Semester-wise titles of the Papers and marks distributions

M.Sc. (Biochemistry)

Year	Course Code	Paper Title	Core Compulsory/ Elective/ Value added	Theory/ Practical	Marks			Credits
					Ext	Int	Total	
FIRST SEMESTER								
I	CPDBC-1111	General Chemistry	Elective1	Theory	70	30	100	04
		Drug designing and Medicinal Chemistry	Elective 2	Theory	70	30	100	04
	CPDBC-1112	Fundamental Genetics and Microbiology	Core Compulsory	Theory	70	30	100	04
	CPDBC-1113	Cytology and Human Physiology	Core Compulsory	Theory	70	30	100	04
	CPDBC-1114	Bioenergetics and Intermediary Metabolism	Core Compulsory	Theory	70	30	100	04
	PR-101	Chemistry Practical	Core Compulsory & Ability enhancement	Practical	70	30	100	08
		Biochemistry Practical 1	Core Compulsory & Ability enhancement	Practical				
		Biochemistry practical 2	Core Compulsory & Ability enhancement	Practical				
		Total Marks and credits			**380**	**120**	**500**	**24**
SECOND SEMESTER								
	CPDBC-1121	Plant Biochemistry	Elective3	Theory	70	30	100	04
		Environmental Biochemistry	Elective 4	Theory	70	30	100	04
	CPDBC-1122	Advanced Enzymology	Core Compulsory	Theory	70	30	100	04
	CPDBC-1123	Immunology	Core Compulsory	Theory	70	30	100	04
	CPDBC-1124	Biostatistics and Bioinformatic	Core Compulsory & Ability enhancement	Theory	70	30	100	04
	PR-202	Biochemistry Practical 3	Core Compulsory & Ability enhancement	Practical	70	30	100	08
		Bioinformatics and Biostatistics Practical	Core Compulsory & Ability enhancement	Practical				
		Total Marks and credits			**380**	**120**	**500**	**24**

Year	Course Code	Paper Title	Core Compulsory/ Elective/ Value added	Theory/ Practical	Marks			Credits
					Ext	Int	Total	
THIRD SEMESTER								
2	CPDBC-1131	Bioprocess Engineering and Fermentation Technology	Core Compulsory	Theory	70	30	100	04
	CPDBC-1132	Molecular Biology	Core Compulsory	Theory	70	30	100	04
	CPDBC-1133	Clinical Biochemistry	Elective 5	Theory	70	30	100	04
		Nutritional Biochemistry	Elective 6	Theory	70	30	100	04
	CPDBC-1134	Biophysics and Biochemical Technology	Core Compulsory	Theory	70	30	100	04
	PR-303	Biochemistry Practical 4	Core Compulsory & Ability enhancement	Practical	70	30	100	08
		Biochemistry Practical 5	Core Compulsory & Ability enhancement	Practical				
		15 days Instrumentation Training	Core Compulsory & Ability enhancement					
			Total Marks and credits		**380**	**120**	**500**	**24**
FOURTH SEMESTER								
	CPDBC-PRO	Research Project	Core Compulsory		-	-	500	24

Semester 1

Title of Course: General Chemistry (Elective 1)	4 Hrs/week	4 Credits (60 hours)
Max Marks: 100 (Int: 30; Ext:70)		

Course Outcomes: Upon completion of this course, students will be able to:

CO1: This course develops skills of students to understand chemical processes in broader discipline.

CO2: Students understand the structure, properties, composition, reactions, and preparation of carbon-containing compounds

CO3: Students will be able to differentiate between optical isomers (enantiomers and diastereomers), geometric isomers (cis/trans, E/Z), and conformational isomers

CO4: students should be able to explain electrochemical reactions, calculate cell potentials, analyze electrode kinetics, and understand the principles of corrosion and energy storage devices, all of which are important for employment in R&D and related industries

CO5: Students should be able to solve problems related to heat transfer, work, energy, and entropy, and analyze the behavior of different substances and systems under various conditions.

Unit	Topics	No. of Hrs
I	**Basics** Electronic Theory of valency, dipole moments, electronic displacements in a molecule- inductive effect, electrometric effect, resonance effect; hyperconjugation, Bonding Interaction, hydrogen bond, Vander Waal interaction, electrostatic force, hydrophobic interaction, Atomic and molecular orbital and concept of hybridization. Types of Organic Reactions in brief Substitution, (SN1, SN2), addition, elimination, rearrangement condensation and polymerization, mechanism of substitution in benzene ring: o-, p- and m- directing groups.	10
II	**Hetero cyclic compounds** Heterocycle system occurring in living systems: Numbering of the ring and properties of pyran, Furan, thiazole, indole, pyridine, pyrimidine, quinoline, purine. Free radical in biological system: oxygen as a free radical in auto oxidation of fats, antioxidants.	10
III	**Stereochemistry** Structural isomerism, stereoisomerism, geometrical isomerism (E and Z nomenclature), Optical isomerism, optical activity, meso compound, chirality, enantiomers, diasterioisomer, D, L, R, S, threo, erythro, conformation and configuration, conformational analysis of n- butane, cyclohexane, mono and di substituted cyclohexane, (boat and chair forms), Anomers and mutarotation..	10
IV	**Electrochemistry-** Types of electrodes, standard electrode potential and its determination, its relationship with emf, electron transfer measures, Nernst equation, phosphate group transfer potentials, coupled reactions	10
V	**Water** Physical properties and structure of water, hydrogen bonding, ionization of water, pH scale, acid bases, Henderson- Hasselbalch equation, buffers, buffer solution and their action, ionization behavior of amino acids and protein, titration curve, buffer solutions and their action	10
VI	**Thermodynamics** Open, closed and isolated system, first law of thermodynamics, heat of formation and heat of reaction, second law of thermodynamics and calculation of entropy, Gibbs free energy, application of the first and second law of thermodynamics in understanding in living cells and chemical potential, equilibrium constant	10
	REFERENCES: • Physical Chemistry – Thomas Engel & Philip Reid,Pearson,2012 • Stereochemistry Conformation and Mechanism - P.S. Kalsi Publisher, New Age International, 2008. • Analytical Electrochemistry - Alfred J. Bard,Wiley,2015 • Stereochemistry of Organic Compounds – E. L. Eliel. Wiley-Interscience Publication.1994 • Principles of Physical Chemistry- Puri, Sharma & Pathania, Vishal Publishing Co. 2020 • Organic Chemistry - Morrison and Boyd, Pearson,2022	

Title of Course: Drug designing and Medicinal Chemistry (Elective 2)	4 Hrs/week	4 Credits (60 hours)

Max Marks: 100 (Int: 30; Ext:70)

Course Outcomes: Upon completion of this course, students will be able to:

CO1: To understand the basic principles of Drug design and development and the sequence of events necessary to bring a drug to market

CO2: Student will be able to describe and justify the role and importance of the various disciplines involved in the different phases of drug discovery and development

CO3: Students can understand how modern drugs were developed by using pharmacophore modelling and docking technique

CO4: Student can demonstrate knowledge on the most recent developments of drug design and can illustrate drug action through examples

CO5: Stiudents can recognise the role of the drug target and how its activity is screened

Unit	Topics	No. of Hrs
I	**Basics of Drug Designing** Drug discovery process–traditional approach and rational approach. Drug discovery phase–preclinical evaluation phase, clinical trial phase, phases of clinical trials and pharmacovigilance. Patent Protection, regulation, the future of pharmaceutical industry Introduction to Computer Aided Drug Discovery–importance and significance.	12
II	**Structure based drug design** Target identification and Validation Protein mapping: Constructing a model protein– homology modelling, Validation of protein models– Ramachandran plot, binding site identification- Receptor Grid generation. Molecular docking and drug receptor interactions: Rigid docking, flexible docking, and extra precision docking. Docking Software's–ArgusLab and Autodock..	12
III	**Ligand Based Drug Designing** Structure Activity Relationships in Drug Design, Structure Activity Relationship. Qualitative and quantitative approaches–advantages and disadvantages the two approaches. Quantitative structure activity relationship QSAR Parameters–Lipophilicity, electronic and steric factors. Experimental and theoretical approaches for the determination of these physicochemical parameters (descriptor generation)..	12
IV	**Basic Medicinal Chemistry** Drugs - Definition, historical evolution, classification of drugs, nomenclature of drugs. General idea regarding the milestones in drug research. Sources of Drugs. Routes of drug administration. Illustration of drug action through examples- Anticancer agents: Taxol - mechanism of action & uses. Antidiabetics: Diasulin mechanism of action& application. Anticholestemics: Mevastatin origin & mechanism of action	12
V	Concepts of agonist, antagonists (Competitive and noncompetitive), Partial agonist, Inverse agonist, functional antagonist, spare receptors, addiction, tolerance, dependence, tachyphylaxis, idiosyncrasy, allergy in pharmacology. Chiral drugs, Therapeutic uses of natural products such as streptomycin, erythromycin, study of therapeutical efficacy of laxatives (aloe, senna), Cardiotonic(digitalis arjuna), Antihypertensive (rauwolfia, Anti-tumour(vinca), Oxytocic(ergot)	12

REFERENCES:

- Medicinal Chemistry–The Modern Drug Discovery Process, E. Stevens, Pearson, 2014.
- Medicinal Chemistry -V. K. Ahluwalia and Madhu Chopra, Anes Student Edition, 2008
- An Introduction to Medicinal Chemistry - Graham L. Patrick, Oxford University Press, 1995.
- Computational Drug Design: A Guide for Computational and Medicinal Chemists-D.C.Young, Wiley Publications 2009
- The Practice of Medicinal Chemistry, C. G. Wermuth Elsevier, 2008.
- Fundamentals of Medicinal Chemistry, G. Thomas, Wiley Publications, 2003.
- Computational Drug Design–A guide for Computational and Medicinal Chemists, David C. Young., 2009
- The Organic Chemistry of Drug Design and Drug Action, R.B. Silverman Academic Press. 3rd edn., 2014

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M.Sc. (Biochemistry)

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		Biochemistry Practical 1	Core Compulsory & Ability enhancement	Practical				
		Biochemistry practical 2	Core Compulsory & Ability enhancement	Practical				
		Total Marks and credits			**380**	**120**	**500**	**24**
SECOND SEMESTER								
	CPDBC-1121	Plant Biochemistry	Elective3	Theory	70	30	100	04
		Environmental Biochemistry	Elective 4	Theory	70	30	100	04
	CPDBC-1122	Advanced Enzymology	Core Compulsory	Theory	70	30	100	04
	CPDBC-1123	Immunology	Core Compulsory	Theory	70	30	100	04
	CPDBC-1124	Biostatistics and Bioinformatic	Core Compulsory & Ability enhancement	Theory	70	30	100	04
	PR-202	Biochemistry Practical 3	Core Compulsory & Ability enhancement	Practical	70	30	100	08
		Bioinformatics and Biostatistics Practical	Core Compulsory & Ability enhancement	Practical				
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FOURTH SEMESTER								
	CPDBC-PRO	Research Project	Core Compulsory		-	-	500	24

Semester 1

Title of Course: General Chemistry (Elective 1)	4 Hrs/week	4 Credits (60 hours)
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CO4: students should be able to explain electrochemical reactions, calculate cell potentials, analyze electrode kinetics, and understand the principles of corrosion and energy storage devices, all of which are important for employment in R&D and related industries

CO5: Students should be able to solve problems related to heat transfer, work, energy, and entropy, and analyze the behavior of different substances and systems under various conditions.

Unit	Topics	No. of Hrs
I	**Basics** Electronic Theory of valency, dipole moments, electronic displacements in a molecule- inductive effect, electrometric effect, resonance effect; hyperconjugation, Bonding Interaction, hydrogen bond, Vander Waal interaction, electrostatic force, hydrophobic interaction, Atomic and molecular orbital and concept of hybridization. Types of Organic Reactions in brief Substitution, (SN1, SN2), addition, elimination, rearrangement condensation and polymerization, mechanism of substitution in benzene ring: o-, p- and m- directing groups.	10
II	**Hetero cyclic compounds** Heterocycle system occurring in living systems: Numbering of the ring and properties of pyran, Furan, thiazole, indole, pyridine, pyrimidine, quinoline, purine. Free radical in biological system: oxygen as a free radical in auto oxidation of fats, antioxidants.	10
III	**Stereochemistry** Structural isomerism, stereoisomerism, geometrical isomerism (E and Z nomenclature), Optical isomerism, optical activity, meso compound, chirality, enantiomers, diasterioisomer, D, L, R, S, threo, erythro, conformation and configuration, conformational analysis of n- butane, cyclohexane, mono and di substituted cyclohexane, (boat and chair forms), Anomers and mutarotation..	10
IV	**Electrochemistry-** Types of electrodes, standard electrode potential and its determination, its relationship with emf, electron transfer measures, Nernst equation, phosphate group transfer potentials, coupled reactions	10
V	**Water** Physical properties and structure of water, hydrogen bonding, ionization of water, pH scale, acid bases, Henderson- Hasselbalch equation, buffers, buffer solution and their action, ionization behavior of amino acids and protein, titration curve, buffer solutions and their action	10
VI	**Thermodynamics** Open, closed and isolated system, first law of thermodynamics, heat of formation and heat of reaction, second law of thermodynamics and calculation of entropy, Gibbs free energy, application of the first and second law of thermodynamics in understanding in living cells and chemical potential, equilibrium constant	10
	REFERENCES: • Physical Chemistry – Thomas Engel & Philip Reid,Pearson,2012 • Stereochemistry Conformation and Mechanism - P.S. Kalsi Publisher, New Age International, 2008. • Analytical Electrochemistry - Alfred J. Bard,Wiley,2015 • Stereochemistry of Organic Compounds – E. L. Eliel. Wiley-Interscience Publication.1994 • Principles of Physical Chemistry- Puri, Sharma & Pathania, Vishal Publishing Co. 2020 • Organic Chemistry - Morrison and Boyd, Pearson,2022	

Title of Course: Drug designing and Medicinal Chemistry (Elective 2)	4 Hrs/week	4 Credits (60 hours)

Max Marks: 100 (Int: 30; Ext:70)

Course Outcomes: Upon completion of this course, students will be able to:

CO1: To understand the basic principles of Drug design and development and the sequence of events necessary to bring a drug to market

CO2: Student will be able to describe and justify the role and importance of the various disciplines involved in the different phases of drug discovery and development

CO3: Students can understand how modern drugs were developed by using pharmacophore modelling and docking technique

CO4: Student can demonstrate knowledge on the most recent developments of drug design and can illustrate drug action through examples

CO5: Stiudents can recognise the role of the drug target and how its activity is screened

Unit	Topics	No. of Hrs
I	**Basics of Drug Designing** Drug discovery process–traditional approach and rational approach. Drug discovery phase–preclinical evaluation phase, clinical trial phase, phases of clinical trials and pharmacovigilance. Patent Protection, regulation, the future of pharmaceutical industry Introduction to Computer Aided Drug Discovery–importance and significance.	12
II	**Structure based drug design** Target identification and Validation Protein mapping: Constructing a model protein– homology modelling, Validation of protein models– Ramachandran plot, binding site identification- Receptor Grid generation. Molecular docking and drug receptor interactions: Rigid docking, flexible docking, and extra precision docking. Docking Software's–ArgusLab and Autodock..	12
III	**Ligand Based Drug Designing** Structure Activity Relationships in Drug Design, Structure Activity Relationship. Qualitative and quantitative approaches–advantages and disadvantages the two approaches. Quantitative structure activity relationship QSAR Parameters–Lipophilicity, electronic and steric factors. Experimental and theoretical approaches for the determination of these physicochemical parameters (descriptor generation)..	12
IV	**Basic Medicinal Chemistry** Drugs - Definition, historical evolution, classification of drugs, nomenclature of drugs. General idea regarding the milestones in drug research. Sources of Drugs. Routes of drug administration. Illustration of drug action through examples- Anticancer agents: Taxol - mechanism of action & uses. Antidiabetics: Diasulin mechanism of action& application. Anticholestemics: Mevastatin origin & mechanism of action	12
V	Concepts of agonist, antagonists (Competitive and noncompetitive), Partial agonist, Inverse agonist, functional antagonist, spare receptors, addiction, tolerance, dependence, tachyphylaxis, idiosyncrasy, allergy in pharmacology. Chiral drugs, Therapeutic uses of natural products such as streptomycin, erythromycin, study of therapeutical efficacy of laxatives (aloe, senna), Cardiotonic(digitalis arjuna), Antihypertensive (rauwolfia, Anti-tumour(vinca), Oxytocic(ergot)	12

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- Fundamentals of Medicinal Chemistry, G. Thomas, Wiley Publications, 2003.
- Computational Drug Design–A guide for Computational and Medicinal Chemists, David C. Young., 2009
- The Organic Chemistry of Drug Design and Drug Action, R.B. Silverman Academic Press. 3rd edn., 2014

Title of Course: Fundamental Genetics and Microbiology (Core compulsory)	4 Hrs/week	4 Credits (60 hours)

Max Marks: 100 (Int: 30; Ext:70)

Course Outcomes: Upon completion of this course, students will be able to:

CO1: The student will gain the Knowledge and practical skills of molecular genetic analysis of genetic diseases.
CO2: They can construct pedigrees and do analysis of pattern of inheritance in the families.
CO3:Students should be able to apply these concepts to explain biological phenomena and analyze genetic data
CO4: This course also demonstrates the knowledge to understand the microbial physiology and to identify the microorganisms
CO5: The aim is to equip students with a fundamental understanding of microorganisms, their interactions with their environment, and their role in various fields

Unit	Topics	No. of Hrs
I	**Genetics** Nature of Genetic Material, Chromatin, Chromosomes and Genes, Mutation and mutagenesis: Types and mechanism of mutagenesis, Detection, Molecular basis and application, Biochemical event occurring during Mitosis and meiosis, Transposons, Transposition in human Chromosomes, Chromosomal Abnormality.	12
II	**Mendelian Inheritance** Mendelian Genetics and Analysis: Extension of Mendelian Analysis, Mendelian Inheritance Chromosomal Basis of Inheritance, Genetic Recombination in Eukaryotes: Linkages and Crossing Over, Chromosome mapping, Chromosomal number (Euploidy and aneuploidy) and structural variation (Deficiencies, Duplications, Inversion and Translocation), Tetrad analysis, and Gene Conversion, Non-mendal inheritance.	12
III	**Gene Regulation and Developmental Genetics** Gene expression regulation during differentiation and growth: Heterochromatization in human being and other mammals, dosage compensation, Mechanism, Sex chromatin Position effect. Developmental Genetics: Model system Drosophilla: Genetic screen, Pattern formation, Maternal effect, Homeotic Transformation	12
IV	**Microbiology** Types of Microorganism, general characteristics of main Group of microorganisms, Criteria used in the classification of microorganism, nutrition and growth of microbial cell, gram positive and gram-negative organism. Lytic and lysogenic life cycle of Bacteriophages, Basic microbial genetics. Special feature of bacterial metabolism Entner-Doudroff Pathway, modified ED pathway	12
V	**Microbiology and its application** Role of Microorganism in Nitrogen Carbon, Sulphur and Phosphorus cycle, food spoilage, fermentation, food borne Infection, Involvement of Microorganism in Domestic and Industrial sewage.	08

REFERENCES:

- Microbiology :An Introduction 9th edition. Pearson Education. Tortora, Funke and Case. 2008
- Prescott's Microbiology. 9 th Edition, Wiley, Sherwood and Woolverton, McGraw Hill International,2013
- Principles of Microbiology. 2nd edition, Atlas RM. WM.T.BrownPublishers,1997.
- Microbiology. 5th edition. Pelczar,Chan and Krieg, McGrawHill Book Company. 1993
- Essential Cell Biology Alberts B. et al., Garland Science, Taylor & Francis Group,2020
- Genes IX Lewin B., Pearson,2007
- An Introduction to Genetic Analysis Griffith A. F. et al, Freeman,2007

Title of Course: Cytology and Human Physiology (Core compulsory)	4 Hrs /week	4 Credits (60 hours)
Max Marks: 100 (Int: 30; Ext:70)		

Course Outcomes: Upon completion of this course, students will be able to:

CO1: Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes

CO3:Student will understand how these cellular components are used to generate and utilize energy in cells.

CO2: The objective of this course is to demonstrate significant cell biological principles, quantitative and analytical approaches

CO4: It enable the students to translate the theoretical foundation in cell biology to be translated into human physiology

CO5: It provide students with a comprehensive understanding of how the human body functions, both in health and disease

Unit	Topics	No. of Hrs
I	**Cell Organization** Structural organization and function of prokaryotic and Eukaryotic intracellular organelles. Cell wall, Nucleus, Mitochondria, Ribosomes, Golgi bodies, lysosomes, Endoplasmic reticulum, peroxisomes, plastids, Vacuoles, Chloroplast, structure and function of cytoskeleton and its role in motility, Cell cycle and their checkpoints, Mitosis and meiosis, their regulation steps in cell cycle and control, programmed cell death, ageing, senescence, apoptosis, CDK- Cyclin	12
II	**Cellular communication** cell adhesion and role of different adhesion molecules, gap junction, ionophores, porin, nuclear pores, extracellular matrix, integrins.	08
III	**Cancer** Characteristics of normal and transformed cell, Genetic rearrangement in progenitor cells, oncogenes, Proto-oncogenes, P53 and Rb as tumor suppressor genes, virus induced cancer, metastasis and interaction of cancer cell with normal cells, apoptosis and therapeutic intervention of uncontrolled cell growth, molecular approaches to Cancer Treatment.	12
IV	**Human Physiology1** **Digestive system**: Composition, function and regulation of saliva, gastric, pancreatic, intestinal and bile secretion, Digestion and absorption of carbohydrate, lipids, proteins, nucleic acids, minerals and vitamins. **Excretory system:** Kidney, structure of nephron, glomerular filtration, Formation of Urine,, tubular reabsorption of glucose, water and electrolytes and tubular secretion **Endocrine system**: Human hormone, basic mechanism of hormone action.	14
V	**Human Physiology 2** **Blood:** Blood corpuscles, composition and function of plasma proteins, hemoglobin: synthesis and estimation, blood coagulation: its component and mechanism, role and clinical importance of 2,3- DPG, Bohr effect and chloride shift, transfer of blood gases: O2 and CO2, acidosis and alkalosis Biochemistry of vision and muscle contraction.	14

REFERENCES

- Human physiology, 12th edition, Stuart Ira Fox McGraw-Hill Education, 2011
- Tortora's Principles of Anatomy & Physiology, 15th edition by Gerard J. Tortora & Bryan H. Derrickson, John Wiley & Sons, 2017
- Vander's Human physiology, 15th edition by Hershel Raff, Eric Widmaier& Kevin Strang, McGraw-Hill Education, 2018
- Cell and Molecular Biology-Concepts and experiments,7th ed.,Gerald Carp, Wiley&Sons, 2008
- The Cell: A Molecular Approach, G.M. Cooper R.E. Hausman, 6 th ed., ASMPress, 2007
- Cell and Molecular Biology,8th ed.E.D.P.De Robertis & E.M.F.De Robertis, Lippincott Williams and Wilkins, 2001
- Molecular Biology of the Cell, 5th ed., Albertsetal.Garland Science,Taylor and Francis Group,2008
- Molecular Cell Biology, 6 th ed. Lodishet al., W.H. Freeman &Company, 2006

Title of Course: Bioenergetic and Intermediary Metabolism (Core compulsory)	4 Hrs/week	4 Credits (60 hours)

Max Marks: 100 (Int: 30; Ext:70)

Course Outcomes: Upon completion of this course, students will be able to:

CO1: Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and

CO2: Student will understand how cellular components are used to generate and utilize energy in cells

CO3:The objective of this course is to demonstrate significant cell biological principles, quantitative and analytical approaches

CO4: They will also explore the intricate pathways of intermediary metabolism, covering carbohydrate, lipid, and amino acid metabolism, as well as the regulation of these pathways

CO5: Students will understand the interactions between different metabolic pathways.

Unit	Topics	No. of Hr.
I	**Carbohydrate Metabolism** Approach for studying metabolism Glycolysis, Citric Acid Cycle, its function in energy generation and biosynthesis of energy rich bonds, Glyoxylate cycle, Pentose phosphate pathway and its regulation, alternate pathway of carbohydrate metabolism, Gluconeogenesis, interconversion of sugars, biosynthesis of glycogen, starch and oligosaccharides, glyoxylate cycle, regulation of blood glucose, hormonal regulation of carbohydrate metabolism.	12
II	**Fatty Acid Metabolism** Digestion and absorption of dietary lipids, Fatty acid biosynthesis: acetyl CoA carboxylase, fatty acid synthetase, desaturase and elongase, biosynthesis of saturated and unsaturated fatty acid, Fatty acid oxidation: α, β, Γ oxidation and ω-oxidation Lipid biosynthesis: biosynthesis of triacyl glycerol and phosphoglycerides and sphingolipids, biosynthetic pathways of terpenes, cholesterol, steroids and prostaglandins, ketone bodies: formation and utilization, metabolism of circulating lipids, chylomicron, LDL, HDL and VLDL, free fatty acids, lipids level in pathological conditions	12
III	**Amino acid & Nucleic acid Metabolism** **Amino acid:** Classification, Chemical structure and general properties of amino acid general concept of Amino acid metabolism, Peptide bond, Ramachandran Plot, Protein and its level of structure, intracellular proteins degradation (lysosomal, ubiquitin- the proteosomes), transamination, oxidative deamination, urea cycle and its regulation. **Nucleic acids:** De novo synthesis and salvage pathway of purine and pyrimidine nucleotides, regulation and degradation of purines and pyrimidines nucleotide, structure of ribonucleotides reductase, biosynthesis of ribonucleotides and deoxyribonucleotides and its regulation, Inhibitors of nucleotide metabolism	12
IV	**Biological oxidation** Biological oxidation, oxygenase, Hydroxylases, Dehydrogenases, and membrane potential, photon energy interconversion, chemotaxis and chemoreceptors, chemiosmotic theory, ion transport across energy transducing membranes, influx and efflux mechanism, transport and distribution of cations, anions and ionophores, uniport, antiport and symport mechanism, active and passive transport system, shuttle system, The mitochondrial respiratory chain, order and organization of carrier protein, proton gradient, p/O and H/P ratio, oxidative phosphorylation, uncouplers and inhibitors of energy transfer, fractionation and constitution of respiratory chain complexes. ATP- synthetase complex, microsomal electron transport, partial reduction of oxygen, superoxide	12
V	**Cell signaling** Types of signals and Cell surface receptor, signalling through G-Protein and receptor tyrosine kinase mediated signalling, Ca^{2+} flux and its interpretation in cytoplasm, Role of	12

	calcium binding protein, Importance of integrin in signalling, coupled receptor, Signal transduction pathway, second messenger and regulation of signalling pathway	

REFERENCES :

- Biochemistry (7th ed.), Berg, Tymoczko and Stryer (Freeman and Company (New York), 2012
- Lehninger: Principles of Biochemistry (7th ed.) Nelson, D.L. and Cox, M.M. Freeman & Company (New York), 2017
- Principles of Biochemistry 4th ed., Voet, Donald, Voet, Judith & Pratt, charlotte. Wiley & Sons,,2013
- Fundamentals of Biochemistry ,J L Jain,S.Chand Publishing ,2016
- Biochemistry, 4 th ed. Zubay, G., Wm.C Brown Publishers, 2009.
- Biochemistry, 6th edition, R H Garrett and C M Grisham Saunders College Publishing, 2017.
- Biochemistry, 6th edition, by Jeremy M. Berg W.H. Freeman & Co., NY. 5. 2007.
- Harper's Biochemistry, 26th edition, by R.K. Murray, P.A.Hayes, D.K.Granner, P.A. Mayes and V.W. Rodwell Prentice Hall International, 2003.
- Biochemistry, 3rd edition, by C.K. Mathews, K.E. vans Holde and K.G. Ahern Addison-Wesley Publishing Company 2000.

Title of Course: Practical - General Chemistry, Biochemistry Practical 1&2	4 Hrs /week	8 Credits (240 hours)
Max Marks: 100 (Int: 30; Ext:100)		

Course Outcomes: Upon completion of this course, students will be able to:

CO1: Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and

CO2: Student will understand how these cellular components are used to generate and utilize energy in cells.

CO3 : Students get more acquainted with the basic practical techniques related to various biomolecules and techniques involved in cell biology.

CO4: Student will be able to standardize and qualitatively& quantitatively estimate various biomolecules including carbohydrates, lipids and proteins in the biological samples

CO5: Student will able to quantitative and analytical approaches that enable the students to translate the theoretical foundation in cell biology to be translated into human physiology

Practical	Topics
I	1. Solving problems based on the first law of Mendel. 2. To solve problems based on the second law of Mendel. 3. To solve problems based on incomplete dominance. 4. To solve problems based on multiple allelism. 5. To solve problems based on co-dominance. 6. To solve problems based on gene interactions. 7. To solve problems based on sex-linked inheritance. 8. To solve problems based on limited traits. 9. To introduce the concept of linkage and calculations of linkage group. 10. Measurement of cells concentration of bacteria. 11. Counting of bacterial population by the spectrophotometer. 12. Cover slip culture technique for preparing permanent fungus mounts 13. Staining methods 14. Preparation of basic liquid media for routine cultivation of bacteria 15. Agar stands preparation 16. Streak plate methods 17. Pour plate methods 18. Spread-plate technique 19. Isolation of microorganisms from air **Instruments** Laminar Air flow Autoclave Hot air oven Cloning counter
II	1. Terms used in making solutions. 2. Working in principle of pH meter, Spectrophotometer, Centrifugation, Oven, Incubator. 3. To make a phosphate buffer. 4. Qualitative test for carbohydrates. 5. Determination of starch in plant tissue. 6. Determination of reducing sugar by Nelson Somogyi's method. 7. Qualitative test for lipids. 8. Determination of acid value of fats and oils. 9. Determination of saponification value of fats and oils 10. Determination of iodine number of fat sample 11. Estimation of cholesterol by Liberman Burchard method 12. Qualitative test for amino acid and protein. 13. To prepare casein protein from milk and its estimation 14. Estimation of protein by Bradford method 15. Determination of protein by Lowry's method

	16. Estimation of ascorbic acid in lemon juice using Folin's reagent	
General Chemistry	1.To standardize the given solution of KMNO4 2.To determine temporary and Permanent hardness of water 3. To determine the strength of the given potassium permanganate. 4. To determine the alkalinity of water sample by using N/5 HCL solution 5.To analyze given organic compound (I, II, III) 6. To determine Biochemical Oxygen Demand of a given wastewater sample 7.To determine chemical demand in a given wastewater sample	

Semester 2

Title of Course: Plant Biochemistry (Elective 3)	4 Hrs/week	4 Credits (60 hours)

Max Marks: 100 (Int: 30; Ext:70)

Course Outcomes: Upon completion of this course, students will be able to:

CO1: This course will provide students with a learning environment to understand important plant biochemical pathways.

CO2: A theme that underlies this course are the structure and function of enzymes in metabolic pathways and their contributions in plant growth and development.

CO3: Students will be able to answer the problem-based situations related to plant productivity, stress responses, chemical ecology and the production of secondary metabolites and their importance to mankind.

CO4 :Understand the light phase of photosynthesis and pathways of CO2 assimilation in C3, C4 and CAM plants.

CO5:Explain the various plant processes viz. nitrate assimilation, biological nitrogen fixation and sulphate assimilation in plants.

Unit	Topics	No. of Hrs
I	**Plant Cell** Structures and functions of plant cell (including cell wall, plasmodesmata, meristematic cells, vacuoles, secretary system and root quiescent zone)	10
II	**Photobiology** Structure of organelles involved in photosynthesis in plants and bacteria, proton gradient and electron transfer in chloroplast of plant and in purple bacteria-differences from mitochondria, light receptors-chlorophyll, light harvesting complexes, bacteriorhodopsin, rhodopsin as an ion pump. Hill reaction, photophosphorylation and reduction of CO2.	12
III	**Primary Metabolites** C2, C4 and CAM metabolism, light and dark reactions, light activation of enzymes, regulation of photosynthesis, photorespiration, biological nitrogen fixation and ammonia assimilation, nitrate and sulphate reduction and their incorporation into amino acids translocation of organic and inorganic substances.	14
IV	**Metabolites** Special features of secondary plant metabolism, formation of phenolic acids, tannins, lignin, pigments, terpenes, terpenoids, plant phenolics alkaloids and surface waxes-their biosynthesis and functions.	14
V	**Plant Hormones** Growth regulating substances and their work of action, molecular effects of auxins in regulation of cell extension and of gibberellic, abscisic acids and cytokinin in the regulation of seed dormancy, germination, growth and development and embryogenesis. Biochemistry of seed development and fruit ripening defense system in plants	12

REFERENCES:

- Hopkins – Introduction to plant physiology, Wiley, 2013
- Taiz and Zeiger – Plant physiology and developments 6th ed., Sinauer Associates Inc.,2014
- Biochemistry and Molecular Biology of Plants, Bob,B.Buchanan,W.Gruissen andR.L.Jo nesPublished by American Society of Plant Physiologists, 2000.
- Plant Biochemistry & Molecular Biology, 3rd ed., Hans Walter Heldt, AcademicPress 2005
- Introduction to Plant Biochemistry, T.W.Goodwin and E.I.Mercer Pergamon Press, Oxford,1983.

Title of Course: Environmental Biochemistry (Elective 4)	4 Hrs/week	4 Credits (60 hours)

Max Marks: 100 (Int: 30; Ext:70)

Course Outcomes: Upon completion of this course, students will be able to:

CO1: Understand air, water and soil pollution and its effects in living organisms.

CO2: Students will be familiar with bioremediation techniques in removing pollutants from soil and water

CO3: Understand biofuels and its types, production of biofuels from plants.

CO4: Understand the techniques in monitoring pollution including solid waste management and will be familiar with green chemistry and its twelve principles, green chemistry metrics.

CO5: Understand the concept of xenobiotics, interaction between xenobiotic and living organisms.

Unit	Topics	No. of Hrs
I	**Pollution** **Air pollution:** Types, sources (natural and anthropogenic sources) and consequences in living organisms.air borne diseases.diseases of the upper respiratory tract diseases (pharyngitis, laryngitis and diphtheria) and lower respiratory tract (whooping cough, pneumonia and tuberculosis). **Water pollution:** Types and sources (municipal, industrial and agricultural sources). Types of water pollutants (physical, chemical and biological). eutrophication, consequences of water pollution-water borne diseases (diarrheoa, dysentry, cholera, typhoid). **Soil pollution:** Types (agricultural soil pollution, soil pollution by industrial effluents and solid waste, soil pollution due to urban activities), sources and consequences of soil pollution – effects on human health and growth of plants. Electronic waste (e-waste) and its components	12
II	**Pollution Monitoring** Bioindicators, biomarkers, biochemical indicators, immunochemistry, genetic indicators. Toxicity testing using biological material- using plants and algae, luminescent organisms, ames test and molecular biology markers, biosensors. Air pollution monitoring, surveillance, surveys and investigation, water pollution monitoring, effluent analysis: measurement of metal pollutant using atomic absorption spectrophotometer (aas) and measurement of common anions (cyanide, sulphide, sulphite and chlorides).	12
III	**Bioremediation** Definition, scope and advantages. Bioremediation strategies. Indigenous micro-organisms, stimulation of indigenous microbial growth, bioaugmentation, genetically manipulated organisms. Bioremediation techniques: *in situ* – land farming, bioventing, biosparging and *ex situ* – composting (vermicomposting), biopile process, bioreactors (fluidized bed reactors, rotating disc bioreactors, single blanket reactors, sequential reactors). Phytoremediation: phytoextraction, phytodegradation, hytovolatilization, phytostabilisation. Removal of pollutants from the atmosphere: rhizofiltration, rhizostimulation. Applications of genetic engineering to phytoremediation.	12
IV	**Xenobiotics:** Behavior of xenobiotics in living organisms- absorption, distribution, biotransformation, toxic effects and elimination. Metabolism of xenobiotics: phase i reactions - oxidation, hydrolysis, sulphation, phase ii reactions- conjugation reactions. Role of cytochrome p450 **Metal toxicity and detoxification:** Introduction, biosorption and extra cellular precipitation. Biochemical toxicology and detoxification of cyanide, chromium, lead, cadmium, mercury and arsenic. Use of nanomaterials in detoxification	12

V	**Green Chemistry** Introduction, twelve principles of green chemistry, examples-production of 1,3-propanediol using genetically modified strain of e.coli, synthesis of tryptanthrin using β-cyclodextrin as catalyst and polylactic acid polymerization process. Green chemistry metrics- concepts like effective mass yield, carbon efficiency, atom economy,reaction mass efficiency, environmental factor and eco scale. Carbon credit. Water audits – water efficiency products india (wepi)	12

REFERENCES:

- Alexander. Martin Biodegradation and Bioremediation, second edition, ,Academic Press 2001
- Mukhopadhyay S.N. Process Biotechnology: Theory and Practice.Vol I The Energy and Resources Institute TERI 2012.
- Rajvaidya Neelima and Markandey D.K.. Environmental Biochemistry. APH Publishing Corporation 2005.
- Maheshwari D.K. and Dubey R.C. Bioremediation of Pollutants.Vol I.I.K.International Publishing House.2012.
- Indu Shekhar Thakur . Environmental Biotechnology -Basic concepts and Applications. I.K International Publishing house PvT LTD., Second Edition 2012.
- Pandey.S.N and Misra. S.P. Environment and Ecology.Ane Books Pvt LTD., Ane's Student Edition 2011

Title of Course: Advanced Enzymology (Core compulsory)	4 Hrs/week	4 Credits (60 hours)
Max Marks: 100 (Int: 30; Ext:70)		

Course Outcomes: Upon completion of this course, students will be able to:

CO1 The course is designed to give students an understanding of procedures involved in purification of enzymes, enzyme assays and quantitative evaluation of the influencing parameters such as concentrations of substrate/enzyme, pH, temperature and effect of inhibitors on enzyme activity.

CO2: The major learning objective of the course is to understand the theories of enzyme kinetics, the mechanisms of enzyme catalysis, and the mechanisms of enzyme regulation in the cell.

CO3:At the conclusion of the course make students able to describe the principles of enzyme inhibition.

CO4:Study of factors affecting enzymatic reactions, application of biochemical calculations for enzyme kinetics and plotting graphs based upon kinetic data.

CO5: Conceptualize the co-operative behavior of enzyme, Allosteric enzyme and understanding of regulatory mechanism of enzyme action

Unit	Topics	No. of Hrs
I	**Introduction** Characteristics of enzyme, isolation and purification of enzyme, methods of enzyme analysis, coenzyme, holoenzyme, prosthetic group and cofactor, IUB system of enzyme, nomenclature and classification, specific activity, activation energy, active site, factor affecting rate of enzyme catalyzed reaction, enzyme assay, collision and transition state theory, Multiple forms of enzyme: Zymogen, Isozyme, Abzyme, Ribozyme, Multienzyme complex.	12
II	**Enzyme Kinetics** Uni and multi substrate reaction with e.g. of each class, concept of ES complex, steady state hypothesis and Derivation and Modification of Michelis & Menton equation and their significances, different plot for determination of Km and Vmax and their physiological significance, Kcat /Km and its importance, Multi substrate Reaction: Sequential and Ping Pong Mechanism with Examples, enzyme turnover and its significance,	16
III	**Enzyme Catalysis** Experimental approach to study enzyme action: orientation and proximity effect, Acid-Base catalysis, covalent catalysis, nucleophilic catalysis, and microenvironment, mechanism of action of serine protease, chymotrypsin, lysozyme, ribonuclease and triose phosphate isomerase. Enzyme Inhibition: reversible and irreversible inhibition, Determination of KI	12
IV	**Enzyme Regulation** General mechanism of enzyme regulation feedback inhibition, feed forward stimulation, Enzyme repression. induction and degradation, control of enzyme activity by product and substrate, covalent modification of enzyme, Allosteric concept with special reference to aspartate transcarboxylase and phosphofructokinase. concerted and sequential model for action of allosteric Enzyme, Positive and Negative Cooperativity, Half site activity Hill Plot, Scat chard Plot monocyclic and multicycle cascade system with specific examples	12
V	**Enzyme Technology** Immobilized Enzyme and its Industrial application, Enzyme engineering, Enzyme Therapy: Assay of Enzyme activity for Diagnostic Purpose	08

REFERENCES:

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

Title of Course: Immunology (Core compulsory)	4 Hrs/week	4 Credits (60 hours)

Max Marks: 100 (Int: 30; Ext:70)

Course Outcomes: Upon completion of this course, students will be able to:

CO1 The course is designed to make students able to describe the roles of the immune system in both maintaining health and contributing to disease by identifying the cellular and molecular basis of immune responsiveness.

CO2: It develops the skills in students to describe how immunological responses are triggered and regulated through which they could transfer knowledge of immunology into clinical decision-making through case studies presented in class.

CO3: Conceptualization of molecular basis of Antigen Antibody interaction, immune cell interactions, recognition molecules and immunomodulatory molecules.

CO4: Understanding of genetic basis of diversity of immune response and also knowledge of immunization.

CO5: Knowledge of immune response against infectious agents and tumors, adverse effects of immune response including autoimmune disorders, hypersensitivity and immunodeficiency disorders.

Unit	Topics	No. of Hrs
I	**Introduction to Immune System** Innate and acquired immunity, active and passive immunity, humoral and cell mediated immunity, primary and secondary immune modulation, haptenes and adjuvant, Hematopoiesis, structure and function of primary and secondary lymphoid organs and cells of immune system, T and B cells lymphocytes with subsets and surface markers, Antigen presenting cells, Immune responses against foreign particle.	14
II	**Nature of Antigens and Antibody** Structure and function of immunoglobin, classes and subclasses of immunoglobulin with its biological activity, antigen antibody interaction, epitope and paratope, Antigen, vs. immunogenicity, factor that influence immunogenicity, immunoglobulin as antigen, clonal selection theory Generation of diversity in immune system. Monoclonal antibodies production and purification	12
III	**Immune activation** Major histocompatibility complex, polymorphism of MHC genes. HLA and H2 system, MHC antigen in transplantation, antigen processing and presentation: endogenous and exogenous response, T- cell diversity, T-cell activation and differentiation, B-cell activation and proliferation.	10
IV	**Immune Effector Mechanism** Cytokines, Complement System, Vaccination, Transplantation and graft rejection, ELISA, RIA, ELISPOT Assay, Immunoelectrophoresis, Immunofluorescence.	12
V	**Immunity and Infection** Autoimmunity, Hypersensitivity Immunotherapy, Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infection, Congenital and Acquired immunodeficiency.	12

REFERENCES:

- Immunology, 13th ed. by Roitt et al., Mosby Publications.
- Cellular and Molecular Immunology, 9thed. by Abbas and Litchman, Saunders Publication.
- Kuby Immunology, 7th ed. by R.A. Goldsby et al, W.H. Freeman & Co.
- Immunology: an introduction, 4th Edition by Ian R Tizard, Saunders College Publishing.

Title of Course: Biostatistics and Bioinformatics (Core compulsory)	4 Hrs/week	4 Credits (60 hours)

Max Marks: 100 (Int: 30; Ext:70)

Course Outcomes: Upon completion of this course, students will be able to:

CO1 The course is designed and merged in such a way so that curriculum could impart the basic knowledge to design, develop and analysis of software and hardware used to solve problems in a various scientific and social context.

CO2: The student would be able interpret the results accurate and meaningfully. They got the skills to organize vast reams of molecular biology data in an efficient manner and can develop tools that aid in the analysis of such data.

CO3: Understand the basic statistics and know how to analyse the biological data. 401.2 Equip the students to infer their results in a better way which is essential to get scientific data published in reputed journals.

CO4: Understand the fundamentals of bioinformatics.

CO5: Know how to use biological databases, retrieve information and link the wet and dry lab knowledge for better understanding of biological phenomenons.

Unit	Topics	No. of Hrs
I	**Introduction to Biostatistics** Aim and scope of statistics in biological sciences, Basic definition and applications, sampling and techniques, Data Collection and presentation: Types of data, methods of collection and graphic representation of data; Measure of central tendency: mean median and mode Measure of Variability: Standard deviation, standard error, Mean Deviation and coefficient of variation, corelation and regression, linear regression and regression equation. Test of significance: Chi-square test, t-test, Z-test, f-test and standard error Introduction to probability theory and distribution	12
II	**Introduction to Computer** Basic organization of computers, CPU, Input and Output devices, Personal computers, Mainframes and supercomputers, Hardware and software, Introduction to windows as an operating system, file and folders, commonly use commands, Basics of common application software packages for word processing (MS word), Spreadsheet (MS Excel) and Presentation (MS PowerPoint).	12
III	**Introduction to Bioinformatics:** Bioinformatics and its relation with molecular biology with applications. Human genome Project. Examples of related tools (FASTA, BLAST, BLAT, RASMOL), databases (GENBANK, PubMed, PDB) and software (RASMOL, Ligand Explorer). Data generation; Generation of large-scale molecular biology data (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction, and microarray), Important bioinformatics resources (NCBI, EBI, SIB).	12
IV	**Biological Databases:** Introduction to data types and Source, Primary & Secondary Database Primary & Secondary nucleotide sequence database (GenBank, EMBL, DDBJ, (TrEMBL) Primary & Secondary Protein sequence database- (PIR, SWISS PROT, PROSITE, Pfams, PRINTS, Uniports), Primary & Secondary Molecular Structure database (-PDB, CSD, CATH, SCOP) Composite and other database.	12

V	**Sequence Analysis:** Concept of Scoring matrix (PAM and BLOSUM), local alignment, global alignment, multiple sequence alignment (Clustal W algorithm), Heuristic Method-FASTA and BLAST and their types, similarity searching scores and their statistical interpretation, BLAT PS I & PI II BLAST. introduction to Phylogenetic: Phylogenetic Basics, Tree styles, Terminologies, types of phylogenetic tree, Distant based method – (UPGMA, NJ) Character Based Method - (MP and ML).	12

REFERENCE BOOKS:

- Statistical Methods by S P Gupta Sultan Chand and Sons. 2017, New Delhi
- Fundamentals of Mathematical Statistics, S C Gupta and V K Kapoor Sultan Chand and Sons,2014
- Essential Bioinformatics, JinXiong Cambridge University Press,2007
- Bioinformatics for Dummies, Jean-Michel Claverie, Cedric Notredame John Wiley and Sons,2003
- Introduction to Bioinformatics, 5th ed., Arthur M. Lesk Oxford University Press,2019
- Fundamental Concepts of Bioinformatics , Dan E. Krane, Michael L Raymer,2003

Title of Course: Biochemistry Practical 3 & Bioinformatics	4 Hrs /week	8 Credits (240 hours)
Max Marks: 100 (Int: 30; Ext:100)		

Course Outcomes: Upon completion of this course, students will be able to:

CO1: Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes,

CO2: Students will understand how these cellular components are used to generate and utilize energy in cells.

CO3: The objective of this course is to demonstrate significant cell biological principles, quantitative and analytical approaches that enable the students to translate the theoretical foundation in cell biology to be translated into human physiology

CO4: Develop the skills of extraction, purification assay of enzymes from plant and animal tissue.

Practical	Topics
III	1. To study time course of reaction catalyzed by alkaline phosphatase. 2. To examine effect of enzyme concentration on the reaction of enzyme catalyzed reaction. 3. To determine temperature Optima for alkaline phosphatase. 4. Effect of pH on reaction catalyzed by alkaline phosphatase. 5. Effect of substrate concentration on reaction catalyzed by alkaline phosphatase and to determine Km and Vmax. 6. Estimation of hemoglobin content of human blood. 7. Blood group determination slide agglutination. 8. Titration of polyclonal antiserum by radial immunodiffusion assay. 9. ELISA 10. Production of reducing equivalent by isolated chloroplast. 11. Production of starch during Photosynthesis. 12. Estimation of chlorophyll content using acetone. 13. Estimation of starch by Anthrone method. 14. To fractionate leaves cell by differential centrifugation technique.
Bioinformatics	1. To perform sequence manipulation suite (Combine Fasta) 2. To perform sequence manipulation suite (DNA stat) 3. To perform sequence manipulation suit to determine the protein molecular weight 4. To perform sequence manipulation suite (One to three) 5. To perform sequence manipulation suite (Three to one) 6. To perform transcriptional and translational tool for converting DNA<.> RNA<.> Protein 7. To perform nucleotide BLAST for local sequence alignment 8. To perform nucleotide BLAST for local sequence alignment (BLASTp) 9. To perform nucleotide BLASTx for local sequence alignment 10. To compare protein sequence to another sequence in a database (FASTA) 11. To perform Clustal w for aligning multiple protein or nucleotide sequence 12. To find out domain of casein protein by using smart tool

Semester 3

Title of Course: Bioprocess engineering and FermentationTechnology (Core compulsory)	4 Hrs/week	4 Credits (60 hours)
Max Marks: 100 (Int: 30; Ext:70)		

Course Outcomes: Upon completion of this course, students will be able to:

CO1: The course outcomes ensure students ability for effective communication within biotech and other interdisciplinary professionals and

CO2: They would be able to acknowledge health, safety and environment (HSE) issues in handling chemicals and biological materials and

CO3: Students can understands the environmental impacts associated with the activity.

CO4: To understand proteins, their structure, conformation and dynamics, protein folding, and protein purification and their separation

CO5: This course empowers them with the ability to think and solve problems in the field of biotechnology by converting theoretical knowledge into practical

Unit	Topics	No. of Hrs
I	**Recombinant DNA technology** Methods of creating recombinant DNA molecules, spacing properties of restriction enzymes and their modes of action, selection screening, y, synthesis of genes, cloning vector(lambda phage, plasmid, M-13 phage, Cosmid, BAC,YAC) shuttle vectors yeast and viral vector, expression vectors production in bacteria, cloned genes, subcloning, sequencing by Sanger's method, protein production in bacteria, site directed mutagenesis, AFLP, PCR, RAPD, antisense- RNA technology, chromosomal walking, jumping, landing , DNA chips, mycelium cell fusion ,selection of hybrid, hybridomas, protoplast fusion and HAT- medium, screening assay.	12
II	**Plant cell culture** Micropropagation, somatic cell culture, soma clonal variation, somatic cell hybridization, protoplast isolation, protoplast fusion, protoplast culture, genetic transformation various method for gene transformation (all vectors and vector less method), production of transgenic plants and their uses, production of secondary metabolites, primary and transferred cell culture, differentiated cell in culture	12
III	**Animal Cell Culture** Primary cell culture and established cell line, measurement of viability and cytotoxicity, characterization of culture cell, disaggregation of tissues and primary culture, maintenance of cell culture, cell separation, scaling up of animal cell culture, cell synchronization, cell transformation, application of cell culture	12
IV	**Genomics and Proteomics** Structural, functional and comparative Genomics, construction of cytological maps based on banding Pattern, construction of DNA library, genomic Vs. cDNA library, Sequence-tagged sites (STSs), Expressed sequenced Tags (ESTs), microsatellites, Variable number tandem repeats The Human Genome Project- mapping and sequencing of Human Genome, Proteomics and proteome, RNA and Protein assays of genome function and expressed sequences	12
V	**Fermentation Technology** Primary and. secondary metabolites in biotechnology, continuous and batch type culture technique, principal types of fermenter, general design of fermenter, fermentation process brewing, manufacture of penicillin, production of single cell protein, production strategies for antibodies and other organic compounds	12

Title of Course: Molecular Biology (Core compulsory)	4 Hrs/week	4 Credits (60 hours)

Max Marks: 100 (Int: 30; Ext:70)

Course Outcomes: Upon completion of this course, students will be able to:

CO1 This course imparts students the ability to demonstrate use of evolutionary theory and related equations.

CO2: They will understand the central dogma of biology and predict outcomes when the process malfunctions and gain skills required doing effective scientific research.

CO3: More specifically, students will learn to implement the scientific method by proposing hypotheses to explain biological phenomena, designing and conducting experiments to test these hypotheses, and critically interpreting the resulting data.

CO4: They also learn about DNA, RNA and protein synthesis.

CO5: They also learn about DNA damages and various repair mechanism.

Unit	Topics	No. of Hrs
I	**DNA** DNA as genetic material-Biochemical evidence, Primary, secondary and three-dimensional structure of DNA, Circular and Spherical DNA, Satellite and Repetitive DNA, Structure of Chromosomes and Chromatin, Heterochromatin, Euchromatin, DNA Supercoiling, Denaturation and Renaturation of DNA, Histones, Nucleosomes, DNA replication, DNA repair and Recombination c-values paradox, cot curve, counterions	16
II	**RNA** Role of RNA, Types of RNA, Primary and Secondary structure of RNA, Transcription –DNA directed RNA synthesis, Transcription Factor, RNA polymerase, Initiation, Elongation, and Termination of transcription, RNA processing, inhibitors of transcription, post transcriptional Modification—Splicing, cap addition, Polyadenylation, RNA directed DNA synthesis	12
III	**Translation** Structure and function of ribosome, genes, split genes, general features of genetic code, identification of genetic codes, identification of anticodon, wobble hypothesis, initiation elongation & termination of protein synthesis in prokaryotes and eukaryotes, post translation modification of protein, protein sorting and targeting	12
IV	**Gene Regulation in Prokaryotes and Eukaryotes** Interaction between DNA-DNA binding protein in eukaryotes, short term and long term regulation of gene expression, DNA binding protein to regulate transcription, (Zinc Finger, Leucine, Zipper, Helix loop Helix protein), DNA methylation coordination positive and negative control of gene –operon model, inducible system-lactose and arabinose operon, repressible system-tryptophan operon, lytic cascade and lysogenic, repression attenuation and antitermination, antisense RNA	12
V	**Transposable genetic element** Transposons, prokaryotic transposable genetic elements and mechanism of transposition, eukaryotes transposable genetic element in yeast, drosophila and maize, reassociation kinetics, Transgenic Organism.	08

REFERENCES:

- Genetics - A Conceptual Approach, 6th ed., 2012
- Lewin's Gene X 10th edition, Learning publishers, 2018
- The Cell: A Molecular Approach 7th ed.,Cooper, G.M. and Hausman, R.E. ASM Press & Sunderland (Washington DC), 2009
- Biochemistry 6th ed., Garrett, R. H., & Grisham, C. M. Brooks Cole,. 2016
- Lehninger: Principles of Biochemistry 7th ed. Nelson, D.L. and Cox, M.M W.H. Freeman & Company (New York),(2017
- Molecular biology of the gene: (7th ed), Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. ,Pearson. 2014

Title of Course: Clinical Biochemistry (Elective 5)	4 Hrs/week	4 Credits (60 hours)

Max Marks: 100 (Int: 30; Ext:70)

Course Outcomes: Upon completion of this course, students will be able to:

CO1: This course enhances the skill of students to understand the causes of different diseases with reference to their symptoms and could relate their impact in the body.

CO2: They further able to understand the processes of drug designing and

CO3: Students will be able to explain how the biochemical processes and signal transduction pathways.

CO4: Learn the etiology of disorders associated with carbohydrates, amino acids, lipids, nucleic acids, vitamins & minerals metabolism.

CO5: Understand and explain disorders associated with various hormones, disorders of acid-base and electrolytes balance in the body and neuropsychiatric disorders.

Unit	Topics	No. of Hrs
I	**Introduction, symptoms and treatment of Metabolic disorders** **Disorder associated with Carbohydrate:** Glucuronic acid pathway, glycogen storage disease; factors influencing blood glucose level, pentosuria, Diabetes milletus, Galactosemia **Protein calorie malnutrition-** Kwashiorkor and Marasmus; Ketone bodies, ketosis caused by abnormal metabolic pathway of Fatty acid, Disorders associated with protein and lipid metabolism: Gaucher's disease, Tay- Sach's, Niemann Pick Diseases, Alkaptonuria, Cystic	12
II	**Introduction, symptoms and treatment of Inherited Disorders** Phenylketonuria, Alkaptonuria, Albinism, Lesch-Nyhn syndrome, Down syndrome, Cystic fibrosis, Thalassemia, Turner's syndrome, Cirrhosis, Klinefelter Syndromes.	12
III	**Clinical analysis** Clinical investigation of sugar levels in blood and urine, carbohydrate tolerance tests, haemorrhagic disorders, disseminated intravascular coagulation, acquired prothrombin complex disorders, Functional test of liver, kidney, thyroid, gastrointestinal and pancreas, biochemical diagnosis of diseases by enzymatic assays, Clinical tissue analysis: biopsy and liquid biopsy, Molecular diagnostic tests	12
IV	**Vitamins and Minerals** Role of Vitamins in metabolic processes and various diseases resulting from the deficiencies of vitamins. Biochemistry of vitamin and minerals and diseases with their deficiency	12
V	**Pharmacology** History of development of pharmacology, introduction & general principles for route of drug administration, pharmacokinetics (absorption, distribution, metabolism and excretion) and pharmacodynamics (general mechanism of drugs). Clinical trial and drug development; Study of drug discovery, preclinical studies and phases of clinical trials in drug development.	12

REFERENCES:

- Textbook of Biochemistry for Medical student by Vasudevan DM 9th edition, Jaypee Brothers Medical Publisher, 2019
- Teitz text book of clinical chemistry 3rd ed., Carl A. Burtis and Edward R. Ashwood, W. B. Saunders Company,1999
- Harper's Biochemistry, 31st edition, R.K.Murray, P.A.Hayes, D.K.Granner, P.A. Mayes and V.W.Rodwell, Prentice Hall International. 2018
- Textbook of Biochemistry with Clinical Correlations, 6th edition by T.M. Devlin, Wiley-liss, 2005
- Biochemistry by U. Satyanarayana Books and allied (P) Ltd. 6. 2002
- Text Book of Biochemistry & Human Biology by G.P. Talwar, Prentice Hall, New Delhi,1989

Title of Course: Nutritional Biochemistry (Elective 6)	4 Hrs/week	4 Credits (60 hours)

Max Marks: 100 (Int: 30; Ext:70)

Course Outcomes: Upon completion of this course, students will be able to:

CO1: This course enhances the skill of students to understand the causes of different diseases with reference to their symptoms and could relate their impact in the body.

CO2: They further able to understand the processes of drug designing and would be able to explain how the biochemical processes and signal transduction pathways.

CO3: Students acquire detailed knowledge regarding dietary sources and nutritional importance of different nutrients.

CO4: Students will be able to describe different food toxicants, nutritional disorders and various applications

CO5: Students will acquire detailed knowledge regarding nutritional importance of different nutrients and how diet influences health.

Unit	Topics	No. of Hrs
I	**Basic concepts** Composition of Human body energy content of foods, measurement of energy expenditure: direct and indirect calorimeter, definition of BMR and SDA and factor affecting these, thermogenic effect of foods, energy requirement of man and women with factor affecting energy requirement. Carbohydrates: Dietary requirements and source of available and unavailable carbohydrates, physico chemical properties and physiological action of unavailable carbohydrates (dietary fibers)	12
II	**Proteins and Lipids** Protein-protein reserves of human body, nitrogen balance studies and factor influencing nitrogen balance, essential amino acids for man and concept of protein quality, cereal proteins and their limiting amino acids, protein requirement at different stages of development Lipids: major classes of dietary lipids properties and composition of plasma lipoproteins, dietary needs of lipids, essential fatty acids and their physiological functions	12
III	**Electrolytes and Water Balance** Electrolyte concentration of body fluids, acid-base regulation by the human body concept of metabolic and respiratory acidosis and alkalosis Minerals: Nutritional significance of dietary calcium, phosphorous, magnesium, iron, iodine, zinc and copper	12
IV	**Vitamins** Dietary sources, biochemical functions and specific deficiency diseases associated with fat and water soluble vitamins, nutritional requirement during proteins during pregnancy, lactation and of infant & children, protein energy malnutrition (PEM) Aetiology, clinical features, metabolic disorders and management of marasmus and kwashiorkor diseases	12
V	**Starvation** Techniques for the study of starvation, protein metabolism in prolonged fasting, protein sparing treatment during fasting, basic concept of high protein, low calorie weight reduction diets Obesity : definition and classification, genetic and environmental factors leading to obesity, obesity related and management of obesity, role of leptin in regulation of body mass, clinical nutrition, role of diet and nutrition in the prevention and the treatment of diseases: dental caries, fluorisis, renal failure, hyperlipidemia, Atherosclerosis and rheumatic disorders, inherited metabolic disorder, phenyl ketonuria, maple syrup disease,	12

	Hemocystinuria, galactosemia, gout, diabetes inspidus and diabetes mellitus, nutrigenomics	

REFERENCES:

- Biochemistry by U. Satyanarayana Books and allied (P) Ltd., 2002
- Essentials of Human Nutrition by J. Mann and A.S. Truswell 3rd ed. Oxford University Press Inc., New York, 2008
- Contemporary Nutrition by Wardlaw Smith 6th ed. Mc Graw Hill Inc., New York, 1996
- Nutritional Biochemistry by S. Ramakrishnan and S. Venkat Rao T. R. Publications, 1995
- Food Chemistry by Owen Fennema 3rd ed. CRC Press, 1996
- Food Science Chemistry and Experimental Foods by M. Swaminathan The Bangalore Printing and Publishing Co. Ltd. 1990
- Essentials of Human Nutrition,J.Mannand A.S.Truswell, 3rd ed.,Oxford University Press Inc., NewYork, 2008
- Contemporary Nutritionby Ward law Smith 6thed., McGraw Hill Inc., New York, 1996
- Food Chemistry, Owen Fennema 3rd ed. CRC Press.,1996

Title of Course: Biophysical and Biochemical Technology (Core compulsory)	4 Hrs/week	4 Credits (60 hours)

Max Marks: 100 (Int: 30; Ext:70)

Course Outcomes: Upon completion of this course, students will be able to:

CO1 This course is designed to expose Biochemistry students about the analytical skills and practical aspects of biochemistry.

CO2: The course is particular designed to understand principles underlying the various biochemical techniques. Students will gain the knowledge and skills to interpret and evaluate analytical data in order to communicate the results of biochemical analyses.

CO3: Know the radio-isotopic techniques and their application in biological science research.

CO4: Understand the basic techniques of molecular biology and relate modern DNA technology for disease diagnosis and therapy.

CO5: Know the antigen antibody interactions, experimental methods of monoclonal antibody synthesis and types of vaccines.

Unit	Topics	No. of Hrs
I	**Spectroscopy** Nature of electromagnetic radiations; Basic principle, instrumentation and applications; Atomic absorption and emission spectroscopy and its application, Principles and application of biophysical methods used for analysis of biopolymer structure-UV, Visible, Infrared, X-ray diffraction, Raman, Fluorescence and NMR spectroscopy, ORD and CD	12
II	**Electrophoretic technique** General principles and instrumentation, Factors affecting mobility migration of charged particles in an electric field, Electrophoresis of proteins -Native PAGE, SDS-PAGE, Gradient gels, isoelectric focusing gels, two-dimensional PAGE, Detection estimation and recovery of proteins in gels, Northern, Southern and Western Blotting, Electrophoresis of Nucleic Acid- Agarose gel electrophoresis, Pulse field electrophoresis	12
III	**Chromatography:** Principle and application of normal and reverse phase chromatography, paper and thin layer chromatography, column chromatography: adsorption & gas liquid chromatography, ion exchange, Affinity chromatography, HPLC—Basic principle, instrumentation and application	12
IV	**Centrifugation:** Basic principle, relate centrifugal force, instrumentation factors affecting sedimentation velocity, sedimentation coefficient, determination of molecular weight, differential centrifugation, density gradient, rate zonal, isoprene centrifugation	12

	Radioisotope technique & Microscopy Types of Radioactive decay; rate of radioactive decay; radioactive isotopes and their half -lives; Units of radioactivity; Measurement of radioactivity-methods based upon gas ionization & excitation; quenching emulsion counting, Geiger Mueller counter Autoradiography; Specific activity of radioisotope; Safety aspects; Radiation Dosimetry; Detection and measurement of isotopes and application of isotopes in biological science **Microscopy:** Light microscopy, electron (scanning and transmission) microscopy, and phase contrast, freeze-etch and freeze-fracture methods for EM staining of organelles and marker enzyme, resolving power of different microscopes'	12

REFERENCE BOOKS:

- Physical Biochemistry, 3rd edition, by K. E Van Holde.
- Principles and Techniques of Practical Biochemistry, 8th edition by Keith Wilson and John Walker
- Physical Biochemistry, 2nd edition, by D Friefelder.
- Biophysical Chemistry: Principles and Techniques, 3rd edition by A Upadhyay, K Upadhyay and N Nath

Title of Course: BIOCHEMISTRY Practical 4&5	4 Hrs /week	8 Credits (240 hours)

Max Marks: 100 (Int: 30; Ext:100)

Course Outcomes: Upon completion of this course, students will be able to:

CO1: Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and will understand how these cellular components are used to generate and utilize energy in cells.

CO2: The objective of this course is to demonstrate significant cell biological principles, quantitative and analytical approaches that enable the students to translate the theoretical foundation in cell biology to be translated into human physiology

CO3: Elucidate the basic elements of clinical biochemistry and specialized tests of biochemistry.

CO4: Develop the skills of performing basic biochemical tests important in clinical investigations and to develop familiarity with biochemical laboratory techniques.

CO5 Learn about use of instrumentation in design, execution and critical interpretation of experiments

Practical	Topics
IV	1. An enzymatic method for quantitative estimation of glucose in blood plasma using glucose oxidase. 2. To have RBC and WBC count. 3. Estimation of amylase activity in Saliva. 4. Estimation of glucose and ketone bodies in urine sample. 5. To estimate sugar in blood. 6. Quantitative determination of thymine in cereals and foods. 7. Measurement of riboflavin in human urine. 8. Estimation of blood groups. 9. The determination of RNA by orcinol method. 10. Quantitative determination of DNA and RNA by spectrophotometric method.
V	1. Isolation of different proteins by electrophoresis. 2. Visualization of DNA by gel electrophoresis. 3. Extraction of genomic DNA from animal or plants cells. 4. Estimation of total nucleic acid from plant tissue. 5. Estimation of DNA by diphenyl amine reaction. 6. Amplification of specific regions of genomic DNA. 7. Spectrophotometric method. 8. Separation and Identification of sugars by TLC. 9. To identify lipid in given sample by TLC. 10. Separation and identification of amino acid by ascending paper chromatography. 11. Separation and identification of amino acid by descending paper chromatography. 12. To verify the validity of beer's law and determine molar extinction coefficient of NADH. 13. Determination of requirements of NADH for LDH activity.

Semester 4

Title of Course: Research Project (Core compulsory)		24 (Credits) 720 hrs

Max Marks: 500; (Int: 00; Ext: 500)

Course Outcomes after completion of Research Project:

CO1: Students will identify a relevant problem, conduct a comprehensive literature review, define objectives, and design experiments or simulations to solve research questions in polymer science.

CO2: Demonstrate proficiency in advanced experimental techniques and characterization methods.

CO3: Analyze and interpret complex data to draw valid scientific conclusions.

CO4: Develop innovative solutions or materials for sustainable, industrial, or advanced applications.

CO5: Communicate research outcomes effectively through technical writing and presentations and inculcate varieties of learning styles and Software tools (Powerpoint presentation, Chem Draw and Origin, etc.).