Syllabus Theory and Practical
B.Sc. (Basic/Honors) Semester-I

Course code:DSC-1T: BC-101;
Course Title: Chemical Foundations of Biochemistry-1 (Theory)

Course title	Chemical Foundation of Biochemistry-1
Couse code	DSC-1T: BC-101
Course credits	04
Total contact hours	56
Duration of ESA (Hour)	03
Formative assessment marks	30
Summative assessment marks	70

Course Outcome:
This will inculcate confidence and clarity of mind in students to understand the chemistry of Biomolecules, and Biological reactions.

Course Outcomes /Program Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude	x	x	x									
Critical thinking		x										
Subject clarity	x	x										x
Analytical Skill	x				x	x						

Content of Theory course- **Chemical Foundation of Biochemistry-1** **Total credits = 4**	**56hr**
Unit 1: Scope of Biochemistry and Units of measurement	**14 hr**
Origin of life, types of organisms, prokaryotes, eukaryotes, unicellular, multicellular, compartmentation of functions in lower and higher organisms, and common physiological events of organisms, chemical composition of living organisms, subcellular organelles, SI units, mass, volume, temperature, amount, length and time. An overview on the metric system, atomic weight, molecular weight, equivalent weight, basicity of acids, acidity of bases, Avogadro`s number, molarity, normality, molality, Dalton concept, mole concept, concentration, mole to molar conversion, oxidation number and its significance, density and specific gravity, their significances.	
Unit 2 : Atomic structure and Chemical bonds	**14 hr**
Structure of an atom, electrons and Quantum numbers, orbitals, shapes of orbitals, s, p, d, and f subshells, K, L, M, N, O, P, and Q shells. Illustration of Pauli`s exclusion principle, Aufbau principle, and Hund`s rule, electron configuration, octet rule. Formation and properties of noncovalent and covalent bonds, hydrogen bonds, ionic bonds, van der Waals interactions, London forces, dipole-dipole interactions, electrostatic interactions, and hydrophobic interactions. Sigma, pi and co-ordinate bonds, back bonding.	

Corresponding energy associated, outline of theories of bonding.	
Unit 3: Buffers and Colligative properties	**14 hr**
Acids, bases, Arrhenius concept, proton transfer theory, Lewis concept, Lowry and Bronsted concepts. Buffers, composition, pH, pH scale, Henderson-Hasselbalch equation, titration curve of H_3PO_4, pK value, isoelectric pH, ionization of HCl, HNO3, H2SO4. Colligative properties and anomalous colligative properties of solutions, structure of water, phase diagram of pure water, ionic product of water, special properties of water, buffers in animal system. Solutions and types, ionizable solutes, non-ionizable solutes, vapor pressure and its application in distillation, Vant Hoff law, Roult`s law, boiling point, freezing point, de-icing, osmosis and osmotic pressure determination, reverse osmosis, surface tension.	
Unit 4: Electrochemistry and Redox reactions	**14 hr**
Scope of electrochemistry, electrochemical cells, Daniel cell, galvanic cell, electrode potential and its measurement, electrolysis, types of electrolytes, primary and secondary batteries, electrodes, half-cell reaction, standard electrodes. Laws of thermodynamics, entropy and enthalpy, their relation, Gibb`s energy, free energy change, Lewis concept, ions, redox reactions, redox potential, application of redox potential, energy linked to redox reactions, reduction of oxygen, oxidation and reduction of iron in hemoglobin, biological active forms of zinc, calcium, nickel, molybdenum, selenium, and cobalt, NAD+/NADH, NADP+/NADPH, FAD/FADH2, FMN/FMNH2. Molecularity and order of a reaction.	

Course code: DSC-1P: BC-102;
Course Title: Volumetric Analysis – Practicals-1

Course title	Volumetric analysis – practicals-1
Couse code	DSC-1P: BC-102
Course credits	02
Total contact hours	56 (4 h/ week)
Duration of ESA (Hour)	3
Formative assessment marks	15
Summative assessment marks	35

Content of Practical course- Volumetric analysis- Practical-1	
Total Teaching Hours = 56; Total Credits = 2	**56 hr**
List of experiments to be conducted	
1. Concept of molarity, molality and normality. Calculation and preparation of molar solutions. (Problems to be given in exams). Calculation and preparation of normal solutions and percent solutions and dilute solutions. 2. Calibration of volumetric glassware's (Burette, pipette). 3. Preparation of standard Sodium carbonate solution, standardization of HCl (Methylorange) and estimation of NaOH in the given solution. (methyl orange or phenolphthalein). 4. Preparation of standard Oxalic acid. Standardization of NaOH and estimation of H_2SO_4in the given solution (phenolphthalein). 5. Preparation of standard Oxalic acid. Standardization of $KMnO_4$ and estimation of H_2O_2 in the given solution. 6. Preparation of standard $K_2Cr_2O_7$. Standardization of $Na_2S_2O_3$ and estimation of $CuSO_4$ in the given solution. 7. Preparation of $ZnSO_4$. Standardization of EDTA and estimation of total hardness of water using Eriochrome-Black-T indicator. 8. Preparation of standard potassium bipthalate. Standardization of NaOH and estimation of HCl in the given solution. (Phenolphthalein). 9. Estimation of sulphuric acid and oxalic acid in a mixture using standard NaOH solution and standard $KMnO_4$ solution. 10. Preparation of standard Potassium dichromate and estimation of ferrous/ferric mixture using diphenylamine indicator (Demonstration). 11. Preparation of standard oxalic acid solution. Standardization of NaOH solution and estimation of acidity in vinegar. 12. Preparation of standard potassium bi-phthalate solution, standardization of sodium hydroxide solution and estimation of alkalinity of antacids 13. Preparation of standard Oxalic acid solution. Standardization of $KMnO_4$ solution and estimation of calcium in milk.	

Open Elective Course Code: OE-1T:BC-103;
Course Title: Biochemistry in Health and Diseases (theory)

COURSE TITLE	Biochemistry in Health and Diseases
Couse code	OE-1T: BC-103
Course credits	03
Total contact hours	42
Duration of ESA (Hour)	03
Formative assessment marks	30
Summative assessment marks	70

Course Outcome: This open elective course offering to students of various streams gives knowledge about health and various terminologies used in health and disease conditions; Difference between communicable and non-communicable diseases; Health promotion and treatments for various diseases and disorders.

Content of Theory course- Biochemistry in Health and Diseases Total credits =3	**42 hr**
Unit 1: Introduction::	**14 hr**
WHO definition of health, Health and hygiene, General health care, Factors affecting health, Indices and evaluation of health, Disease patterns in developed and developing world; Classification of diseases - Endemic, Epidemic, Pandemic; Professional health hazards. Disease conditions: Acute disease, Chronic disease, Incurable disease, Terminal disease, Illness, disorders, Syndrome, Pre-disease.	
Treatment: Psychotherapy, Medications, Surgery, Medical devices, and Self-care. Dimensions of Health: Physical, Mental, Spiritual, Emotional, Environmental, and Philosophical.	
Unit 2:Communicable Diseases:	**14 hr**
Tuberculosis, Cholera, Typhoid, Conjunctivitis. Sexually transmitted diseases (STD): Information, statistics, and treatment guidelines for STD, Prevention: Syphilis, Gonorrhea, AIDS, etc. Non-communicable diseases: Malnutrition- Under nutrition, Over nutrition, Nutritional deficiencies; Anemia, Stroke, Rheumatic heart disease, Coronary heart disease, Cancer, blindness, accidents, mental illness, Iodine deficiency, Fluorosis, Epilepsy, Asthma. Genetic disorders: Down's syndrome, Klinefelter's syndrome, Turner's syndrome, Thalassemia, Sickle cell anemia. Lifestyle disorders: Obesity, Liver cirrhosis, Diabetes mellitus, Hypertension (Causative agents, symptoms, diagnosis, treatment, prognosis, prevention)	
Unit 3: Health Promotions:	**14 hr**

Preventing drug abuse, Oral health promotion by tobacco control. Mental hygiene and mental health: Concepts of mental hygiene and mental health,Characteristics of mentally healthy person, Warning signs of poor mental health, Promotive mental health, strategies and services, Ego defense mechanisms and implications, Personal and social adjustments, Guidance and Counseling. Infection control: Nature of infection, Chain of infection transmission, Defenses against infection transmission	

Skill enhancement course: Course Code: SEC-1T:BC-104.1; Course Title: Biochemical Techniques-1 (theory)

Course title	Biochemical Techniques-1
Course code	SEC-1T: BC-104.1
Course credits	02
Total contact hours	28
Duration of ESA (Hour)	03
Formative assessment marks	30
Summative assessment marks	70

Course Level Learning Outcomes: Students will be exposed to various spectrophotometry and chromatographic techniques and their applications in separation of chemicals like biomolecules, organic chemicals, drugs etc.

Content of Theory course- Biochemical Techniques-1 Total credits =2	**28 hr**
Unit 1: Photometry:	14 hr
Principle of light absorption by molecules. Beer-Lambert law, Types of spectrophotometers. Principals and working of colorimeter, Visible spectrophotometer, UV-Visible spectrophotometer, Fluorescent spectrophotometry, nano-drop-spectrophotometry, Atomic absorption spectrophotometry. Types of Detectors-Phototube, Photomultiplier tube, Photo diode, Diode array detector, Charge coupled device detectors. Applications of spectrophotometry in estimation of organic compounds, enzyme assays, enzyme kinetics, recording spectrum, time-lapse studies.	
Unit 2: Chromatography:	14 hr
Separation of small molecules by TLC, column chromatography, HPLC, and GLC.RP-HPLC, normal phase HPLC, HILIC. Column materials, ODS v/S BDS columns, Different columns used in HPLC, and GLC. Different types of detectors used in HPLC and GLC. Preparation of sample for separation by HPLC and GLC. Importance of column material and pore size. Isocratic v/s gradient HPLC	

Assignment/ open discussion/ quiz	05
Total	30

Skill enhancement course: Course Code: SEC-1T: BC-104.2; Course Title: Microbiological quality of food and water(Theory)

Course title	Microbiological quality of food and water
Couse code	SEC-1T: BC-104.2
Course credits	02
Total contact hours	28
Duration of ESA (Hour)	03
Formative assessment marks	30
Summative assessment marks	70

Course Level Learning Outcomes: Students will learn various means of microbial contaminations in water and food and their implications on health. Student will learn about the standard methods of detection of contaminating microorganisms in food and water

samples.

Content of Theory course- Microbiological quality of food and water **Total credits =2**	**28 hr**
Unit 1	**14 hr**
Sampling of water to detect the microbiological quality of water. Isolation of microorganisms from water sample. Medium: Growth medium, differential medium and specific medium. Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for fecal coliforms (b) Membrane filter technique and (c) Presence/absence tests	
Unit 2	**14 Hr**
Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general. Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods. Cultural and rapid detection methods of food borne pathogens in foods. Food borne diseases: Food intoxication, food infection, shigellosis. Food sanitation and control: HACCP, Indices of food sanitary quality and sanitizers.	

Syllabus Theory and Practical

B.Sc. (Basic/Honors) Semester-II

Course code:DSC-2T: BC-201;

Course Title: Chemical Foundations of Biochemistry -2(theory)

Course title	**Chemical Foundations of Biochemistry -2**
Couse code	DSC-2T: BC-201
Course credits	04
Total contact hours	56
Duration of ESA (Hour)	03
Formative assessment marks	30
Summative assessment marks	70

Course Outcome: These topics will enable students to understand the fundamentals of chemical processes in biological systems

Course Outcomes / Program Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude	x	x	x									
Critical thinking	x	x										
Subject clarity	x	x										x
Analytical Skill	x	x			x	x						

Content of Theory course- Chemical Foundations of Biochemistry-2 **Total credits = 4**	**56 hr**
Unit 1: Chemical Catalysis:	**14 hr**
Definition, characteristics, types, intermolecular, multifunctional, theories of catalysis, properties, characteristics of enzyme catalysis, autocatalysis, industrial catalysis and their role in biological systems (brief). Colloids: true solutions, classification, peptisation, purification, ultrafiltration, Brownian movements, electric properties, coagulation, mutual, lyophilic sols, boiling, dialysis, electro and persistent dialysis, addition of electrolytes, colloids in daily life and applications. Emulsion, types, micelles with biomolecules and its biological applications.	
Unit 2: Nomenclature of Organic Compounds:	**14 hr**
Classification, naming- IUPAC nomenclature, compounds containing one, two functional groups with chains, homologous series. Stereochemistry, geometrical and structural Isomerism, conformation and free rotation. Optical isomerism, symmetry of elements, plane polarized light and optical purity. Nomenclature of enantiomers, epimers, racemic mixture, resolution. Fischer and Newman projection formulae, molecule with one and two chiral and achiral centers. Priority rules; E and Z (CIP rules), R and S, D and L notations, absolute (r and s) and relative (d and l) configuration. Role of stereochemistry in biological systems.	
Unit 3: Organometallic Compounds:	**14 hr**
Metal atom linked organic compounds. Preparation of Grignard reagents and structure, limitations, protonolysis and reactions. Organolithium compounds, preparation and reactions. Organozinc compounds. Organoboranes its mechanisms. Ferrocenes. Introduction to mineral and ores, classification, concentration, extraction, refining, uses of minerals and metals and its importance. Porphyrins and Metal ions: Role of metal ions in biological systems, Fe, Cu, Zn, structureand functions of porphyrins, metalloporphyrins and iron-sulphur clusters with suitableexamples and their role in biological systems.	
Unit 4: Inorganic Chemistry:	**14 hr**

Nomenclature of inorganic molecules and coordination compounds, formula. IUPACnomenclature. Central metal ion, ligand, coordination number, sphere, complex ion, oxidation number of central atom, homoleptic and heteroleptic complexes. Isomerism in complexes, structural, ionisation, solvate, linkage and coordination, Stereoisomerism, geometrical, optical isomerism with simple inorganic complexes. Applications of qualitative, quantitative analysis, photographic, metallurgy, medicine, catalysis and biosystems. Heavy Metal Poisons: Introduction, poisons, lead, mercury, aluminium, arsenic, corrosives, cyanide, irritants, phosphorus, CO2, SO2, SO3, NO2, halides and acid fumes, poisoning, sources, signs and symptoms. Free radicals: introduction, definition, generation and scavenger systems. Redox reactions, types, stock notations, change in oxidation number and combination. Endergonic and exergonic reactions with examples. The Importance in biological systems.	

Course code: DSC-2P: BC-202;
Course Title: Qualitative and Quantitatve analysis – practicals-2

Course title	**Qualitative and Quantitative analysis-practicals-2**
Couse code	DSC-2P: BC-202
Course credits	02
Total contact hours	56 (4 h/ week)
Duration of ESA (Hour)	3
Formative assessment marks	15
Summative assessment marks	35

Course Outcome: The Course Objective is to provide experimental practice of quantitative and qualitative analysis. Also it provides training in physical chemistry laboratory techniques. Upon successful completion, students should develop skills in handling instruments and understand its application in research work.

Content of Practical course- Qualitative and quantitative analysis-2	
Total Teaching Hours = 56; Total Credits = 2	**56 hr**
List of experiments to be conducted	

1. Systematic Semi micro–Qualitative Analysis of Inorganic Salt Mixtures Systematic semi micro qualitative analysis of two acid and two basic radicals in the given inorganic salt mixture. The constituent ions in the mixture to be restricted to the following. (Any four binary mixtures shall be given) Anions: HCO -, CO_2-, Cl-, Br-, NO -, BO 3-, SO 2- and PO_3-. Cations: Pb_2+, Al_3^+, Fe_2^+, Fe_3^+, Mn_2^+, Zn_2^+, Ca_2^+, Sr_2^+, Ba_2^+, Mg_2^+, K^+, Na^+ and NH^+. Determination of density and viscosity of the given liquid using specific gravity bottleand Ostwald's viscometer. 2. Determination of density and surface tension of the given liquid using specific gravity bottle and stalagnometer. 3. Determination of molecular weight of non-volatile solute by Walker-Lumsden method. 4. Determination of rate constant of decomposition of H_2O_2 using $KMnO_4$ by volumetric analysis method using ferric chloride as catalyst. 5. Determination of distribution coefficient of benzoic acid between water and benzene or iodine between water and carbon tetrachloride. 6. Separation of Two Components from given Binary Mixture of Organic Compounds Qualitatively. (Types of binary mixtures- Solid – Solid, Solid – Liquid, Liquid – Liquid) 7. Verification of Beer's Law. Estimation of unknown concentration of a biomolecule by using colorimeter 8. Calibration of pH meter and determination of pH of aerated soft drinks.	

Open Elective Course Code: OE-2T:BC-203;
Course Title: Nutrition and Dietetics (theory)

Course title	Nutrition and Dietetics
Couse code	OE-2T: BC-203
Course credits	03
Total contact hours	56
Duration of ESA (Hour)	03
Formative assessment marks	30
Summative assessment marks	70

Course outcomes:

- The student will gain knowledge about energy requirements and the Recommended Dietary Allowances.
- The student will understand the functions and role of macronutrients, their requirements and the effect of deficiency and excess
- The student learns the impact of various functional foods on our health

- The student will be able to apply basic nutrition knowledge in making foods choices and obtaining an adequate diet.
- The student gains competence in connecting the role of various nutrients in maintaining health and learn to enhance traditional recipes.

Content of Theory course- Nutrition and Dietetics **Total credits =3**	**42 hr**
Unit 1: Basic Concepts of Nutrition:	**14 hr**
Introduction, Basic principles of a balanced diet to provide energy and nutrients. Composition of foods and proximate analysis of foods. Calorific value of foods and Basal metabolism. Basal Metabolic Rate (BMR), Factors affecting BMR, Energy requirements for different physical activities, Specific dynamic action of food, Nutritive value of proteins. Energy requirements and recommended dietary allowance (RDA) for infants, children and pregnant women. Protein calorie malnutrition.	
Unit 2: Macronutrients and Micronutrients:	**14 hr**
Carbohydrates- Digestible and non-digestible, Dietary fibers, Essential fatty acids, lipoproteins and cholesterol. Essential amino acids, Fortification of foods, Protein requirement for different categories. 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).	
Unit 3: Dietetics and Diet Therapy:	**14 hr**
Introduction. Food pyramid. Diet planning and introduction to diet therapy. Nutritionalrequirements for different age groups, anemic child, expectant women, and lactating women. Diet planning for prevention and cure of nutritional deficiency disorders. Diet therapy: Functional foods, Anthropometric measurements, dietary considerations during fever, malaria, and tuberculosis. 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.	

Formative Assessment	
Assessment occasion	Weightage in marks
Class test (Two class tests)/ Continuous evaluation	20
Seminar/ class work	05
Assignment/ open discussion/ quiz	05
Total	30

Skill enhancement course: Course Code: SEC-2T:BC-204.1; Course Title: Biochemical Techniques-2 (theory)

Course title	Biochemical Techniques-2
Couse code	SEC-2T: BC-204.1
Course credits	02
Total contact hours	28
Duration of ESA (Hour)	03
Formative assessment marks	30
Summative assessment marks	70

Course Level Learning Outcomes: Students will be exposed to various electrophoretic and mass spectrometry techniques and their applications in biomolecular separations and drug discovery. A thorough understanding of the above techniques would provide job opportunities in CROs for drug discovery and metabolism and also in diagnostic development companies.

Content of Theory course- Biochemical Techniques-2 Total credits =2	28 hr
Unit 1: Electrophoresis:	14 hr
Protein and nucleic acid Separations: PAGE, Non-denaturing PAGE, Non-reducing SDS-PAGE. 2-D electrophoresis, Preparation of pH gradient gel. Procedure of preparation of polyacrylamide gels, importance of buffers in electrophoretic separations, importance of stacking and resolving gels, use of denaturing agents and reducing agents in electrophoresis. Applications of electrophoretic techniques in disease diagnosis. Staining techniques- Coomassie staining, PAS staining, Silver staining, Fluorescent dye staining, Submerged-gel electrophoresis for the separation of nucleic acids. Nucleic acid staining techniques.	
Unit 2: Mass spectrometry:	14 hr
Ionization techniques: Electro ionization, Fast-atom bombardment, Electro-spray ionization, Chemical ionization, Photo-ionization, MALDI. Construction and applications of Mass spectrometer, LC-MS/MS, GC-MS/MS. Preparation of samples for LC-MS and GC-MS. Detectors: Electron	

multiplier, Faraday's cup, Photomultiplier conversion dynode, Array detectors. Application of LC-MS and GC-MS in drug discovery and metabolic studies.	

Pedagogy: MOOC/desk work/book chapter/problem solving /assignment

Formative Assessment	
Assessment occasion	Weightage in marks
Class test (Two class tests)/ Continuous evaluation	20
Seminar/ class work	05
Assignment/ open discussion/ quiz	05
Total	30

Skill enhancement course: Course Code: SEC-2T:BC-204.2; Course Title: Bioinformatics(theory)

Course title	**Bioinformatics**
Couse code	SEC-2T: BC-204.2
Course credits	02
Total contact hours	28
Duration of ESA (Hour)	03
Formative assessment marks	30
Summative assessment marks	70

Course level learning outcomes:

By studying this course the students completing B.Sc. (Hons) Biochemistry will have an understanding of the tools of bioinformatics and computational biology and will be in a position to access biological data bases and softwares which will be helpful in understanding sequence alignments and predicting the structures of biomolecules such as proteins. Students will be exposed to available bioinformatics tools and databases. They will be in a position to comprehend the fundamental aspects of in-silico protein structure prediction. They will understand application of theoretical approaches to biological

systems. Students will get trained in the application of programs used for database searching, protein and DNA sequence analysis, and prediction of protein structures.

Content of Theory course- Bioinformatics **Total credits =2**	**28 hr**
Unit 1	**14 hr**
Bioinformatics: Introduction, Basics of Computer and operating systems, Hardware, Software, Introduction to programming Languages and Paradigms, PERL/R programming, role of supercomputers in biology. Scope of bioinformatics - Genomics, Proteomics, comparative and functional genomics, Genome annotation, gene prediction approaches and tools. Transcriptome and Proteome, Tools of proteome analysis. DNA microarray: understanding of microarray data and correlation of gene expression data to biological processes and computational analysis tools. Computer aided drug design (CADD) and Systems Biology.	
Unit 2	**14 hr**
Biological databases: Introduction to biological databases - primary, secondaryand composite databases, useful programs, ClustalW, BLASTp. NCBI, EBI,ExPaSy, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), proteindatabases (PIR, Swiss-Prot,TrEMBL, PDB), metabolic pathway database(KEGG, EcoCyc). Sequence alignment: Similarity, identity and homology. Concept of Alignment: Pair-wise sequence alignment, gaps, gap-penalties, scoring matrices, PAM250, BLOSUM62, local and global sequence alignment, multiple sequence alignment, Progressive Alignment Algorithm, Application of multiple sequence alignment. BLAST and CLUSTALW.	

Pedagogy: MOOC/desk work/book chapter/problem solving /assignment

Formative Assessment	
Assessment occasion	Weightage in marks
Class test (Two class tests)/ Continuous evaluation	20
Seminar/ class work	05
Assignment/ open discussion/ quiz	05
Total	30

SEMESTER III

COURSE TITLE	**BIO-ORGANIC CHEMISTRY**
COURSE CREDITS	**04**
TOTAL CONTACT HOURS	**56**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course outcome:

These topics will enable students to understand the fundamentals of organic chemistry pertinent to their importance in understanding biochemical reactions.

Course outcomes /Program outcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude	X	X	X	X								
Critical thinking		X										
Subject clarity	X	X				X	X	X		X		X
Analytical skill	X				X	X	X	X	X			X

UNIT 1: Reaction mechanisms and aliphatic hydrocarbons 14 hours

Introduction, meaning of the term, kinetic and non-kinetic. Fundamental aspects: Homo and heterolytic cleavage. Concept of inductive effect, mesomeric effect, resonance, and hyper conjugation. Classification of organic reactions (substitution, addition, elimination, and re- arrangement), with two examples for each. Concepts Reactive intermediates of the following – free radicals, carbo cations and carbanions, free radicals, carbines, nucleophiles and electrophiles (Formation and Stability).

Hydrocarbons -Mechanism of addition of HCl to propene, Morkownikoff's rule. Peroxide effect, Alkenes – Ozonolysis, oxidation. Alkynes – formation of acetylides and their importance. Dienes– types with examples. Conjugate dienes, 1,3-butadiene – stability, mechanism of addition of HBr. Conformational analysis of ethane and n–butane.

UNIT 2: Mechanism of substitution, elimination, and addition reactions 14 hours

S_N1 and S_N2 reactions on tetrahedral carbon, energy profile diagrams, Stereochemistry, factors affecting SN_2 and SN_1reactions

The Elimination reactions- E_2 reaction, Zaitsev rule, E_1 reaction. Stereochemistry of E_1 & E_2 reactions, E_2 & E_1 elimination from cyclic compounds. Substitution and Elimination reactions

in Synthesis. Addition reactions - Aldehydes and Ketones - nucleophilic addition of acetals & ketals. Addition of Ammonia, primary amines, and other ammonia derivatives. Conjugate addition. Conjugation addition in alpha and beta unsaturated aldehydes and ketones 1, 2 and 1,4 addition.

UNIT 3: Mechanism of electrophilic aromatic substitution reactions 14 hours

Aromatic compounds - aromaticity, criteria for aromaticity, anti-aromatic, and non-aromatic compounds with examples. Mechanism of electrophilic aromatic substitution reactions- Halogenation, nitration, sulfonation, Friedel crafts alkylation. Friedel crafts acylation- mechanism involved. Relative reactivity of substituted benzenes, polycyclic benzenoid hydrocarbons.

The reaction of the coenzymes.

Overall view of metabolism, thiamine pyrophosphate- structure and its role in decarboxylation of alpha- keto acids.

Biotin- structure and its role in carboxylation of some important biochemical reactions of carbohydrate and lipid metabolism.

Vit B_2 its role in rearrangement reactions.

Vit B_2 coenzymes its role in redox reactions with suitable examples.

UNIT 4: Bio-organic compounds 14 hours

Alcohols: Classification, monohydric alcohols: examples, general and distinguishing reactions. Dihydric alcohols: glycols, Tri hydric alcohols: glycerol – synthesis from propene, properties and uses. Phenols: Classification, electronic interpretation of acidity of phenols, mechanism of Kolbe, Reimer– Tiemann and bromination reactions.

Hydroxy acids: Structure and properties: Lactic acid, Citric acid and Isocitric acid. Dicarboxylic acids: Maleic and Fumaric acid. Ketoacids: Pyruvic, α-Ketoglutaric, Oxaloacetic acid.

Carbonyl compounds: General properties, Keto-enol tautomerism. Mechanisms: addition of HCN to acetaldehyde, Claisen and aldol condensations. Quinones: o and p-benzoquinones-structure and properties.

Amines: Classification, properties, functional group – Basicity of amines, acylation. Reaction with HNO_2 & Schiff's base formation. Distinguishing reactions of primary, secondary and tertiary amines.

Heterocyclic compounds: Definition, classification with examples, structure and biological importance of furan, pyrrole, thiophene, pyridine, pyran, thiazole, pyrimidine, purine, indole, imidazole, quinoline and isoquinoline. Basicity of pyrrole and pyridine.

Terpenes: Definition, Isoprene rule, classification, isolation, structure and biological importance of menthol, camphor, farnesol, phytol, lanosterol, lycopene and dolichols.

Steroids: Basic ring structure in steroids. Structure and biological importance of cholesterol, phytosterols, ergosterol, cortisol, β-estradiol, testosterone, and aldosterone. Bile acids (Mono, Di & Tri cholic acids).

Alkaloids: Definition, classification based on their structure and biological functions, Isolation of alkaloids, structure and physiological action of morphine, nicotine and atropine.

SEMESTER III

PRACTICALS

III

COURSE TITLE	**BIO-ORGANIC CHEMISTRY**
COURSE CREDITS	**02**
TOTAL CONTACT HOURS	**4 Hours/Week**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**25**
SUMMATIVE ASSESSMENT MARKS	**25**

Course outcome:

This course aims to familiarize students with the principles of organic chemistry and basic qualitative analysis of organic compounds. Course objective is to provide experimental practice of preparation of organic compounds and extraction of biologically important compounds.

Experiments:

I. Systematic qualitative analysis of organic compounds (6 practicals)

1. Urea
2. Aniline
3. Benzoic Acid
4. Salicylic acid
5. Benzaldehyde
6. Acetophenone
7. Chlorobenzene
8. Nitrobenzene

II. Preparation of following organic compounds (2 practicals)

1. Acetylation: Preparation of acetyl salicylic acid from salicylic acid.
2. Oxidation: Preparation of benzoic acid from benzaldehyde.
3. Nitration: Preparation of m-dinitrobenzene from nitrobenzene.
4. Hydrolysis: Preparation of benzoic acid from ethyl benzoate.

III. Extractions

1. Extraction of caffeine from tea leaves
2. Extraction of starch from potatoes
3. Extraction of casein from milk

SEMESTER III

OPEN ELECTIVE

1

COURSE TITLE	**BIOCHEMICAL TECHNIQUES**
COURSE CREDITS	**03**
TOTAL CONTACT HOURS	**42**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course outcome:

These topics will enable students to develop competence in handling various chromatographic, electrophoretic and isotopic techniques and apply them in isolating and characterizing different biological molecules.

UNIT 1 : 14 hours

Microscopy: Different types of microscopes – electron microscopes – TEM, SEM. Fluorescence and confocal microscopes used in fine structure studies.

Centrifugation Techniques: Introduction, basic principles, and applications of sedimentation. Centrifuges and their use - small bench centrifuges, large capacity refrigerated centrifuges, high speed refrigerated centrifuges, Preparative ultra-centrifuges, analytical ultracentrifuges, and density gradient centrifugation.

UNIT 2 : 14 hours

Chromatography: Introduction, classification of chromatographic techniques. Principle, materials, theory and applications of paper chromatography, thin layer chromatography, column chromatography- adsorption chromatography, gel permeation, ion exchange chromatography, affinity chromatography, gas chromatography, FPLC, high performance (pressure) liquid chromatography.

Electrophoresis techniques: Introduction. Principles and application of electrophoretic techniques-paper electrophoresis, starch gel electrophoresis, polyacrylamide gel electrophoresis, agarose gel electrophoresis, isoelectric focusing, isotachophoresis, pulse field electrophoresis, two-dimensional electrophoresis, capillary electrophoresis, preparative and high voltage electrophoresis.

UNIT 3 : 14 hours

Radio isotopic techniques: Introduction to isotopes; mass and radioisotopes. Nature of radioactive decay, rate of radioactive decay, units of radioactivity, measurement of radioactivity- proportional counters, scintillation counters, autoradiography, isotopic dilution technique. Applications of radioisotopes in the biological sciences.

Spectroscopy: Introduction, Nature of electromagnetic Radiations. Principles and applications of the following spectroscopic techniques in biochemical investigations- Visible and Ultraviolet spectroscopy, Fluorescence spectroscopy, Infrared spectroscopy, Optical rotation dispersion (ORD), Circular dichroism (CD) spectroscopy, electron spin resonance (ESR), Atomic Absorption spectroscopy, Nuclear Magnetic resonance (NMR) spectroscopy and Mass spectroscopy

SEMESTER III

OPEN ELECTIVE

2

COURSE TITLE	HORMONES - BIOCHEMISTRY AND FUNCTION
COURSE CREDITS	03
TOTAL CONTACT HOURS	42
DURATION OF ESA	03
FORMATIVE ASSESSMENT MARKS	40
SUMMATIVE ASSESSMENT MARKS	60

Course outcome: These topics will enable the students to:

- Understand the function of hormones and their regulation.
- Know how hormonal systems act in an integrated manner to regulate overall body functions.
- Understand how failure of these normal physiologic functions and integrations are associated with some endocrine disorders.

UNIT 1 : 14 hours

Introduction to the system and concepts of signaling. Classification, intercellular communication, regulation of synthesis and secretion of hormones. Chemical signaling- endocrine, paracrine, autocrine, and neuroendocrine mechanisms. Mechanisms of hormone action: synergism, antagonism, permissive effects. Division of hormones by the origin, chemical structure, location, and mechanism of action. Physiological role and disorders of Pituitary, Pineal, Thyroid and Parathyroid hormones. Introduction to the hypothalamus as the true master gland with Releasing hormones and inhibitory substances. Neurohypophysis and its secretions – ADH and Oxytocin

UNIT 2 : 14 hours

Physiological role and disorders of hormones of pancreas, adrenal, and placenta. Introduction to gastrointestinal hormones and neurotransmitters (Acetyl choline, GABA,

Serotonin). Mechanism of action, target tissues, and the physiological effects of gastrointestinal hormones. Structure and functions of sex hormones. Hormones during ovarian and uterine phases of menstrual cycle; Placental hormones; role of hormones during parturition and lactation. Hormone receptors: receptors in the cell membrane and in the cell. Secondary and tertiary messengers (cAMP and Ca^{+2}). Overview on signal transduction pathways for steroidal and non-steroidal hormones (One example each).

UNIT 3 : 14 hours

Clinical endocrinology- Blood volume, composition and functions of plasma and serum. Separation and storage of body fluids. Methods of hormone estimation, principles of assay systems, normal range of hormones in tissues and clinical conditions leading to abnormal levels with interpretations. Thyroid function test- Determination of T3, T4, and TSH. Infertility profile: Determination of LH, FSH, TSH, Estrogen, Progesterone, Total Testosterone, Free testosterone. Major manifestations of disease of the endocrine pancreas, thyroid, hypothalamus, and pituitary disease.

SEMESTER IV

COURSE TITLE	ANALYTICAL BIOCHEMISTRY
COURSE CREDITS	04
TOTAL CONTACT HOURS	56
DURATION OF ESA	03
FORMATIVE ASSESSMENT MARKS	40
SUMMATIVE ASSESSMENT MARKS	60

Course outcome: These topics will enable the students to

- Understand the concept of biological sample preparation
- Appreciate chemistry and application of analytical instruments.
- Get acquainted with care and maintenance of equipment and chemicals.
- Understand clinically relevant biochemical analysis of all biochemical components i.e., proteins, electrolytes, hormones etc.,
- Have basic knowledge of clinical and forensic analytical methods and their principles.

Course outcomes /Program outcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude	X	X	X	X								
Critical thinking		X				X						
Subject clarity	X	X						X				X
Analytical skill				X	X	X	X	X	X	X	X	X

UNIT 1: Biological sample preparation and fractionation 14 hours

Introduction and objectives of bioanalysis and extraction of molecules from tissues and cells. Sample preparation types of sample living, postmortem extraction of macromolecules from tissues; liquid-liquid, liquid-solid and precipitation methods.

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; Application in sub-cellular fractionation. Sedimentation coefficient, care, and maintenance of instrument.

UNIT 2: Chromatography 14 hours

General principles of chromatography, history of chromatography. Classification based on 1. physical way stationary and mobile phase are brought together- Planar and column chromatography, 2. based on types of mobile and/or liquid phaseadsorption and partition- Gas chromatography and liquid chromatography. Based on stationary phase-thin layer chromatography, Paper chromatography - ascending, descending and circular, 2-D chromatography, Rf values.

Classification of chromatography based on separation: Principles, methodologies and applications of adsorption, partition, ion-exchange, gel-filtration and affinity-chromatography. Advanced chromatography- HPLC and FPLC, UPLC and GLC.

UNIT 3: Electrophoretic and isotopic methods 14 hours

Electrophoresis: General principle of electrophoresis, velocity of a charged molecule in the applied electric field. Supporting media for electrophoresis; work of Tiselius, paper, agarose, polyacrylamide. Chemistry of polymerization of acrylamide gels, methodology and applications of native PAGE and SDS- PAGE, 2-D electrophoresis, Identification of proteins post electrophoresis- dyes and biological activities. Agarose gel and Pulse field electrophoresis, Applications of capillary electrophoresis and isoelectric focusing. Cellulose acetate electrophoresis. Principle and applications of immune- electrophoresis.

Isotopic methods: Radioactivity–Types of radioactive decay, Properties of α, β, γ radiations. Group displacement law. Decay law - decay constant, Half-life period and average life of a radioactive element. Detection of radioactivity – GM counter and scintillation counters (only principal and working) Applications of radioisotopes – ^{3}H, ^{14}C, ^{131}I, ^{60}Co and ^{32}P. Biological effects of radiations. Radiolabeling, safety measure in handling radio isotopes. Heavy isotopes, quantification and applications.

UNIT 4: Spectroscopic methods of bio-analysis 14 hours

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

SEMESTER IV

PRACTICALS

IV

COURSE TITLE	**ANALYTICAL BIOCHEMISTRY**
COURSE CREDITS	**02**
TOTAL CONTACT HOURS	**4 Hours/ Week**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**25**
SUMMATIVE ASSESSMENT MARKS	**25**

Course outcome: This course aims to provide experimental practice of analytical techniques in Biochemistry. Upon successful completion, students should develop skills in handling instruments and understand its application in research work.

- Sourcing and handling biological samples.
  Develop skill and proficiency in basic techniques
- Centrifugation
- Chromatography
- Electrophoresis and
- Spectroscopy

Experiments:

1. Haematology: WBC counting: TC and DC.

2. Determination of packed cell volume/ hematocrit

3. Resolution of basic, acidic and aromatic amino acids by descending and circular paper chromatography.

4. Separation of plant pigments by adsorption chromatography

5. Identification and resolution of pigments by thin layer chromatography.

6. Demonstration of gel-filtration chromatography

7. Colorimetric estimation of glucose by DNS method

8. Estimation of DNA by diphenylamine method Electrophoretic separation of plasma proteins

SEMESTER IV

OPEN ELECTIVE

1

BIOCHEMICAL TOXICOLOGY

COURSE TITLE	BIOCHEMICAL TOXICOLOGY
COURSE CREDITS	03
TOTAL CONTACT HOURS	42
DURATION OF ESA	03
FORMATIVE ASSESSMENT MARKS	40
SUMMATIVE ASSESSMENT MARKS	60

Course outcome: This open elective course offered to various streams gives basic idea about biochemical basis of various effects of toxins/ pharmaceuticals and an outline of process involved in toxicity testing and drug dosing.

- Categorize the classes of toxicants/drugs and know specific examples
- State the routes of exposure to toxins/drugs;
- Explain the processes of absorption, metabolism and elimination of toxins/drugs; and
- Explain environmental and physiological factors that affect toxicant metabolism

UNIT 1 : Fundamentals of toxicology and dose response 14 hours

Scope of toxicology; why should we know about toxins/xenobiotics (drugs) and What makes a substance toxic? Grading toxicity, Use of animal studies for toxicity, *in vitro* toxicity, organ toxicity (liver and kidney toxicity). Indicators of toxicity/drug effects; biomarkers. Concentration and site of action, dose response, effect of route of administration, ED_{50}, LD_{50}/TD_{50}. Hazard and risk assessment, risk, acceptable daily intake (ADI) and tolerable daily intake (TDI).

UNIT 2 : Factors affecting toxic responses 14 hours

Disposition- Outline of toxin/drug uptake, entry to cells and systemic circulation. Effect of size, shape, solubility, and charge on their uptake. Major sites of absorption, liver, intestine, skin, role of transporters, role of plasma proteins in distribution, plasma levels of toxins/drugs, plasma half-life, excretion- disposition by kidney, biliary excretion. Metabolism- types of metabolic changes of foreign compounds, biotransformation/detoxification reactions, phase-1 and, phase -2 reactions, nature of phase-1 and phase 2 enzymes.

UNIT 3 : Targets of toxic damages and biochemical mechanism of toxicity 14 hours

Toxins/drugs causing liver, kidney, gall bladder, and lung damage, methods of identifying the damages.
Examples of biochemical toxicity mechanisms; chemical carcinogens - Benzo[a]pyrene, Tamoxifen.
Liver necrosis- carbon tetrachloride, Valproic Acid, and Iproniazid,
Kidney damage- Chloroform, Antibiotics- gentamycin,
Lung damage- 4-Ipomeanol,
Neurotoxicity- Isoniazid, parquet, primaquine, cyclophosphamide.

SEMESTER IV

OPEN ELECTIVE

2

PLANT BIOCHEMISTRY

COURSE TITLE	PLANT BIOCHEMISTRY
COURSE CREDITS	03
TOTAL CONTACT HOURS	42
DURATION OF ESA	03
FORMATIVE ASSESSMENT MARKS	40
SUMMATIVE ASSESSMENT MARKS	60

Course outcomes: These topics will enable the students to

- Understand the plant cell, photosynthesis, transporters, and important primary metabolites.
- Illustrate plant growth regulators, plant's responses to various biotic and abiotic stresses.
- Explain about plant secondary metabolites and their functional importance.

UNIT 1 : 14 hours

Plant cell- structure and molecular components: Cytoskeleton- an overview. Plant cell division, cell cycle. Outlines of energy production in plant cells, Carbon assimilation and nitrogen assimilation.

An overview of photosynthesis: C3, C4 plants and crussulacean acid metabolism (CAM); photorespiration; Phytochromes, cryptochromes and phototropins. Non-protein thiols and sulfur cycle.

Plant cell membranes and membrane transport: Introduction to plant cell membranes and membrane constituents. Organization of transport systems across plant membranes; Different types of pumps operate at plant cell and organelle membranes; classification and importance of H^+-ATPases. Ion channels-properties and significance; Aquaporins and water transport.

Important Primary metabolites of plants: Cellulose, starch, sucrose, oligosaccharides; fructans, gums, mucilages, poly unsaturated fatty acids, lignin, suberin, surface waxes, sulfides and sweet proteins.

UNIT 2 : 14 hours

Plant growth regulators: Auxins, cytokinins, gibberellins, abscisic acid, ethylene, brassinosteroids, polyamines, jasmonic acid, salicylic acid.

Plant responses to biotic and abiotic stresses: Introduction; Plant pathogens and diseases; plant defense systems - hypersensitive response; systemic acquired resistance; induced systemic resistance; Plant biotic stress response to pathogens and insects.

Plant abiotic stress responses: Salt stress, drought, and heavy metal stress responses; osmotic adjustment and significance of osmotic agents such as proline, sugar alcohols and quaternary ammonium compounds; An overview of oxidative stress and oxidative damage. Antioxidant enzymes and stress tolerance.

UNIT 3 : 14 hours

Plant secondary metabolites (Natural products):
Introduction; secondary metabolites (natural productions) definition; classification of plant secondary metabolites (natural products). An overview of primary metabolism contribution to secondary metabolites biosynthesis.

Alkaloids: Classification of alkaloids; Contribution of amino acids for alkaloid biosynthesis; Isolation, purification and characterization of alkaloids. (S)-Seticuline-the chemical chameleon.

Phenolics: Classification of phenolic compounds; Classification of flavonoids; Classification of anthocyanins; Isolation, purification and characterization of phenolics.

Terpenoids: Classification of terpenoids, biogenic isoprene rule; volatile compounds; plant growth regulator terpenoids – gibberellin, abscisic acid; brassinosteroids and saponins Isolation, purification, and characterization of terpenoids

Biological properties of secondary metabolites: Role of secondary metabolites - in plants' defense; in insects' signalling, morphogenesis, and defense. Physiologically active secondary metabolites in modern medicine and therapeutic compounds for human ailments