will be able to:
CO1: Describe basic concepts of Bioenergetics, mechanisms of oxidative phosphorylation .
CO2: Simplify free energy and standard free energy, categorize the high energy phosphate groups, understand the ATP cycle
CO3: Demonstrate the electron transport system, structure of chloroplast, and analyze the photosynthetic system.
CO4: Elucidate the structural basis of photosynthetic pigments and their role in Photophosphorylation.

Unit I: Concept of Bioenergetics	Principle of bioenergetics: Bioenergetics and thermodynamics- biological energy transformations obey laws of thermodynamics, first and second laws of thermodynamics and their applications to biological systems; Gibbs free energy, enthalpy, entropy, and their relationships; Free energy change and direct relationship to the equilibrium constant. Coupling of energetically unfavorable and favorable reactions.	10 periods
Unit II: ATP as energy	Energy cycle and specialized role of ATP as universal currency in the biological system; free energy change for ATP hydrolysis. High phosphoryl potential of ATP- structural basis. Role of ATP in shifting the equilibrium of coupled reactions. High energy thioesters and phosphorylated compounds (other than ATP). Group transfer reactions of ATP. ATP-driven cellular processes, trans-phosphorylation. Inorganic phosphate as a potential phosphoryl donor.	10 periods
Unit III: Mitochondrial Electron transport	a) Mitochondrial Electron transport - Mitochondrial organisation,, sequence of electron carriers and site of oxidation phosphorylation, heme and non-heme iron binding proteins (Electron transport particles), flow of electron transport, water evolving complex. b) Thermodynamic consideration, Redox potential, phosphate group transfer potential, Respiratory	10 periods

	controls, Factors affecting ETC, reversible ETC.	
Unit IV: Oxidative phosphorylation	ATP synthase complex, its coupling factors, Theories of oxidative phosphorylation, Mechanism of oxidative phosphorylation coupled reactions, Uncouplers and inhibitors of energy transfer.	10 periods
Unit V: Photosynthetic Electron Transport	Ultra structure of chloroplast, Light harvesting complexes, photosystem I and II, Location and mechanism of energy transfer, Photosynthetic Electron Transport, Photo respiration	10 periods
Unit VI: Photophosphorylation	Cyclic and non-cyclic photo phosphorylation, Molecular mechanism of photo phosphorylation. Photoregulation, Inhibitors of Photophosphorylation and its mechanism.	10 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
1BCM 4	Metabolism and its Regulation	4 periods per week

PAPER-IV
Metabolism and its Regulation
[DSE2, 1BCM 4]
Number of periods per week: 4
Number of Credits: 4

Course learning outcomes (COs)

After completion of this course students will be able to:

CO1: Acquire deep knowledge about metabolism and regulation of biomolecules
CO2: Understand metabolism of mucopolysaccharides, lipids and inflammatory lipid mediators etc.
CO3: Understand metabolism of nucleotides and some biologically important amines.
CO4: Develop critical understanding in heme metabolism and mineral metabolism.

Unit I: Metabolism of Carbohydrates	Overview of glycolysis, gluconeogenesis, citric acid cycle, detailed study of regulatory mechanism and energetics. Importance of pyruvate dehydrogenase. Significance of Cori cycle. Pentose phosphate pathway- significance and regulation machinery. Biosynthesis and degradation of glycogen, detailed study of hormonal regulation and role of secondary messengers in glycogen metabolism. Biosynthesis and biochemistry of mucopolysaccharides- hyaluronic acid, chondroitin sulfate and heparin	10 periods
Unit II: Metabolism of Lipids	Biological regulation and significance of fatty acid metabolism. Metabolism of ketone bodies - Formation, utilization, excretion and clinical significance. Metabolism of triglycerides, phospholipids and sphingolipids. Fatty acid derivatives: eicosanoids, their function and metabolism. Lipoprotein metabolism and its regulation. Lipid peroxidation. Cholesterol – Biosynthesis, regulation, transport and excretion. HMG CoA reductase regulation.	10 periods
Unit III: Metabolism of Amino acids	Overview of biosynthesis of nonessential amino acids. Catabolism of amino acid nitrogen - transamination, deamination, ammonia formation and the urea cycle. Catabolism of amino acid carbon skeleton. Common enzymatic reactions of amino acid degradation – degradation of individual amino acids - regulation of amino acid metabolism.	10 periods

Unit IV: Metabolism of Nucleic acids	Nucleotide biosynthesis - de novo and salvage pathways for biosynthesis of purine and pyrimidine. Mechanism of feedback regulation. Biosynthesis of dNTPs. Mechanism of purine and pyrimidine catabolism, uric acid, xanthine oxidase inhibitors.	10 periods
Unit V: Heme metabolism	Biosynthesis and degradation of porphyrin, porphyrias. Hemoglobinopathies and Jaundice	10 periods
Unit VI: Mineral Metabolism	Major and minor and ultra trace minerals: their occurrence, functions, toxicity and interaction with other nutrients. Iron metabolism and regulation Calcium and phosphorus metabolism and regulation	10 periods

Code of the Course/Subject Title of the Course/Subject (Total Number of Periods)

(Laboratory/Practical/practicum/hands on/Activity)

Lab I General Biochemistry and Enzymology 4 periods per week

PRACTICAL-I
[LAB-I]
Number of periods per week: 4.
Number of Credits: 2.

Course learning outcomes (COs)
After completion of this course students will be able to:
CO1: Explain the principle, instrumentation and applications of colorimetric analysis of various biochemical compounds.
CO2: Quantify biomolecules with appropriate methods.
CO3: Isolate enzyme and determine enzyme activity
CO4: Study the effect of pH, temperature, substrate and inhibitor concentration on enzyme.
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Sr. no	Experiments
	Part A General Biochemistry
1.	Preparation of Buffers and Measurement of pH
2.	To determine the titration curve for an amino acid to estimate the pKa values of ionizable group.
3.	Determination of saponification value of oil/ fat
4.	Estimation of glucose by Dinitrosalicylic acid method
5.	Estimation of protein by Bradford method
6.	Estimation of total amino acids by Ninhydrin method
7.	Estimation of DNA by Diphenylamine method
8.	Estimation of RNA by Orcinol reaction
	Part B Enzymology
1.	Isolation and purification of enzyme from the given source
2.	Determination of specific activity of an Enzyme.
3.	Effect of substrate concentration on enzymatic activity

4.	Determination of optimum temperature
5.	Determination of optimum pH
6.	Preparation of MM curve and study of 3 phases of progress.
7.	Determination of activity in presence of inhibitors
8.	Determination of Enzyme activity in presence of activators.

Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands on/Activity)	**Total Number of Periods**
Lab II	Nutritional Biochemistry	4 periods per week

PRACTICAL-II
[LAB-II]
Number of periods per week: 4.
Number of Credits: 2.

Course learning outcomes (COs)
After completion of this course students will be able to:
CO1: Understand biochemical techniques that are relevant for the investigation of nutrients.
CO2: Estimate vitamins and minerals with appropriate methods.
CO3: Calculate and compare the nutrients and fibre content of cereals.
CO4: Identify adulterants present in the different food samples.
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Sr. no	Experiments
1.	Estimation of Uric acid in serum by phosphotungstic reagent
2.	Estimation of Vit. C in fruits
3.	Extraction and estimation of carotenoids from green vegetables
4.	Determination of calcium in food samples
5.	Determination of iron in food samples
6.	Determination of inorganic phosphorous
7.	Determination of total lipids.
8.	Determination of trypsin, chymotrypsin inhibitors in seeds
9.	Estimation of thiamine in cereals or food samples
10.	Estimation of crude fiber content
11.	Estimation of gluten from cereals
12.	Estimation of iodine value in oils/fat

13.	Qualitative testing of adulterants in food samples- milk, honey, turmeric powder, chilli powder

Books recommended for M.Sc. Part-I Sem I (Biochemistry)

1. Principles of Biochemistry by Lehninger
2. Biochemistry by Stryer
3. Biochemistry by Campbell
4. Text Book of Biochemistry by West & Todd.
5. Harper's illustrated Biochemistry by Robert K Murray
6. Principles of Biochemistry by White Handler & Smith
7. Textbook on Metabolism by Ravi Dabhade and Dr Pooja Rana, Nirali Publication
8. Textbook of Biochemistry & Human Physiology by G.P.Talwar.
9. Outlines of Biochemistry by Conn & Stumpf. B
10. Fundamentals of Biochemistry by I L Jain, S Chand.
11. Elementary Biochemistry by J.LJain, S.Chand & Co.
12. Biochemistry (4th edn. 1992) by Lubert Stryer WH Freeman & Co., NY
13. Satyanarayan,U (2014) Biochemistry (4th ed), Arunabha Sen Books & Allied (P) Ltd, Kolkata
14. General Enzymology, Kulkarni and Deshpande, Himalaya Publishing House.
15. Enzyme - Dixon &. Webb
16. Practical Biochemistry - Plummer (TMH Pub.)
17. Practical Biochemistry - Jayraman (Wiley Estern Pub.)
18. Enzyme Biotechnology by N Gray, M Calvin, SC Bhatia
19. Fundamentals of Enzymology (2000) by N. Price and L. Stevens.
20. Understanding Enzymes by Trevor Palmer
21. Lehninger: Principles of Biochemistry (2017) by Nelson and Cox Seventh edition
22. Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons.
23. Biochemistry Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc.(2010).

24. Enzyme Kinetics and Mechanism; Paul F. Cook, W. W. Cleland, Garland Science (2007).
25. Enzyme Kinetics; Roberts, D.V. (1977), Cambridge University Press.
26. Principles of Enzymology for Food Sciences; Whitaker, Marcel Dekker (1972) AcademicPress.
27. Enzyme Kinetics; the Steady state approach; Engel, P.C. (1981) 2nd Edn. Champman andHall
28. Nutritional Biochemistry, Tom Brody (1994) Academic Press
29. Elementary Statistical Methods by S.P. Gupta, Sultan Chand & Sons
30. Clinical Dietetics and Nutrition, 2002, Antia FP and Abraham P. Oxford University Press; 4th Edition. ISBN-10: 9780195664157.
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33. Human Nutrition and Dietitics. 1986, Passmore R. and Davidson S. Churchill Livingstone Publications
34. Zar, J.H. (1984) "Bio Statistical Methods", Prentice Hall, International Edition
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37. Rosner,B (2005), "Fundamentals of Biostatistics", Duxbury Press
38. C. R. Kothari, Quantitative Techniques, Vikas Publishing House, 3 rd Edition, 2013.
39. Deal H Glasman, Science Research Writing, Imperial College Press, 2010.
40. R. K. Surya, Biostatistics for health and life sciences, Himalaya Publishing House, 1st Edition, 2010
41. Applied Biostatistics for Health Sciences, Rossi R.J. (2010). Wiley
42. "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches" by John W. Creswell
43. How the Internet works - Preston Gralla, Techmedia.
44. The Craft of Research by Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams
45. Biostatistics - A Foundation for analysis in Health Sciences - W.D.Daniels, John wiley and Sons.
46. S.D. Sharma, "Operational Research", Kedar Nath Ram Nath & Co., 1972.

47. B.L. Wadehra,"Law Relating to Patents, Trademarks, Copyright Designs and Geographical Indications", Universal Law Publishing, 2014.
48. Organic Chemistry (6th Ed. 2000) by R.T. Morrison & R.N.Boyd
49. Applied Nutrition (3/E) by Rajalkshmi (Oxford & IBH Pub.)
50. Naomal and Therapeutic Nutrition (16/E) By Robinson/Proudfit (Oxford & IBH Publishings)

Part B

Syllabus Prescribed for <u>First</u> Year PG ProgrammeProgramme: M.Sc.
PART I (BIOCHEMISTRY)

M.Sc. PART I (BIOCHEMISTRY) EXAMINATION (Semester –II)
Examination scheme under NEP-2023 for the subject BIOCHEMISTRY

Sr. No	Subjects, Paper number, Title of the Paper	Subject Code	Teaching & Learning Scheme							Duration of Exam Hours	Examination & Evaluation Scheme							
			Teaching Period Per week				Credits				Maximum Marks					Minimum Passing Marks		
											Theory		Practical					
			L	T	P	Total	L/T	P	Total		Theory Internal	Theory + MCQ External	In	Ex	Total Marks	Mks In	Mks Ex	Grade
1	PAPER-V [DSC, 2BCM1] CLINICAL BIOCHEMISTRY	2BCM1	4			4	4		4	3	40	60			100	16	24	P
2	PAPER-VI [DSC, 2BCM2] ENDOCRINOLOGY	2BCM2	3			3	3		3	3	40	60			100	16	24	P
3	PAPER-VII [DSC, 2BCM3] ANALYTICAL BIOCHEMISTRY	2BCM3	3			3	3		3	3	40	60			100	16	24	P
4	PAPER-VIII [DSE1, 2BCM4] CELL BIOLOGY/ [DSE2, 2BCM4] ANIMAL CELL BIOTECHNOLOGY/ MOOC	2BCM4	4			4	4		4	3	40	60			100	16	24	P
5	PRACTICAL-III [LAB-3] CLINICAL BIOCHEMISTRY	LAB-III			4	4		2	2	6			50	50	100	50		P
6	PRACTICAL-IV [LAB-4] ANALYTICAL TECHNIQUES	LAB-IV			4	4		2	2	6			50	50	100	50		P
7	# On Job Training, Internship/ Apprenticeship, Field projects Related toMajor @during vacations cumulatively		120 Hours cumulatively during vacations of S I and S II						4*									P*

8	Co-curricular Courses: Health and wellness,Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine, Applied/Visual/Performing Arts During Sem I, II, III and IV.		90 Hours Cumulatively From Sem I to Sem IV												
9	Total						**18+4***						**600**		

Total Marks 600, Total maximum credits 18+4*

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
2BCM 1	Clinical Biochemistry	4 periods per week

PAPER-V
[DSC, 2BCM 1]
Clinical Biochemistry
Number of periods per week: 4
Number of Credits: 4

Course Learning Outcomes COs
After completion of this course students will be able to:
CO1: Understand the molecular and biochemical basis of human diseases.
CO2: Perform biochemical tests to diagnose the disorders of kidney, GIT and liver.
CO3: Identify and interpret the various types of blood and metabolic disorders.
CO4: Understand the significance of diagnostic enzymes.

Unit I: Evaluation Of Blood Glucose	Clinical significance of variations in blood glucose. Estimation of blood glucose by glucose oxidase peroxidase method. Various blood glucose laboratory tests: fasting blood sugar test, post-prandial blood sugar test, glucose tolerance test, glycosylated haemoglobin (HbA1c)	10 periods
Unit II: Gastric disorders	Disorders of gastric function, Methods of Evaluation, Pancreatic diseases, Steatorrhea, Malabsorption syndrome, Test for their evaluation.	10 periods
Unit III: Blood disorders	Blood: Composition and functions of various components. Mechanism of coagulation and fibrinolysis, Abnormalities in blood coagulation– Von willebrand‟s disease, Hemophilia, diagnostic test for clotting disorders, variation of plasma proteins (Properties and Function) in	10 periods

	various diseases, Abnormalities of blood formation anemias, Haemoglobinopathies, Disorders of blood cells- Hemolytic, iron deficiency and aplasticanemia, Thrombocytopenia, leucopenia, leukemia and leucocytosis.	
Unit IV: Liver disorders & Renal disorders	Jaundice, Fatty Liver and Liver function tests and Renal function tests and Renal disorder, Isoenzymes in health and diseases, Biochemical diagnosis of diseases by enzyme assay. Clinical significance of Fecal and urine analysis and clearance tests.	10 periods
Unit V: Inborn errors of metabolism	Inborn errors of metabolism- Galactosemia, fructosuria, Glycogen storage diseases –causes and symptoms Inborn errors of lipid metabolism –Taysach‟s disease, Gaucher‟s and Niemannpick‟s disease-causes and symptoms. Inborn errors of amino acid metabolism-phenyl ketonuria, Tyrosinemia, Maple syrup urine disease and alkaptonuria- causes and symptoms.	10 periods
Unit VI: Clinical Enzymology	Functional and non- functional serum enzymes – Normal levels. Clinical significance of AST, ALT, ALP, ACP, CK, γ-GT, amylase, pseudocholinesterase. Enzyme pattern in diseases- myocardial infarction and liver diseases. Isoenzymes –LD, CK and ALP. Enzymes as therapeutic agents.	10 periods

Code of the Course/Subject **Title of the Course/Subject** **(Total Number of Periods)**

2BCM 2 Endocrinology 3 periods per week

PAPER-VI
[DSC, 2 BCM 2]
Endocrinology
Number of periods per week: 3
Number of Credits: 3

Course Learning Outcomes COs

After completion of this course students will be able to:
CO1: Classify and understand the role of various hormones secreted from pituitary gland.
CO2: Understand the actions of pancreatic hormones disorders associated with their hypo and hyper secretion.
CO3: Gain insight into the biochemical nature of thyroid hormones and their regulation.
CO4: Predict the biological effects of gonadal hormones and biochemistry of reproduction.

Unit I: Introduction to Hormones	Classification, Biosynthesis, circulation in blood, modification and degradation. Mechanism of hormone action, Target cell concept – Feedback control and regulation.	07 periods
Unit II: Hormones of Hypothalamus and pituitary	Hormones of Hypothalamus and pituitary – Vasopressin and oxytocin, Hypothalamic releasing factors. Anterior pituitary hormones – actions and feedback regulation of synthesis. Growth promoting, Lactogenic hormones. Glycoprotein hormones.	07 periods
Unit III: Insulin & Glucagon	Islets of langerhans and hormone secretions, biosynthesis, secretion and mechanism of action, receptor signaling, pathway of insulin and glucagon, somatostatin. Various types of hyperglycemias, Diabetes Mellitus, Experimental diabetes, hypoglycemial polyurea	08 periods
Unit IV: Thyroid Parathyroid hormones	Synthesis, secretion, transport and mechanism of action. Metabolic fate and biological action, thyroid diseases, thyrotoxicosis, goiter, hypothyroidism, grave's disease, Hashimoto's disease, thyroid function tests, calcium and phosphorus metabolism, calcitriol, pathophysiology.	08 periods

Unit V: Gonadal Hormones and Reproduction.	Chemical Nature, Biosynthesis and metabolism of action of androgen, estrogen and progesterone. Factors involved in the regulation of gonadal hormone activities. Ovarian cycle. Pregnancy, biochemical changes in pregnancy. Invitro fertilization.	08 periods
Unit VI : Adrenal hormones	Glucocorticoids, mineralocorticoids, synthesis, secretion, transport, metabolism and excretion. Biological effects. Mechanisms of action, adrenal androgens, metabolic effects and functions. Adrenal medulla – Catecholamines, biosynthesis, storage, metabolism, regulate of synthesis. Chemical nature and biological action of prostaglandins.	07 periods

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
2BCM 3	Analytical Biochemistry	3 periods per week

PAPER-VII
[DSC, 2BCM 3]
Analytical Biochemistry
Number of periods per week: 3
Number of Credits: 3

Course learning outcomes (COs)

After completion of this course students will be able to:

CO1: Understand the principles and applications of: UV-visible, atomic absorption, infra-red, circular dichroism, fluorescence spectroscopy techniques, and related techniques of NMR, ESR and X-ray crystallography.

CO2: Design chromatographic experiments, categorize chromatography, analyze suitability of chromatographic methods.

CO3: Use techniques for separation and identification of proteins and nucleic acids using electrophoretic methods.

CO4: Apply electrophoretic methods for separation of biomolecules, interpret gel electrophoresis results

CO5: Use practical application of tracer techniques in biological system.

Unit I: Fundamentals of Analytical Techniques	Technology Fundamentals (Life Science) – General Scheme for purification of bio-components methods for studying cells and organelles. Sub cellular fractionation and marker enzymes, Methods for lyses of plant, animal, and microbial cell. Cell fractionation techniques: Cell lysis, homogenization, extraction, salting in, salting out, dialysis and ultra -filtration.	07 periods
Unit II: Centrifugation	Principle and types. Ultracentrifugation - basic principles, types of centrifuges and rotors. Preparative Centrifugation – Differential and Density gradient, Analytical Centrifugation - application and design.	07 periods

Unit III: Chromatography	Basic principles and application of Ion Exchange, gel filtration, purification, affinity, HPLC and Reverse phase chromatography, Gas chromatography, TLC and paper chromatography.	08 periods
Unit IV: Electrophoresis	Polyacrylamide/ starch / agarose gel electrophoresis, 2D-Electrophoresis, Isoelectric focusing, Southern, Northern and Western blotting.	08 periods
Unit V: Spectrophotometric techniques	UV, Visible and Infra-Red, ESR, NMR, Mass Spectroscopy, Atomic emission and absorption, X-ray diffractions, fluorescence.	08 periods
Unit VI: Tracer technique	Principle and application of tracer technique, Isotopic labeling and their measurements, Auto radiography, liquid scintillation spectrometry	07 periods

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
2BCM 4	Cell Biology	4 periods per week

PAPER-VIII
[DSE1, 2 BCM 4]
Cell Biology
Number of periods per week: 4
Number of Credits: 4

Course learning outcomes (COs)

After completion of this course students will be able to:

CO1: Learn about cell theory, cell cycle mechanisms, various cellular organelles, and their fractionation.
CO2: Acquire insight into the processes of transport across cell membranes, process of endocytosis and protein sorting/translocation to various organelles.
CO3: Gain knowledge about the concepts of various cellular signal transduction pathways
CO4: Acquire insight into the mechanisms of cellular responses under varying conditions

Unit I: Cells And Subcellular Organelles	Structural organization of eukaryotic cells. Ultrastructure of nucleus (nuclear envelope, nucleolus, nucleosome and chromatin packaging), mitochondria, endoplasmic reticulum (smooth and rough), Golgi apparatus (role in secretion, coated vesicles). Role of ER and GA in synthesis of membrane proteins; protein glycosylation, post-translational modifications, sorting, maturation and secretion of proteins. Lysosomes (primary and secondary lysosomes and their functions), peroxisomes, vacuoles and microbodies.	10 periods

Unit II: Membrane dynamics of cell organelles	Study of mitochondrial and chloroplast membranes, Dynamics of endoplasmic membrane system, Study of plasma membranes of certain cell types, Model membranes and liposomes, drug targeting.	10 periods
Unit III: Biophysical aspects of membrane	Specialized region of membranes, Membrane junction types and function. Membrane charge density, cell antigens and cell-cell recognition.	10 periods
Unit IV: Major Organs of Movement of Cellular Motility	Major Organs of Movement of Cellular Motility – Muscle Contraction: Ultrastructure Sliding filament and the cross-bridge cycle. Organization, energy transduction, control of contraction by Ca++ ions. Spasmonemes.	10 periods
Unit V: Cytoskeletal system and its activity	Cytoskeletal system and its activity – Microtubules, microfilaments and vesicles, the cytoplasmic matrix, biochemical dynamics of the cytoskeleton, amoeboid movements, pseudopod formation, sperm motility, cytoplasmic streaming cytoplasmic transport of vesicles.	10 periods
Unit VI: Cell Cycle	Cell Division and Cell cycle (Mitosis and Meiosis, their regulation, phases in cell cycle, regulation and control of cell cycle)	10 periods

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods)**
2BCM 4	Animal Cell Biotechnology	4 periods per week

PAPER-VIII
[DSE2, 2BCM 4]
Animal Cell Biotechnology
Number of periods per week: 4
Number of Credits: 4

Course learning outcomes (COs)

After completion of this course students will be able to:

CO1: Acquire deep knowledge about complete animal cell laboratory set up.
CO2: Understand various methods of cell preparation
CO3: Understand properties and differences of normal and cancerous cell line.
CO4: Develop critical understanding in various methods of cell fusion.
CO5: Apply basic cell culture techniques required for research in animal cell culture.

Unit I: Equipments and Materials for animal Cell Culture Technology	Basic Aseptic Techniques, Design of Tissue Culture Laboratory, Equipments : Laminar Flow Hoods, CO_2 incubator, Open and closed cultures, Microscopes, centrifuge, Refrigerators and Freezers, pipetting aids, Miscellaneous small items of Equipments, Materials, filters, Miscellaneous Items.	10 periods

Unit II: Characters of cells	a) Cells in primary culture, Established Cell lines, Tumor/cancer originated cells b) Nutritional Requirements of Cells and growth media: Basal salt solution (BSS), Minimum Essential Medium, Serum dependent defined media, Serum independent defined media – Cell specific media	10 periods
Unit III: Basic Techniques of mammalian cell culture	Primary Cell culture – Isolation and separation of cells, viable cell count, maintenance of cell culture, Types of cell cultures – a. Monolayer b. Suspension c. Clone culture d. Mass culture-microcarrier culture (monolayer) e. Stem cell culture Contamination Testing of Culture, Viability measurement and cytotoxicity, Measurement of growth parameters, Cell cycle analysis and Synchronization of culture	10 periods
Unit IV: Cell Preparation methods	Cell surgery Methods: Preparation of anucleated cells and polykaryon cells, Preparation of ghost RBCs., Preparation of mini cells, microcells, Surgical manipulation of in vitro fertilization	10 periods
Unit V: Cell Fusion Methods	Fusogens : Virus induced, Chemical induced, Liposome induced (Preparation of liposomes and use) Hybridoma cell preparations and their properties, Use of Hybridoma technology: eg. MAB and other related techniques, Mini cells, micro cells and anucleated cells in fusion and their application	10 periods
Unit VI: Applications of Animal Cell Culture	Evaluation of Chemical carcinogenicity, Cell malignancy Testing, Toxicity Testing, Karyotyping and cytogenetic characterization	10 periods

Code of the Course/Subject	Title of the Course/Subject (Laboratory/Practical/practicum/hands on/Activity)	Total Number of Periods
Lab III	Clinical Biochemistry PRACTICAL-III [LAB-III] Clinical Biochemistry Number of periods per week: 4 Number of Credits: 2	4 periods per week

Course learning outcomes (COs)
After completion of this course students will be able to:
CO1: Estimate different physiological parameters from human samples and clinical interpretation.
CO2: Enumerate differential blood cell types useful in haematological studies
CO3: Quantitatively analyze blood constituents and assay enzymes of diagnostic importance
CO3: Interpret the result patterns in relation to normal level.
CO4: Analyze normal and abnormal constituents of urine.

1	Hematology a) Enumeration of White blood cells, Leukocytosis and Leukopenia. b) Enumeration of Red blood cells and haemoglobin estimation. c) Classification of anemias d) Differential W.B.C. count. e) Peripheral blood smears in Leukemias and hematological disorders f) Erythrocyte sedimentation Rate (ESR), MCV, PCV, bleeding time, Clotting time, and Prothrombin time. g) Immunoelectrophoresis.
2	a) Serum protein Fractionation b) Serum lipoprotein and glycoprotein Electrophoretic pattern.
3	Liver Function Tests. a) Vander Berg Test and bilirubin thymol Turbidity tests. b) SGOT, SGPT, LDH and alkaline and acid phosphatase
4	Kidney Function Tests: Blood Urea, Urea Clearance, Phenol red clearance, P-amino hippuric acid clearance.
5	Adrenal Function Tests: Vanillylmandelic acid Excretion, Ketosteroid and Ketogenic steroid excretion
6	Glucose tolerance test
7	Urine analysis- Normal and Abnormal
8	Assay of serum Na+, K+ and Ca++ by flame photometry
9	Electrophoresis of Hemoglobin and Isoenzymes

Code of the Course/Subject	**Title of the Course/Subject** (Laboratory/Practical/practicum/hands on/Activity)	**Total Number of Periods**
Lab IV	Analytical Biochemistry PRACTICAL-IV [LAB-IV] Analytical Techniques Number of periods per week: 4 Number of Credits: 2	4 periods per week

Course learning outcomes (COs)
After completion of this course scholars will be able to:

CO1: Understand the principles and estimation of biomolecules by using colorimetric, chromatographic, and spectroscopic methods.
CO2: Perform chromatographic procedures for amino acids and sugars

CO3: Isolate, Identify and observe cell organelles and cell division.
CO4: Develop electrophoretic separation and purification techniques for proteins.

Sr. no	Experiment
1	Separation and identification of amino acid mixture by – i) Paper chromatography technique ii) Paper Electrophoresis technique
2	Separation of amino acids/sugars by TLC
3	Separation of proteins by gel filtration
4	Estimation of protein by UV Spectrophotometer by E280/E260 method
5	Separation of amino acids by ion exchange chromatography
6	Estimation of DNA by spectrophotometric method
7	Isolation of plant pigments by column chromatography
8	To isolate mitochondria from cell through differential and density gradient centrifugation
9	To isolate chloroplast and estimate the chlorophyll concentration from spinach leaves
10	To study mitosis in onion root tips
11	Enumeration of WBC (Total leukocytes count) by hemocytometer
12	Measurement of size of cell and subcellular components (nucleus) in light microscope
13	Study/Educational tour and submission of report

M. Sc. I Sem I and Sem II Biochemistry Theory Examination scheme

40: 60 pattern

Marks distribution for Theory Internal: 40 marks

Activities	Marks
Unit test	30
Assignment/ Seminar/ Group Discussion/ Any innovative activity	10
Total	**40**

Marks distribution for Theory External: 60 marks, Duration of Exam: 03 hours

Pattern	**Marks**
Long and short questions (Each unit carry 10 marks 10X6=60) • Each Long answer question: 07 marks • Each Short answer question: 03 marks	60
Total	**60**

M. Sc. I Sem I and Sem II Biochemistry Practical Examination scheme

Total Practical Marks: 100, Duration of Exam: 06 hours			
Internal Practical exam: 50 marks		**External Practical Exam: 50 marks**	
Activities	Marks	Performance	Marks
Attendance /student's performance/Activity Report	10	Long Experiment performance	25
Practical Record Book	10	Short Experiment performance	15
Internal viva	10	External Viva	10
Spotting/quiz	20		
Total	**50**	**Total**	**50**

Books recommended for M.Sc. Part-I Sem II (Biochemistry)

1. Principles of Biochemistry by Lehninger
2. Biochemistry by Stryer
3. Biochemistry by Campbell
4. Text Book of Biochemistry by West & Todd.
5. Harper's illustrated Biochemistry by Robert K Murray
6. Principles of Biochemistry by White Handler & Smith
7. Textbook on Metabolism by Ravi Dabhade and Dr Pooja Rana, Nirali Publication
8. Textbook of Biochemistry & Human Physiology by G.P.Talwar.

9. Outlines of Biochemistry by Conn & Stumpf. B
10. Biophysical Chemistry by Upadhyay & Nath, Himalaya publication
11. Fundamentals of Biochemistry by I L Jain, S Chand.
12. Elementary Biochemistry by J.LJain, S.Chand & Co.
13. Advances in Chromatography (In two vo1umes)by Giddings, S.Chand & Company.
14. Instrumental Methods of Analysis by Willard Merritt Dear CBS, Publication.
15. Cell physiology by Swami (Oxford & IBH Publishings)
16. A Hand book of Modem Physiology (c) by Pal/(Oxford & IBH Publishings)
17. Handbook of Clinical Genetics (C) by Talukdar/Sharms, Oxford & IBH Publishings) .
18. Principles and Techniques of Practical Biochemistry (4th ed 1999) by K.Wilson and J.Walker (eds.) Cambridge Univ. Press.
19. Biochemistry by U Satyanarayan, U Chakrapani
20. Cell and Molecular Biology (8th Ed. 2001) by E D P de Robertis& E M F de Robertis (Jr.) LIppincott Williams & Wilkins, Philadelphia.
21. Principles of Cell Biology (1988) by Klein Smith and M.Kish, Harper-CeIlins Pub.Inc.New Delhi.
22. Text Book of Medical Physiology (10th Ed. 2001) by A.C.Guyton & J.E.Hall, Harcourt Asia.
23. Biochemistry (4th edn. 1992) by Lubert Stryer WH Freeman & Co., NY
24. Biophysical Chemistry - Upadhyay & Nath (Himalaya Pub.)
25. Practical Biochemistry - Plummer (TMH Pub.)
26. Practical Biochemistry - Jayraman (Wiley Estern Pub.)
27. Physical Biochemistry - Morrison (Oxford)
28. The Cell: A Molecular Approach (2018) 8th ed., Cooper, GM, Oxford University Press.
29. Textbook of Medical Laboratory Technology, II Godkar P.B. and Godkar D.P. Edition, Bhalani Publishing House
30. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc
31. Clinical Biochemistry: Metabolic and Clinical Aspects (2014) 3rded., Marshall WJ, Churchill Livingstone
32. Clinical Biochemistry (2018) 6thed., Murphy M, Srivastava R and Deans K, Elsevier
33. Textbook of Medical Biochemistry (7th ed), M.N.Chatterjee and Rana Shinde
34. Text Book of Endocrinology, Larsen PR Williams (10th ed) Saunders

35. Textbook of Endocrinology Wilson JD and Foster DW Williams, (9th ed) Saunders
36. Hormones and the endocrine system B. Kline and W.G. Rossmanith,. Springer, 2016.
37. Genetic Biochemical Disorders - Benson and Fenson
38. Cell physiology by Swami (Oxford & IBH Publishings)
39. Biochemical basis of Inherited diseases by Fredrickson
40. Cell Biology (2005) by SC Rastogi. Third edition, Tata McGraw Hill Publishing Co, New Delhi.
41. Cell Biology (2012) by G. Karp. Seventh edition, Wiley.
42. The vitamins, Fundamental aspects in Nutrition and Health (2008); G.F. Coombs Jr. Elsevier's Publications.