B.Sc. Degree in Biochemistry
Scheme of Examination

Title of the paper	Contact hours/ week	Exam. hour	IA	Marks	Total Marks	Credits
First Semester						
Biochemistry-I: BCT 101 **Chemical Foundations of Biochemistry**	4	3	20	80	100	3
Biochemistry Practical-I: BCP 102 **Experimental Biophysical Chemistry**	4	3	10	40	50	2
Second Semester						
Biochemistry-II: BCT 201 **Bioorganic Chemistry**	4	3	20	80	100	3
Biochemistry Practical-II: BCP 202 **Experimental Bioorganic Chemistry**	4	3	10	40	50	2
Third Semester						
Biochemistry-III: BCT 301 **Biomolecules**	4	3	20	80	100	3
Biochemistry Practical-III: BCP 302 **Experimental Qualitative analysis of Biomolecules**	4	3	10	40	50	2
Elective Paper- III: BCE 303 **Cell Biology**	4	3	10	40	50	2
Fourth Semester						
Biochemistry-IV: BCT 401 **Analytical Biochemistry**	4	3	20	80	100	3
Biochemistry Practical-IV: BCP 402 **Experimental Analytical Biochemistry**	4	3	10	40	50	2
Elective Paper –IV: BCE 403 **Food- Environmental Biochemistry & Hematology**	4	3	10	40	50	2
Skill Enhancement(Project Work): BCPW-604 **Project Work*** (Student can opt this paper either in IV,V, VI Semester)	4	3	10	40	50	2
Fifth Semester						
Biochemistry-V: BCT 501 **Human Physiology and Clinical Biochemistry**	4	3	20	80	100	3
Biochemistry-V: BCT 502 **Molecular Biology**	4	3	20	80	100	3
Biochemistry Practical-V: BCP 503 **Experimental Human Physiology**	4	3	10	40	50	2

Clinical Biochemistry and Molecular Biology						
Sixth Semester						
Biochemistry-VI: BCT 601 **Enzymology and Metabolism**	4	3	20	80	100	3
Biochemistry -VI: BCT 602 **Nutrition and Immunology**	4	3	10	80	100	3
Biochemistry Practical-VII: BCP 603 **Experimental Enzymology Metabolism, Nutrition and Immunology**	4	3	10	40	50	2

***Note : Students can complete the Project work (BCPW-604) in either IV,V or VI Semester**

Theory question paper pattern:

Each theory question paper has three Sections;

1. 25% of the marks seeking short answers; Students have to answer all the questions of 2 marks each.
2. 37.5% of marks seeking medium size answers: Student has to answer 6 out of 8 questions of 5 marks each.
3. 37.5% of question seeking comprehensive answers: Student has to answer 3 out of 4 questions of 10 marks each. These questions may include sub questions (5+5).

Internal Assessment: Tests: 10 Marks (two internal tests to be conducted and average is considered for assessment).

SEMESTER III

Program Name	**B.Sc. Biochemistry**	**Semester**	**III**
Course Title	**Biomolecules**		
Course Code	BCT 301	No of Credits	3
Contact Hours	56 Hours	Duration of SEA/ Exam	3 Hours
Formative Assessment	20	Summative Assessment	80

Course Outcomes:

1. Understand the classification, structure, and biological roles of carbohydrates, proteins, lipids, and nucleic acids.
2. Learn the chemical reactions and physical properties of biomolecules.
3. Comprehend the structural organization of proteins and nucleic acids.
4. Analyze the role of biomolecules in cellular function and metabolism.

UNIT-I 14 Hours

Carbohydrates: Definition, classification, biological importance.
Monosaccharides: Configuration relationship of D-aldoses, D-ketoses. General properties of aldoses and ketoses. Oxidation, reduction, reducing property, formation of glycosides, acylation, methylation, condensation–phenyl hydrazine, addition–HCN. Inter-conversion of aldoses and ketoses by chemical method. Ascending and descending the series by chemical methods. Structure and biological importance of amino sugars, deoxy sugars, sugar acids neuraminic and muramic acid.
Disaccharides: Structures and biological importance of sucrose, lactose, maltose, trehalose and isomaltose.
Polysaccharides: Partial structure, occurrence and importance of starch, glycogen, inulin, cellulose, chitin, and pectin.
Glycosaminoglycans: Occurrence, importance and structure of heparin, hyaluronic acid. Bacterial cell wall polysaccharide, peptidoglycans.

UNIT-II 14 Hours

Amino acids: Structure and general classification of amino acids based on composition, Essential and non essential amino acids. Biological importance, Structure & Shape. Structure and stereochemistry. Reactions of the amino groups with HNO_2, $LiAlH_4$, ninhydrin, phenyl isothiocyante, dansyl chloride, fluro dinitro

benzene. Zwitterions. pKa values. Reaction of carboxyl group–Hydrazine. D&L notation.

Peptides: Peptide bond, structure and biological importance of glutathione, valinomycin. Synthetic peptides-poly glutamic acid.

Proteins: General Classification of proteins, classification based on solubility, structure and functions with examples.

Structure of Proteins: Primary, Secondary (α Helix.β-sheet, β-bend), Tertiary (myoglobin) and Quaternary (hemoglobin) Structure with Suitable examples. Methods of determining Protein Structure by end group Analysis: N and C-terminal amino acids, amino acid composition. Sequencing by Edman's degradation method. Denaturation and Renaturation of proteins. Anfinsen's experiment.

UNIT-III 14 Hours

Lipids: Classification and biological role. Fatty acids– Nomenclature of saturated and unsaturated fatty acids. Physiological properties of fatty acids, omega 3 and omega 6 fatty acids. Sources of fats, invisible fat, essential fatty acids and their biological importance. Saponification, saponification value, iodine value, acid value and significance. Acylglycerols: Mono, di and tri acyl glycerols.

Phospholipids: Structure of lecithin, cephalins, phosphotidylinositol, plasmalogens, and cardiolipin. Biological role of phospholipids.

Sphingolipids: Structure and importance of sphing omyelin.

Eicosanoids: Structure and biological roles of arachidonic acid, prostaglandins, thromboxane, leukotrienes.

UNIT-IV 14 Hours

Nucleic acids: Composition of DNA and RNA, nucleosides and nucleotides. Functions of nucleotides, source of energy, component of coenzyme and second messengers. Chargaff's rule. Watson and Crick model of DNA. Nucleic acid chemistry- UV absorption, Effect of alkali and acid on DNA, Chemical reactions of RNA and DNA. Melting temperature of DNA (Tm). Types of RNA (mRNA, tRNA and rRNA), Secondary structures of tRNA – clover leaf model.

Suggested Readings:

1. A.L., Lehninger, Principles Of Biochemistry (1982), Worth Publishers, Inc. New York.
2. E.E. Conn and P.K. Stumpf. Outlines of Biochemistry (1976) Wiley Eastern, New Delhi.
3. Biochemistry by L. Stryer 1995) W.H. Freeman Press, SanFrancisco, USA.
4. Biochemistry, by Voet, D. and Voet, J.G. (2004). 3rd Edition, John Wiley & Sons, Inc. USA.

5. Biochemistry by U. Sathyanarayana Books and Allied (P) Ltd. Kolkata, ISBN0-87893-214-3, (2014).
6. Textbook of Biochemistry by J.L Jain(2016)
7. Medical Biochemistry by Ramakrishnan (2012)
8. Text Book of Biochemistry by D.M. Vasudevan (2018)
9. Text Book of Biochemistry byA.C.Deb,9threvisededition(2017)

Course Articulation Matrix Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓		✓	✓								
CO 2		✓			✓					✓		
CO 3	✓	✓					✓					
CO 4	✓				✓	✓				✓		

PRACTICAL- III

Program Name	**B.Sc. Biochemistry**	**Semester**	**III**
Course Title	**Experimental Qualitative analysis of Biomolecules**		
Course Code	BCP 302	No of Credits	2
Contact Hours	04 Hours/ Week	Duration of SEA/ Exam	3 Hours
Formative Assessment	10	Summative Assessment	40

Course Outcomes:

1. Perform qualitative tests to identify carbohydrates, proteins, amino acids, nucleic acids, and lipids.
2. Gain skills in interpreting biochemical color reactions.
3. Learn analytical procedures to test for food adulterants and estimate biochemical constituents.
4. Develop competence in handling and processing various biological samples.

Experiments:

1. Qualitative analysis of carbohydrates– Molisch, Benedict's/ Fehling's, picricacid, Barfoed's, Bial's, Seliwanoff's, osazonetests. Colorreactions of Glucose, fructose, lactose, maltose and sucrose.
2. Qualitative analysis of proteins: Albumin and casein
3. Qualitative analysis of proteins**:** Color reactions of proteins– Biuret,

xanthoproteic, Millon's.

4. Qualitative analysis of amino acids– color reactions of amino acids like tryptophan, tyrosine, cysteine, methionine, arginine, proline and histidine.
5. Estimation of amino acid by formal titration.
6. Qualitative analysis of lipids–solubility, acroleintest, Salkowskitest, Lieberman- Burchard test.
7. Qualitative tests for nucleic acid.

Suggested Readings:

1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer, 2011
2. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology 8th Edn Andreas Hoffman and Samuel Clockie, Ed., Cambridge University Press, 2018.
3. Biochemistry and Molecular Biology; 5th Edn. Papachristodoulou, A. Snape, W.H. Elliott, and D.C. Elliott, Oxford University Press, 2014

Course Articulation Matrix Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓	✓	✓	✓		✓						
CO 2			✓	✓						✓		
CO 3	✓	✓	✓		✓							
CO 4	✓	✓	✓	✓				✓		✓		

SEMESTER IV

Program Name	**B.Sc. Biochemistry**	**Semester**	**IV**
Course Title	**Analytical Biochemistry**		
Course Code	BCT 401	No of Credits	3
Contact Hours	56 Hours	Duration of SEA/ Exam	3 Hours
Formative Assessment	20	Summative Assessment	80

Course outcomes:

1. Understand principles of sample preparation and biochemical separation techniques.
2. Learn the operational principles of chromatographic, electrophoretic, and spectroscopic methods.
3. Gain insight into clinical and forensic biochemical analysis.
4. Explore the role of radioisotopes in biological investigations.

UNIT I: 14 Hours

Introduction and cell disruption methods, extraction of macromolecules from tissues; liquid-liquid, liquid-solid and precipitation methods. Indian knowledge system in the preparation of herbal formulations and macromolecules- herbal decoction, Arishta, Lehya, churna, bhasma, herbal oil, herbal creams. Historical perspectives of Ayurvedic medicines.

Centrifugation- Introduction, principles of centrifugation, Sedimentation, angular velocity, centrifugal field, relative centrifugal field. Types of centrifugations- Preparative and analytical. Differential, density gradient and ultra-centrifugation. Basic instrumentation; types of rotors and their design. Laboratory centrifuge; operational instruction and applications. Analytical Centrifuges- Optics, Sedimentation coefficient.

UNIT II: 14 Hours

Chromatography: General principles of chromatography, Classification based on matrices-thin layer chromatography, Paper chromatography - ascending, descending and circular, 2-D chromatography, Rf value. Classification of chromatography based on separation: Principles, methodologies and applications of adsorption, partition, ion-exchange, gel-filtration and affinity-chromatography. Advanced chromatography- GC, HPLC

UNIT III: 14 Hours

Electrophoresis: General principle of electrophoresis and types of electrophoresis- paper, agarose, polyacrylamide electrophoresis. Chemistry of polymerization of acrylamide gels, methodology and applications of native PAGE and SDS- PAGE, Identification of proteins post electrophoresis- dyes. Applications of electrophoresis and isoelectric focusing.

Radio isotopic methods: Radioactivity–Types of radioactive decay, properties of α, β, γ radiations. Decay law- decay constant, half-life period and average life of a radioactive element. Detection of radioactivity – GM counter and scintillation counters (principle and procedure) Applications of radioisotopes – ^{3}H, ^{14}C, ^{131}I, ^{60}Co

and ^{32}P. Biological effects of radiations. Safety measure in handling radio isotopes.

UNIT IV: 14 Hours

Spectroscopic methods: Wave particle duality of light, electromagnetic spectrum, transition in spectroscopy. Beer-Lambert law and its limitations, determination of molar absorption coefficient of molecules. Working principle and application of a colorimeter, principle, design and application of UV-visible spectrophotometer, flame photometer and fluorimeter. Principle and application of IR, Raman and NMR spectroscopy.

Suggested Readings:

1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer 2011.
2. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology 8thEdn. Andreas Hoffman and Samuel Clockie, Ed., Cambridge University Press, 2018.
3. Biochemistry and Molecular Biology; 5th Edn. D. Papachristodoulou, A.Snape, W.H. Elliott, and D.C. Elliott, Oxford University Press 2014.

PEDAGOGY: MOOC/ DESKWORK/ BOOK CHAPTER/ PROBLEM SOLVING/ ASSIGNMENT

Course Articulation Matrix Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓								✓			
CO 2			✓	✓						✓		
CO 3	✓		✓	✓		✓						
CO 4	✓	✓			✓					✓		

PRACTICALS IV

Program Name	**B.Sc. Biochemistry**	**Semester**	**IV**
Course Title	**Experimental Analytical Biochemistry**		
Course Code	BCP 402	No of Credits	2
Contact Hours	04 Hours/ Week	Duration of SEA/ Exam	3 Hours
Formative Assessment	10	Summative Assessment	40

Course outcomes:

1. Acquire hands-on training in basic analytical techniques like centrifugation and chromatography.
2. Develop proficiency in electrophoretic and spectrophotometric techniques.
3. Understand sample handling and preparation for biochemical analysis.
4. Apply instrumentation knowledge in research-based biochemical investigations.

Experiments:

1. Preparation of human lymphocytes using clinical centrifuge
2. Determination of packed cell volume/hematocrit
3. Separation of amino acids by ascending, descending and circular paper chromatography.
4. Separation of plant pigments by thin layer chromatography.
5. Separation of plant pigments by adsorption chromatography
6. Colorimetric estimation of glucose by DNS method
7. Estimation of Protein by Biuret method
8. Estimation of DNA by diphenylamine method
9. Estimation of RNA by orcinol method
10. Electrophoretic separation of plasma proteins

Suggested Readings:

1. Plummer DT. *An Introduction to Practical Biochemistry*. 3rd ed. New Delhi: Tata McGraw-Hill; 2001.
2. Jayaraman J. *Laboratory Manual in Biochemistry*. New Delhi: New Age International Publishers; 1981.
3. Sadasivam S, Manickam A. *Biochemical Methods*. 3rd ed. New Delhi: New Age International Publishers; 2008.
4. Wilson K, Walker J. *Principles and Techniques of Biochemistry and Molecular Biology*. 7th ed. Cambridge: Cambridge University Press; 2010.
5. Sawhney SK, Randhir Singh. *Introductory Practical Biochemistry*. 2nd ed. New Delhi: Narosa Publishing House; 2000.

Course Articulation Matrix Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓	✓	✓	✓					✓			
CO 2	✓		✓	✓								
CO 3	✓	✓	✓	✓	✓			✓				
CO 4	✓	✓	✓	✓	✓							

PEDAGOGY: MOOC/ DESKWORK/ BOOK CHAPTER/ PROBLEM SOLVING/ ASSIGNMENT

SEMESTER V

Program Name	**B.Sc. Biochemistry**	**Semester**	**V**
Course Title	**Human Physiology and Clinical Biochemistry**		
Course Code	BCT 501	No of Credits	3
Contact Hours	56 Hours	Duration of SEA/ Exam	3 Hours
Formative Assessment	20	Summative Assessment	80

Course Outcomes:

1. Understand physiological systems and biochemical basis of digestion, respiration, and excretion.
2. Study the biochemical role of blood constituents and neurological functions.
3. Explore the acid-base balance and its physiological regulation.
4. Analyze biochemical markers in clinical diagnostics and disease conditions.

UNIT I: 14 Hours

Digestive System and GIT: GIT and accessory organs, Digestion, absorption & transport of carbohydrates, lipids and proteins.
Blood- Blood volume, composition and functions. RBC, WBC and platelets- structure and functions. Mechanism of blood coagulation.

UNIT II: 14 Hours

Nervous System: Types of neurons, Generalized structure of multipolar neuron. Resting membrane potential, Action potential. Transmission of nerve impulse along an axon and across synapse. Neurotransmitters.
Muscle: Types of muscles and their structure. Ultrastructure of skeletal muscle. Contractile and regulatory proteins of skeletal muscle. Sliding filament model of skeletal muscle contraction.

UNIT III: 14 Hours

Respiratory System: Functions of lungs, mechanism of respiration (pulmonary ventilation), gas exchange mechanism, Biochemical events in transport of CO2 and O2 in blood. **Excretory System:** Structure of nephron. Formation of urine- Glomerular filtration, tubular reabsorption and tubular secretions.

Acid-Base balance: Blood buffers- Bicarbonate, phosphate and protein buffer system. Role of lungs and kidney in acid- base balance.

UNIT IV: 14 Hours

Urine: Normal composition of urine- volume, specific gravity. Constituents- urea, uric acid, creatinine, pigments and their clinical significance in brief. Kidney disorder.
Blood: Normal constituents of blood. Urea, Uric acid, Creatinine, Glucose, Bilirubin, Total protein, Albumin/ globulin ratio- Variation in pathological conditions. Lipid Profile- Cholesterol, Triglycerides, lipoproteins, HDL and LDL

Suggested Readings:

1. Fundamentals of Biochemistry-JL Jain, S. Jain and N.Jain (2000), S. Chand.
2. Lenhinger's biochemistry- Nelson and Cox (2005) CBS Publishers.
3. Biochemistry- U. Sathyanrayana and U.Chakrapani (2006).
4. Textbook of Physiology- A.K. Jain (2005). APC.

Course Articulation Matrix Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓		✓					✓				
CO 2	✓	✓		✓								
CO 3	✓	✓	✓		✓							
CO 4	✓		✓	✓	✓			✓				

SEMESTER V

Program Name	**B.Sc. Biochemistry**	**Semester**	**V**
Course Title	**Molecular Biology**		
Course Code	BCT 502	No of Credits	3
Contact Hours	56 Hours	Duration of SEA/ Exam	3 Hours

Formative Assessment	20	Summative Assessment	80

Course Outcomes:

1. Learn molecular mechanisms of DNA replication, transcription, and translation.
2. Understand gene structure, regulation, and mutations.
3. Explore techniques of genetic engineering and recombinant DNA technology.
4. Analyze applications of molecular biology in medicine and biotechnology.

UNIT I: 14 Hours

Historical perspective: Central dogma of molecular biology and its modification. DNA as genetic material- Griffith and Hershey Chase experiment.
Replication of DNA: Semiconservative mechanism, Meselson and Stahl experiment. Enzymes and regulatory proteins involved in replication, Mechanism of replication in prokaryotes. Fidelity of replication.

Transcription: Prokaryotic RNA synthesis, Role of RNA polymerase. Initiation, elongation and termination. Reverse transcription. Outlines of eukaryotic transcription, post-transcriptional process- mRNA splicing, cap addition and poly A tail addition.

UNIT II: 14 Hours

Genetic Code: Triplet codon, universal features of genetic code, Wobble hypothesis.
Protein biosynthesis: Activation of amino acids, aminoacyl tRNA synthesis, Initiation, elongation and termination of protein synthesis in prokaryotes and Eukaryotes. Protein translation inhibitors (any three examples) Post translational modifications, Protein sorting and targeting.

UNIT III: 14 Hours

Concept of gene: Functional units in prokaryotic and eukaryotic gene- promoter, introns and exons. Gene expression in prokaryotes, concept of operon, Lac-Operon, Tryptophan Operon.
Mutation and DNA repair: Concept of mutation and mutagens- effect of HNO_2, Alkylating agents, Inter-chelating agents and UV- radiation. Concept of Point mutation and frameshift mutation. DNA repair.

UNIT IV: 14 Hours

Genetic Engineering: Basic principles of recombinant DNA technology. Cutting of DNA by restriction endonucleases- staggered cut and blunt cut. Vectors, Plasmids- PBR322. Insertion of foreign DNA into vectors. Transfection of vectors into host cell. cDNA. Principle of polymerase chain reaction and its application. Blotting techniques- Principle of Southern, Western and Northern blotting. DNA fingerprinting. RFLPs. Transgenic plants, Transgenic animals. Gene Therapy, Human genome project. Application of Genetic Engineering.

Suggested Readings:

Course Articulation Matrix Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓	✓										
CO 2	✓	✓	✓	✓								
CO 3	✓	✓		✓								
CO 4	✓	✓	✓	✓				✓				

PRACTICAL-V

Program Name	**B.Sc. Biochemistry**	**Semester**	**V**
Course Title	**Experimental Human Physiology, Clinical Biochemistry and Molecular Biology**		
Course Code	BCP 503	No of Credits	2
Contact Hours	04 Hours/ Week	Duration of SEA/ Exam	3 Hours
Formative Assessment	10	Summative Assessment	30

Course Outcomes:

1. Identify normal and abnormal constituents in urine through qualitative analysis.
2. Estimate important clinical biomarkers like glucose, urea, creatinine, and iron.
3. Perform isolation of DNA, and apply electrophoretic technique analyze nucleic acids.

4. Gain practical exposure to molecular biology protocols and tools.

Experiments:

1. Qualitative analysis of organic and inorganic constituents of urine.
2. Qualitative analysis of abnormal constituents of urine.
3. Determination of titrable acidity of urine.
4. Estimation of creatinine.
5. Estimation of Urea by DAM method
6. Estimation of Uric acid.
7. Estimation of iron
8. Estimation of inorganic phosphate by Fiske-Subba Rao method.
9. Isolation of DNA from banana/endosperm of coconut/ bacteria / any other source
10. Purity check by UV spectrophotometer (DNA and RNA ratio)
11. Isolation of plasmid from E. coli
12. Agarose gel electrophoresis of nucleic acids

Suggested Readings:

6. Plummer DT. *An Introduction to Practical Biochemistry*. 3rd ed. New Delhi: Tata McGraw-Hill; 2001.
7. Jayaraman J. *Laboratory Manual in Biochemistry*. New Delhi: New Age International Publishers; 1981.
8. Sadasivam S, Manickam A. *Biochemical Methods*. 3rd ed. New Delhi: New Age International Publishers; 2008.
9. Wilson K, Walker J. *Principles and Techniques of Biochemistry and Molecular Biology*. 7th ed. Cambridge: Cambridge University Press; 2010.
10. Sawhney SK, Randhir Singh. *Introductory Practical Biochemistry*. 2nd ed. New Delhi: Narosa Publishing House; 2000.

Course Articulation Matrix Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓							✓				
CO 2	✓	✓	✓	✓				✓				
CO 3	✓		✓	✓								
CO 4	✓							✓				

VI SEMESTER

Program Name	**B.Sc. Biochemistry**	**Semester**	**VI**
Course Title	**Enzymology and Metabolism**		
Course Code	BCT 601	No of Credits	3
Contact Hours	56 Hours	Duration of SEA/ Exam	3 Hours
Formative Assessment	20	Summative Assessment	80

Course Outcomes:

1. Understand enzyme structure, function, kinetics, and regulation.
2. Study catabolic and anabolic pathways of carbohydrates, lipids, amino acids, and nucleotides.
3. Analyze mechanisms of biological oxidation and energy transduction.
4. Explore metabolic disorders and clinical applications of enzymes

UNIT I: 14 Hours

Enzymes: Introductory aspects, General characteristics, co-factors, coenzyme and metal ions. Classification of enzymes based on IUB with examples. Unit of enzymes, activity-specific activity. Enzyme specificity. Concept of active site. Theories of enzyme catalysis-Lock and key model, Koshland's induced fit theory. Regulation of enzymes. Enzyme Kinetics: Factors affecting rate of enzyme catalyzed reaction. Effect of substrate, enzyme, product concentration, pH, temperature. Michali's-Menton equation (Derivation not required). Lineweaver-Burk plot. Determination of Vmax and Km from L-B plot and its significance. K cat and turnover number (only definition)

Enzyme Inhibition: Competitive, noncompetitive and uncompetitive inhibition. Graphical representation by L-B plot. Application of competitive inhibition in chemotherapy.Allosteric enzymes: Definition, ATCase as an allosteric enzyme, sigmoidal kinetics. Isoenzymes- LDH, Multienzyme -complex- pyruvate dehydrogenase complex. Ribozyme. Clinical and Biotechnological application of enzymes.

UNIT II: 14 Hours

Metabolism: Anabolism and catabolism- stages involved in it. Compartmentalization of metabolic pathway.

Metabolism of Carbohydrates: Glycolysis- aerobic and anaerobic and energetics of Glycolysis, regulation of glycolysis. Entry of other carbohydrates into glycolytic

pathway. Fate of pyruvate. Amphibolic integrating roles of TCA cycle. Anapluerosis. Gluconeogenesis and its importance. Outlines of HMP shunt pathway and its significance. Importance of Cori's cycle and 2,3- BPG. Glycogen metabolism, glycogenolysis and glycogen synthesis.

Metabolism of Lipids: Oxidation of fatty acids- alpha, beta and omega types. Beta-oxidation of even number saturated fatty acids. Energetics of beta oxidation. Biosynthesis of even number saturated fatty acids. Ketone bodies formation and ketosis. Outline of Cholesterol synthesis.

UNIT III: 14 Hours

Metabolism of Amino acids: General reaction of amino acid degradation-transamination and its mechanism of action. Deamination and decarboxylation. Ketogenic and Glucogenic amino acids. Urea cycle and its significance. Biosynthesis of biologically important amines epinephrine, nor epinephrine, Histamine and polyamines. Disorders of amino acid metabolism PKU and AKU.

Metabolism of Nucleic acids: Schematic pathway of synthesis and degradation of purines and pyrimidines.

UNIT IV: 14 Hours

Biological oxidation: Ultrastructure of mitochondria, ETC and its complexes-I, II, III, IV. Uncouplers and inhibitors of respiration (Rotenone, Actinomycin D, Cyanide and 2,4-DNP). Oxidative phosphorylation, P/O ratio. Formation of ATP-Outline of Mitchell's hypothesis. Substrate level phosphorylation with examples. Biological importance of ETC, Binding change mechanism.

Bioenergetics: Laws of thermodynamics- First and second law. Concept of enthalpy, entropy, free energy. Endergonic and exergonic reactions. Coupled reactions. High energy compounds- structure of ATP and its free energy change during hydrolysis, other high energy compounds.

Suggested Readings:

1. Fundamentals of Biochemistry-JL Jain, S. Jain and N. Jain (2000), S. Chand.
2. Lenhinger's Biochemistry- Nelson and Cox (2005) CBS Publishers.
3. Biochemistry- U. Sathyanrayana and U. Chakrapani (2006).
4. Enzymes: Biotechnology, Biochemistry and Clinical Chemistry- Trevor Palmer (2006).

Course Articulation Matrix Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓		✓					✓				
CO 2	✓		✓									
CO 3	✓		✓									
CO 4	✓	✓	✓	✓								

VI SEMESTER-PAPER II

Program Name	**B.Sc. Biochemistry**	**Semester**	**VI**
Course Title	**Nutrition and Immunology**		
Course Code	BCT 602	No of Credits	3
Contact Hours	56 Hours	Duration of SEA/ Exam	3 Hours
Formative Assessment	20	Summative Assessment	80

Course Outcomes:

1. Understand nutritional requirements and roles of macronutrients and micronutrients.
2. Study human digestion, absorption, and metabolism.
3. Learn the basics of immune system components and immune responses.
4. Examine mechanisms of innate and adaptive immunity and immunological disorders.

UNIT I: 14 Hours

Concept of nutrition. Calorific value of foods and its determination (bomb calorimeter). Different components of energy expenditure, respiratory quotient, basal metabolic rate, determination of BMR, factors affecting BMR, specific dynamic action of foods. Energy expenditure at rest and work. **Carbohydrates**: Dietary sources, dietary fibres and protein sparing action. **Proteins**: Dietary sources, nutritional classification, nutritional value of protein- PER, NPU and biological value of proteins. Essential amino acids. Nitrogen balance. Mutual supplementation of proteins. Fat: Dietary sources of fats, invisible fats, essential fatty acids (omega 3 and omega 6 fatty acids) and their biological importance. Minerals: Macronutrients- Ca, P, Na, K, Cl and Mg.

Micronutrients- Fe, Zn, Cu, I, Selenium . Dietary sources, physiological functions, deficiency disorders, absorption and excretion.

UNIT II: 14 Hours

Water metabolism: Distribution of water in body fluids. Factors influencing water metabolism. **Antinutritional factors**: Sources and harmful effects of anti-vitamins (eg: Avidin and dicoumarol), Natural toxicants (Lathyrus sativa), and adulterants (eg: Butter yellow, Lead chromate, Malachite green). **Abnormal nutritional States:** Malnutrition- Kwashiorkar and Marasmas. Obesity, Glycemic index of common food items, Fad diets. **Digestion:** Absorption and transport of carbohydrates, proteins and fats. GI tract, secretion, composition, and function of saliva, gastric juice, bile, pancreatic and intestinal juices. Appetite, Gastrointestinal hormones.

UNIT III: 14 Hours

Organs of the immune system: Anatomy and functions of lymphoid tissues, Cellular components of the immune system - Hematopoiesis, stem cells, granulocytes- Neutrophil, eosinophil, basophil and Mast cell, Mononuclear cells- Lymphocytes, Monocytes, Macrophages, NK cells and Dendritic cells. **Antigen:** Concept of antigenic determinants and immunogens, factors that influence immunogenicity, Classes of antigen, Epitopes, Haptens. **Antibody:** Molecular Structure - general features, light and heavy chains, Hyper-variable and constant regions, Different isotypes and subtypes of immunoglobulins, Allotypes and idiotypes.

UNIT IV: 14 Hours

Anatomical and physiological barriers, Soluble factors, Inflammation- characteristics, Chemotaxis, Phagocytosis, Acute inflammatory response, Role of innate immunity. Cytokines, Complement system-classic and alternative pathway.MHC molecules: genes, different classes, structure and function, Antigen processing and presentation: Endogenous and exogenous pathways. Humoral Immunity – B cell receptors (BCR), B-Cell maturation, Activation, Differentiation, generation of plasma cells and memory B cells. Cell-mediated immunity: Structural organization of T cell-receptors, T-cell maturation, Activation, Differentiation, Proliferation, B cell – T cell interaction, Steps in immune response.

Course Articulation Matrix Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓	✓						✓				
CO 2	✓	✓	✓									
CO 3	✓	✓	✓	✓								
CO 4	✓	✓	✓	✓		✓		✓				

PRACTICAL VI

Program Name	B.Sc. Biochemistry	Semester	VI
Course Title	**Experimental Enzymology ,Metabolism, Nutrition and Immunology**		
Course Code	BCP 603	No of Credits	2
Contact Hours	04 Hours/ Week	Duration of SEA/ Exam	3 Hours
Formative Assessment	10	Summative Assessment	40

Course Outcomes:

1. Learn enzyme assay techniques and determine activity parameters like Km and Vmax.
2. Explore enzyme kinetics and effect of various factors on enzyme function.
3. Perform blood grouping , leucocytes cell counting and agglutination reactions.
4. Analyze food adulterants and test physicochemical parameters of food.

Experiments:

1. Determination of activity of salivary amylase by DNS method.
2. Determination of specific activity of salivary amylase
3. Determination of optimum pH for salivary amylase.
4. Determination of optimum temperature of amylase.
5. Determination of Km and Vmax of salivary amylase
6. Blood grouping
7. Hemagglutation inhibition test
8. Total leucocyte count
9. Differential leucocyte count

10. Detection of common adulterants present in the food sample – spices and condiments, food grains, sugars, preserves, fats and oils
11. Determination of acid value of oil/fat.
12. Determination of Iodine value of oil/fat.

Suggested Readings:

1. Plummer DT. *An Introduction to Practical Biochemistry*. 3rd ed. New Delhi: Tata McGraw-Hill; 2001.
2. Jayaraman J. *Laboratory Manual in Biochemistry*. New Delhi: New Age International Publishers; 1981.
3. Sadasivam S, Manickam A. *Biochemical Methods*. 3rd ed. New Delhi: New Age International Publishers; 2008.
4. Wilson K, Walker J. *Principles and Techniques of Biochemistry and Molecular Biology*. 7th ed. Cambridge: Cambridge University Press; 2010.
5. Sawhney SK, Randhir Singh. *Introductory Practical Biochemistry*. 2nd ed. New Delhi: Narosa Publishing House; 2000.

Course Articulation Matrix Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓		✓									
CO 2	✓		✓									
CO 3	✓		✓									
CO 4	✓	✓	✓	✓				✓				

B.Sc. PRACTICAL QUESTION PAPER MODEL
BIOCHEMISTRY
Practical Examination Scheme for III to VI Semester

Duration: 3 Hrs

- Experimentation (Major & Minor/Spotters) - 30 Marks
- Viva-Voce - 10 Marks

Total 40 Marks

Internal Assessment for Practical Paper III-VI Semesters

- Attendance - 05 Marks
- Record/Journal - 05 Marks

Total 10 Marks

<u>Continuous Assessment Programme/ Internal Assessment/ Formative Assessment for Major program/ Subject: Biochemistry</u>

Sl. No.	Continuous Assessment Programme/ Internal Assessment	Maximum Marks
01	Two Session Tests with proper record for assessment (5+5=10)	**10**
02	Assessment of Skill Development activities/Seminars/Group Discussion/Assignment etc., with proper record	**05**
03	• Attendance with proper record	**05**
TOTAL MARKS		**20**

- **Attendance Marks-breakup**

<75%_ 00Marks
75.80%_ 01 Mark
80-85%- 02 Marks
85-90%- 03 Marks
90-95%- 04 Marks
>95%- 05 Marks

THEORY EXAMINATION QUESTION PAPE PATTERN FOR MAJOR COURSE/
SUBJECT: BIOCHEMISTRY
(Semesters III to VI)

_____ Semester B.Sc. -Degree Examination; 2025-26
(Semester Scheme: New Syllabus: 2025-26)

SUBJECT: BIOCHEMISTRY

Paper-_____: _____
Paper Code: _____

Time: 3 Hours **Max. Marks: 80**

Instructions to candidates:

1) All sections are compulsory
2) Draw neat and labeled diagrams wherever necessary.

SECTION-A

1. Answer **all** the following questions: **(2x10=20)**

a)
b)
c)
d)
e)
f)
g)
h)
i)
j)

SECTION-B

Answer any **SIX** of the following: **(5x6=30)**

2. From Unit-I
3. From Unit-I
4. From Unit-II
5. From Unit-II
6. From Unit-III
7. From Unit-III
8. From Unit-IV
9. From Unit-IV

SECTION-C

Answer **Any Three** of the following:
(10x3=30)

10. From Unit-I
11. From Unit-II
12. From Unit-III
13. From Unit-IV

Program Name	**B.Sc. Biochemistry**	**Semester**	**IV/V/VI**
Course Title	**SKILL ENHANCEMENT PROGRAMME-PROJECT WORK**		
Course Code	BCPW 604	No of Credits	2
Contact Hours	04Hours/ Week	Duration of SEA/ Exam	3 Hours
Formative Assessment	10	Summative Assessment	40

Course Outcomes:

1. Understand the fundamental concepts, types, and importance of scientific research, with an emphasis on biochemistry and life sciences.
2. Distinguish between various research designs and methodologies, and apply appropriate qualitative or quantitative approaches for experimental planning.
3. Conduct an effective literature review using scientific databases and manage references using modern citation tools.
4. Demonstrate awareness of research ethics, scientific misconduct, and the use of artificial intelligence in enhancing research quality and academic writing.

Proposed Topics for Project Work:

1. Study of Food adulteration in oil, ghee, tea powder, honey, pepper etc.
2. Preparation of wine from different edible fruits
3. Edible Mushroom cultivation
4. Analysis of sugar content of fruits and market products
5. Analysis of cholesterol content in different animal products.
6. Evaluation of antioxidant properties plant extracts.
7. Evaluation of in vitro anti-inflammatory properties plant extracts.
8. Evaluation of cytotoxicity of plant extracts.

9. Separation of plant extract by silica gel chromatography
10. Separation of amino acids in plant extracts by TLC.
11. Separation of amino acids in plant extracts by paper chromatography.
12. Evaluation of antimicrobial activity of medicinal plants
13. Determination of iodine value of different oil samples
14. Determination of saponication number of different oil samples
15. Evaluation of chlorophyll content in different plant/algal samples
16. Evaluation of phenol content in different plant samples
17. Evaluation of flavonoid content in different plant samples
18. Evaluation of larvicidal potential of different medicinal plants
19. Preparation of different metal nanoparticles using medicinal plant extract/s
20. Isolation and estimation of proteins from different biological samples.
21. Isolation and estimation of reducing sugars from different plant samples.

Note: In addition to the above mentioned, any other topics relevant to the Biochemistry may be chosen.

Guidelines for Project Work

1. Project allotment should be done at the beginning of semester and topic should be finalized in consultation with the guide by the student.
2. Each project work will be carried out as individual (preferably) or in a batch of 2/3/4 students. There shall not be more than 4 students in each group.
3. Dissertation work has to be submitted in the format prescribed.
4. Title page, Page I - Certificate, Page II - Declaration, Page III - Acknowledgements, Page, IV – contents followed by the body of the dissertation.
5. Contents should include the following subheadings:
    1. Introduction with Review of Literature
    2. Materials and Methods
    3. Result and Discussion.
    4. Summary
    5. References
    6. Dissertation should contain a minimum of 20 pages excluding photographs (A4 sheets with 1inch margin on all sides, Times New Roman font, font size -12 and line spacing - 1.5).
    7. A student who is going to other institutions/industry/laboratory/fields for any assistance has to take permission letter by the HOD/Principal of the college.
    8. Dissertation has to be submitted individually even if the work is done in group, i.e. one student has to submit his/her dissertation exclusively. No joint author submission. The dissertation to be certified by project guide and HOD. Certified dissertation shall be submitted during practical examination which shall be evaluated by both internal and external examiners.

Course Outcomes:

1. Perform biochemical tests to detect food adulterants and quantify biomolecules in biological and commercial samples.
2. Apply biotechnological methods to produce wine, cultivate mushrooms, and synthesize nanoparticles using plant extracts.
3. Evaluate the therapeutic and toxicological properties of plant extracts through various in vitro bioassays.
4. Use chromatographic and spectrophotometric techniques to isolate and estimate biochemical constituents from biological samples.

Course Articulation Matrix Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓	✓		✓								
CO 2	✓		✓				✓					
CO 3		✓		✓								
CO 4	✓			✓		✓						

SCHEME OF EXAMINATION
B.Sc. BIOCHEMISTRY: VI SEMESTER
COMPULSORY PAPER - SKILL ENHANCEMENT (PROJECT WORK)
Code: BCPRSEP 605
Duration: 3 hours Max. Marks: 40

I. Project work and preparation of dissertation 20 Marks

(To be evaluated by project guide* + internal examiner** + external examiner** each for 20 marks and average shall be taken).

* Project guide shall asses the candidate based on his/her involvement in the project work and preparation of dissertation. Marks allotment for the same shall be handed over to HOD in a sealed cover which will be transmitted to examiners.

** Distribution of marks: Introduction with review of literature - 3 Marks, Materials and methods – 3 Marks, Result and discussion - 8 Marks, Summary – 1 Mark, References – 1 Mark, Plates containing original photographs - 4 Marks)

II. Presentation by the candidate* (PPT slides preferably or charts) 10 Marks (Preparation of PPT slides or charts – 4 Marks, presentation – 6 Marks)

*Presentation to be done individually even if the project is carried out in team.

III. Viva-voce (Based on the contents of dissertations) 10 Marks

Total = 40 Marks

Note: Internal assessment marks to be allotted based on the preparation and presentation of the dissertation topic.

GROUP II: ELECTIVE PAPER
(SUPPORTIVE TO THE DISCIPLINE OF STUDY)
SEMESTER III

Program Name	**B.Sc. Biochemistry**	**Semester**	**III**
Course Title	**Cell Biology**		
Course Code	BCE 303	No of Credits	2
Contact Hours	24 Hours	Duration of SEA/ Exam	3 Hours
Formative Assessment	10	Summative Assessment	40

. Course Outcomes:

1. Describe the structural organization and functions of prokaryotic and eukaryotic cells, including cellular organelles and membranes.
2. Explain the role and structure of various cytoplasmic organelles involved in biosynthesis, energy production, and intracellular transport.
3. Analyze the components of the cytoskeleton and their involvement in maintaining cell shape, motility, and intercellular connectivity.
4. Differentiate between passive and active transport mechanisms across biological membranes, including the role of transport proteins like the Na^+/K^+-ATPase.

UNIT I: 14 Hours

Cell & Organelles- Cell structure, Cell wall, Cell membrane-structure and functions, Nucleus, Cytoplasm and its organelles- Endoplasmic reticulum, Golgi complex, Mitochondria, Lysosome, Ribosomes, Peroxisomes.

UNIT II: 14 Hours

Cytoskeleton- Microtubules, Microfilaments, Cell junctions. Cell Transport mechanism- Passive transport – types, Glucose transport mechanism. Active transport- types, Na+-K+ transporting ATPase system.

References:

1. Text book of Medical Biochemistry- MN Chatterjee and Rana Shinde
2. Text book of cell and molecular biology – Ajoy Paul
3. Biochemistry – U. Sathyanarayana and U. Chakrapani
4. Cell Biology- C.B. Power
5. Text book of Biochemistry- D.B. Vasudevan and Sreekumari S.
6. Principles and Techniques of Biochemistry and Molecular Biology- Keith Wilson and John Walker

Course Articulation Matrix Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	✓	✓										
CO 2	✓		✓									
CO 3		✓		✓								
CO 4	✓	✓				✓						

GROUP II: ELECTIVE PAPER
(SUPPORTIVE TO THE DISCIPLINE OF STUDY)

SEMESTER IV

Program Name	**B.Sc. Biochemistry**	**Semester**	**IV**
Course Title	**Food- Environmental Biochemistry & Hematology**		
Course Code	BCE 403	No of Credits	2
Contact Hours	24 Hours	Duration of SEA/ Exam	3 Hours
Formative Assessment	10	Summative Assessment	40

Course Outcomes:

1. Understand the structure, classification, and nutritional importance of biomolecules such as carbohydrates, proteins, lipids, and vitamins.
2. Explain the digestion, absorption, and metabolic fate of macronutrients and relate them to lifestyle disorders like obesity, atherosclerosis, and diabetes mellitus.
3. Describe the composition and functions of blood, the role of hemoglobin, and disorders such as anemia, jaundice, and sickle cell anemia.

4. Analyze environmental factors such as air and water pollution, food adulteration, and their biochemical implications on human health.

UNIT I: 14 Hours

Biochemistry of food- Biomolecules- carbohydrates, proteins, lipids, Vitamins. Digestion of carbohydrates, proteins and lipids. ATP. Obesity, Atherosclerosis, Diabetes Mellitus. Blood- Composition, RBC, WBC, Platelets-Functions, hemoglobin- functions. Blood clotting, Anemia, sickle cell anemia, Jaundice.

UNIT II: 14 Hours

Environmental Biochemistry- Definition, -Alteration in atmospheric temperature- Causes and consequences of alteration in atmospheric temperature – Chemical stress and pollution: air pollution- Definition, sources, indicators, Health effects. Water pollution: Definition, sources, Health effects and Importance of pure water. Food contamination, Processing of food, natural toxins, Food adulteration.

References:

1. Text book of Medical Biochemistry- MN Chatterjee and Rana Shinde
2. Text book of cell and molecular biology – Ajoy Paul
3. Biochemistry – U. Sathyanarayana and U. Chakrapani
4. Cell Biology- C.B. Power
5. Text book of Biochemistry- D.B. Vasudevan and Sreekumari S.
6. Principles and Techniques of Biochemistry and Molecular Biology- Keith Wilson and John Walker

Course Articulation Matrix Mapping

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	✓	✓				
CO 2	✓		✓		✓	
CO 3	✓	✓		✓	✓	✓
CO 4	✓	✓				✓

SCHEME OF EXAMINATION

OPEN ELECTIVE PAPERS (BCE 303 and BCE403)

Question No.	PART A	MARKS
I	Answer any FIVE Questions out of SIX Questions (Give 3 questions from each unit)	**5x2=10**
	PART B	
	Answer any TWO Question out of FOUR Questions (Give 2 questions from each unit)	**2x5=10**
II	**UNIT I**	**5**
III	**UNIT II**	**5**
IV	**UNIT I**	**5**
V	**UNIT II**	**5**
	PART C	
	Answer any TWO Question out of FOUR Questions (Give 2 questions from each unit)	**10x2=20**
VI	**UNIT I**	**10**
VII	**UNIT II**	**10**
VIII	**UNIT I**	**10**
IX	**UNIT II**	**10**