I

SEMESTER-WISE DETAILS OF UNIT I TO IV IN EACH THEORY PAPER

SEMESTER

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
SIPSBCH11 Biomolecules-I	I	Proteins	4	1
	II	Proteomics		1
	III	Carbohydrates		1
	IV	Nucleic Acids		1
SIPSBCH12 Cell Biology-I	I	Evolution And Cell Structure	4	1
	II	Membrane Biochemistry		1
	III	Plant Biochemistry		1
	IV	Bioenergetics		1
SIPSBCH13 Biophysical Techniques	I	pH And Buffers; Colligative Properties; Radioisotope Techniques	4	1
	II	Centrifugation; Electrophoresis		1
	III	Spectroscopy		1
	IV	Chromatography		1
SIPSBCH14 Research Methodology; Biostatistics; Bioinformatics-I	I	Research & Research Design	4	1
	II	Data And Sampling		1
	III	Probability Data Analysis		1
	IV	Bioinformatics - I		
SIPSBCHP11	Quantitative Estimation of Biomolecules		2	4
SIPSBCHP12	Basic Microbial Techniques		2	4
SIPSBCHP13	Isolation of Biomolecules; Food Analysis		2	4
SIPSBCHP14	Research methodology; Biostatistics; Bioinformatics; Soft skills		2	4

SEMESTER-WISE DETAILS OFUNIT I TOIV IN EACHTHEORY PAPER

II

SEMESTER

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
SIPSBCH21 Biomolecules-II	I	Lipids; Vitamins	4	1
	II	Enzymes-I		1
	III	Enzymes-II		1
	IV	Endocrinology		1
SIPSBCH22 Cell Biology-II	I	Cell Signaling	4	1
	II	Developmental Biology		1
	III	Biochemistry Of Tissues		1
	IV	Techniques To Study Cells		1
SIPSBCH23 Industrial and Applied Biochemistry	I	Bioprocess Technology; Microbes In Industry	4	1
	II	Industrial Biochemistry; Waste treatment		1
	III	Techniques in Food Preservation		1
	IV	Environmental Biochemistry		1
SIPSBCH24 Research Methodology; Bio-statistics; Bioinformatics-II	I	Report Writing & Presentation	4	1
	II	Estimation and testing of Hypothesis		1
	III	Clinical Interventional Studies		1
	IV	Bioinformatics - II		
SIPSBCHP21	Enzymology		2	4
SIPSBCHP22	Chromatography And Electrophoresis Techniques		2	4
SIPSBCHP23	Chromatography And Electrophoresis Techniques		2	4

SEMESTER-WISE DETAILS OFUNIT I TOIV IN EACHTHEORY PAPER

III

SIPSBCHP24	Extraction Of Phytoconstituents / Bioactive Compounds From Plants	2	4

SEMESTER

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
SIPSBCH31 Molecular Biology-I	I	Classical Genetics; Replication of DNA	4	1
	II	Transcription And Translation		1
	III	Regulation Of Gene Expression		1
	IV	Genetic Recombination		1
SIPSBCH32 Immunology-I	I	The Immune System	4	1
	II	Antigen And Antibody		1
	III	Antigen-Antibody Interaction AndImmunotechniques		1
	IV	MHC; Antigen Presentation; Complement System		1
SIPSBCH33 Metabolism and Metabolic Disorders	I	Carbohydrate Metabolism And Related Disorders	4	1
	II	Lipid Metabolism And Related Disorders; Free Radical Metabolism		1
	III	Amino Acid Metabolism And Related Disorders		1
	IV	Nucleotide Metabolism And Related Disorders		1
SIPSBCH34 Clinical Nutrition	I	Basic Concepts In Nutrition	4	1
	II	Techniques In Nutrition		1
	III	Nutritional Diseases And Disorders		1
	IV	Diet In Health And Disease; Nutraceuticals		
SIPSBCHP31	Molecular Biology		2	4
SIPSBCHP32	Haematology		2	4

SEMESTER-WISE DETAILS OFUNIT I TOIV IN EACHTHEORY PAPER

IV

SIPSBCHP33	Clinical Biochemistry	2	4
SIPSBCHP34	Nutritional Biochemistry	2	4

SEMESTER

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
SIPSBCH41 Molecular Biology-II; Biotechnology	I	DNA Damage And Repair	4	1
	II	Recombinant DNA Technology-I		1
	III	Recombinant DNA Technology-Ii		1
	IV	Cell And Tissue Culture		1
SIPSBCH42 Immunology-II	I	Cytokines; Hypersensitivity	4	1
	II	Immune ResponseTo Infections; Transplantation Immunology		1
	III	Imunological Tolerance; Autoimmunity		1
	IV	Tumour Immunology; Immunodeficiency		1
SIPSBCH43 Medical Biochemistry	I	Water electrolyte balance; Mineral Metabolism	4	1
	II	Hemostasis And Hemoglobin Metabolism		1
	III	Pathophysiology; Organ Function Tests		1
	IV	Pathophysiology Of Cancer; Ageing		1
SIPSBCH44 Pharmaceutical Biochemistry	I	General Pharmacology	4	1
	II	Mechanism Of Action Of Therapeutic Drugs-I		1
	III	Mechanism Of Action Of Therapeutic Drugs-II		1
	IV	Natural Products And Drug Discovery		
SIPSBCHP41	Research Project		2	4
SIPSBCHP42	Serology		2	4
SIPSBCHP43	Clinical Biochemistry		2	4

SEMESTER-WISE DETAILS OFUNIT I TOIV IN EACHTHEORY PAPER

V

SIPSBCHP44	Pharmaceutical Biochemistry	2	4

Detail Theory Syllabus
SEMESTER I

Course Code		Title	Credits:4
SIPSBCH11		**BIOMOLECULES I** **Objectives***:* 1. *To study the structure and function of proteins, carbohydrates and nucleic acids* 2. *To understand the various aspects of proteomics i.e the methods and techniques employed and the applications in biochemistry*	No of Lectures
Unit 1	**Proteins**		**15**
	1.1	An overview of protein structure; Globular and fibrous proteins; Structural hierarchy of protein; Dihedral angles; Ramachandran plot; Primary structure determination: Determination of amino acid composition of protein; determination of sulfhydryl groups; Location of disulfide bonds; Determination of N and C-terminal residues; Edman reaction; peptide mapping motifs, and folds in protein structure; Secondary structure; Tertiary structure; Domains, Quaternary structure	
	1.2	Structure-function relation of proteins- Hemoglobin Protein-Protein interaction (actin, tubulin); Leucine zipper, Zinc finger.	
	1.3	Properties and mechanisms of protein folding. Prion proteins	
	1.4	Biologically important peptides: Insulin, Glucagon, Adrenocorticotrophic Hormone-ACTH, Thyrotropin Releasing Hormone, Corticotropin, Oxytocin, Vasopressin, Gastrin, Angiotensin, Carnocin and Anserine, bradikinin, encephalin, Aspartamine.	
Unit 2	**Proteomics**		**15**
	2.1	Purification of proteins: General strategy, Source identification, isolation, recovery, concentration. Partial/total purification by salting in, salting out, precipitation, ion exchange, dialysis, ultra-filtration, column chromatography (Gel filtration, Affinity, HPLC); determination of purity; gel electrophoresis	

	2.2	Proteomics Overview, tools and applications; Two-dimensional polyacrylamide gel electrophoresis; Protein spot detection; Mass spectrometry: matrix assisted laser desorption ionization MS, electrospray ionization MS, and tandem MS for protein identification; Identification of protein-protein interactions; Protein complexes.	
Unit 3	**Carbohydrates**		**15**
	3.1	Occurrence, classification, characteristics, structure and functions of monosaccharides, disaccharides, trisaccharides and polysaccharides;	
	3.2	Structure and conformation of sugars; stereoisomerism and optical isomerism; selected chemical reactions of the functional groups; sugar derivatives;	
	3.3	Mucopolysaccharides; Glycosaminoglycans; Proteoglycans; Glycoproteins; Carbohydrate-binding proteins- lectins	
	3.4	Carbohydrates of commercial importance: Starch, modified starch, cellulose, dextrins, cyclodextrins, maltodextrins, pectin, chitosan, microbial polysaccharides.	
Unit 4	**Nucleic acids**		**15**
	4.1	Nitrogen bases, nucleosides, nucleotides, polynucleotide; DNA as genetic material; Levels of structures of DNA; Forms: A, B & Z DNA, Properties of DNA in solution; Tm of DNA, its relation to GC content, unique and repetitive sequences of DNA, Cot curves and its significance, C-value paradox Central dogma of molecular biology.	
	4.2	Genome of prokaryotes, viruses, mitochondria, chloroplasts and eukaryotic organisms; Organization of eukaryotic DNA: Histones, nucleosomes, structure of chromatin; Eukaryotic chromosomes, lampbrush & polytene chromosomes; movable genes, transposons & retroposons, invert repeats, overlapping genes, Cryptic genes.	
	4.3	RNA: Structure, function and types of RNAs; unusual bases in RNA, catalytic RNA.	

Detail Theory Syllabus

SEMESTER I

Course Code		Title	Credits: 4
SIPSBCH12		**CELL BIOLOGY-I** **Objectives:** 1. *To provide an insight into the organization, biochemistry and functions of the cell.* 2. *To impart an understanding of the structure and function of biological membranes and mechanisms of solute transport* 3. *To understand the processes of transport and growth in plants.* 4. *To familiarize the learner with energy production pathways in animals and plants*	**No of Lectures**
Unit 1		**Evolution And Cell Structure**	**15**
1.1	**Biochemical Basis of Evolution**		
	1.1.1	Theories of Evolution –Time scale and spontaneous origin of life.	
	1.1.2	Genesis of oxygen generating photosynthesis & aerobic respiration. Methanogens – evolution of prokaryotes, protists & eukaryotes	
	1.1.3	Oparin's Hypothesis, Miller Experiment, Smith's Model, RNA First model. Theories regarding origin of mitochondria and chloroplast	
	1.1.4	Evolution of proteins and nucleic acid – elastic analysis. Evolution of introns, Evolutionary view of exon domain relationships	
1.2	**Cell Structure**		
	1.2.1	Prokaryotes: cell structure and components; Eukaryotes: cell structure, sub cellular components: Nucleus, chromosomes, plasma membrane, cell wall, endoplasmic reticulum, lysosomes, peroxisomes, Golgi apparatus,mitochondria, chloroplast, cytoskeleton, pili, and flagellum. Organelle marker enzymes. (Guided self study)	

	1.2.2	Cell division, mitosis and meiosis, cell cycle and regulation	
	1.2.3	Plant cells:, cell wall and cell organelles, classes of tissue. The interaction and communication between the cells. Purification of cells and their parts: flow cytometry, differential centrifugation.	
	1.2.4	Intergrating cells into tissues: Cell-cell adhesion, CAMs and the extracellular matrix, sheet like epithelial tissues: junctions and adhesion molecules, cell matrix adhesion, collagen, lamenin, elastic fibronectin.	
Unit 2	**Membrane Biochemistry**		**15**
	2.1	Biological membrane; structure and assembly: constituents, bacterial cell envelop, asymmetry flip flop, protein lipid interaction, factors affecting physical properties ofmembranes	
	2.2	Biological and physical membrane models. Specialized features like lipid rafts, caveolae and tight junctions.	
	2.3	Principles and Mechanism of Diffusion and Passive, Active & Facilitated Transport. Endocytosis, Exocytosis.	
	2.4	ATP-Powered Pumps, Role of Na-K ATPase, passive permeability of the plasma membrane to Na,K, Cl. Non-gated ion channels, co-transporters, voltage and ligand gated ion channels. Ion translocating antibiotics, valinomycin, gramicidin, ouabain, Ionophores.	
	2.5	Artificial Membranes (Liposomes), Preparation and applications. Supra-molecular membrane assembly -Viruses and Ribosomes.	
	2.6	Specialized mechanism for transport of macromolecules, gap junctions, nuclearpores.	
Unit 3	**Plant Biochemistry**		**15**

	3.1	Diffusion and Osmosis in plants and their significance, relationship among turgor pressure, wall pressure and osmotic pressure, water potential concept. Mechanism of water absorption, Ascent of sap, Transpiration:- types, mechanism of transpiration and factors affecting transpiration.	
	3.2	Biochemistry of plant growth: Biochemistry of seed development:- dormancy and germination. Phytochrome, photoperiodism and vernilization.	
	3.3	Plant growth regulators- Auxins, Gibberellins, Cytokines Abscisic Acid, Ethylene, oligosaccharins, jassmonic acid. Plant elicitors.	
	3.4	Calvin cycle, Photorespiration, C4 plants, CAM plants. Glyoxylate cycle.	
	3.5	Nitrogen metabolism and Nitrogen cycle : Nitrogen in soil, nitrate reduction in plants, Nitrogen fixation:- Nonbiological and biological nitrogen fixation, biochemistry of symbiotic and nonsymbiotic nitrogen fixation, nitrogen cycle, sulphur cycle, phosphorus cycle.	
	3.6	Secondary metabolites in plants, phytochemicals and their medicinal value.	
Unit 4	**Bioenergetics**		**15**
4.1	**Electron transport chain**		
	4.1.1	Chemistry of Water. Laws ofthermodynamics as applied to biological systems, enthalpy, entropy, free energy, standard free energy	
	4.1.2	Role of high energy phosphates in bioenergetics.	
	4.1.3	Electron Transport Chain in eukaryotes and prokaryotes, significance of redox potentials, mechanism of oxidative phosphorylation. Uncouplers and Inhibitors of energy transfer.	
4.2	**Photosynthesis**		
	4.2.1	Chlorophylls and accessory pigments	

	4.2.2	Photosynthesis-Light and Dark Phases, Schemes-I, II & Z, Cyclic andNon-CyclicPhotophosphorylation,C-3 & C-4 Pathways, CAM pathway.	

Detail Theory Syllabus
SEMESTER I

Course Code	Title		Credits 4
SIPSBCH13	**BIOPHYSICAL TECHNIQUES** **Objectives:** 1. *Understand the concepts of osmosis, surface tension, and viscosity* 2. *Appreciate the importance of buffers in living systems* 3. *Introduce the student to various classical and modern techniques used in biochemical study and research.* 4. *Give an insight to the principles, working, applications, and significance of these techniques.*		**No of Lectures**
Unit 1	**pH And Buffers; Colligative Properties; Radioisotope Techniques**		
1.1	**Colligative Properties**		**15**
	1.1.1	Definitions, Factors affecting , measurement of and physiological applications of Osmosis, Osmotic Pressure, Osmoregulation, Adsorption, Colloids, Surface Tension and Viscosity (Guided self study)	
	1.1.2	Numerical Problems based on above concepts	
1.2	**pH and Buffers**		
	1.2.1	pH, pH-dependent functions and structures of bio-molecules, Henderson–Hasselbach Equation, different methods for measurement of pH, Use of Indicators, Buffers, Amino Acid titrations, Biologically important buffers, ABG Analyzer	
	1.2.3	Numerical problems based on the above	
1.3	**Radioisotope Techniques**		
	1.3.1	Nature of radioactivity & its detection and measurements of radioactivity, Radioactive decay, Interaction of radioactivity with matter GM Counter, Scintillation Counter, Advantages and Disadvantages of Scintillation Counting.	

	1.3.2	Isotope Dilution, Analysis, Autoradiography, Application of radioisotopes in Biological Science	
	1.3.3	Safety Measures in Handling Isotopes.	
Unit 2	**Centrifugation and Electrophoresis**		**15**
2.1	**Centrifugation**		
	2.1.1	Basic principles of sedimentation, relation between g, rpm and Svedberg constant.	
	2.1.2	Principle, instrumentation, working and applications of Preparative and Analytical Ultracentrifugation, Isopycnic centrifugation, Rate Zonal centrifugation, Density gradient.	
2.2	**Electrophoresis**		
	2.2.1	Basic principle, factors affecting electrophoresis, support media used.	
	2.2.2	Instrumentation, working and applications of electrophoretic techniques-zone, Disc, Capillary, 2-D, Pulsed Field Gel, Diagonal, Isoelectric Focussing, immuno-electrophoresis.	
Unit 3	**Spectroscopy**		**15**
3.1		Beer-Lambert Law, its verification and deviations, concept of absorption, transmission, scattering, phosphorescence, fluorescence, luminescence.	
3.2		Principle, Instrumentation, working and application of – UV/Visible spectroscopy, Turbidometry, Nephlometry, IR Spectroscopy, Flame photometry, Atomic Absorption Spectroscopy	
3.3		Principle, instrumentation, working and applications of – Fluorescence spectroscopy; fluorescence spectra and the study of protein structure.	
3.4		Principle and applications of: Nuclear Magnetic Resonance (NMR); Electron Spin Resonance (ESR); Mass Spectrometry; Matrix Assisted LASER Desorption, Ionization-Time of	

		Flight-Mass Spectroscopy (MALDI-TOF-MS); Inductively Coupled Plasma Mass Spectrometer (ICP-MS)	
3.5		Principle and applications of X-Ray Diffraction Spectra, Optical Rotatory Dispersion,(ORD), Circular Dichroism (CD)	
3.6		LASER- Principle, applications in Medicine and Biological Sciences	
Unit 4	**Chromatography; Special Analytical Methods**		**15**
4.1	**Chromatography**		
	4.1.1	Basic Principles, Instrumentation, working and applications of partition chromatography (Paper), Adsorption chromatography (TLC, HPTLC, Column), Affinity, Ion Exchange and Gel permeation chromatography.	
	4.1.2	Basic Principles, Instrumentation, working and applications of Gas-Liquid Chromatography (GLC), High Performance Liquid Chromatography (HPLC), High Resolution Liquid Chromatography Mass Spectrometry (HR LC-MS)	
4.2	**Special Analytical Methods**		
		Basic Principle and applications of Conductometry, Potentiometry, Selective Ion Meters, High Frequency Titrations, Polarography, Anode Stripping Voltammetry, Neutron Activation Analysis.	

Detail Theory Syllabus

SEMESTER I

<table>
<tr><td>Course Code</td><td colspan="2">Title</td><td>Credits
4</td></tr>
<tr><td>SIPSBCH14</td><td colspan="2">RESEARCH METHODOLOGY; BIO-STATISTICS; BIOINFORMATICS-I
Objectives:
This paper has three components.
• The first part emphasizes on research methodology which intends to introduce the student to the methods and skills necessary in conducting research and presenting it.
• The subsequent unit provides an insight in to the fundamentals of statistics and its application in biochemistry.
• The third component of this course i.e. Bioinformatics is meant to familiarize the student with the use of computer software in understanding life processes and retrieval of information, and to learn the use of tools for biological data analysis.</td><td>No. of Lectures</td></tr>
<tr><td>Unit 1:</td><td colspan="2">Research & Research design</td><td>15</td></tr>
<tr><td>1.1</td><td colspan="2">Research</td><td rowspan="8"></td></tr>
<tr><td></td><td>1.1.1</td><td>Meaning of research, Research Process, Types of research</td></tr>
<tr><td></td><td>1.1.2</td><td>Formulating research problem</td></tr>
<tr><td></td><td>1.1.3</td><td>Criteria for good research. Significance of research.</td></tr>
<tr><td>1.2</td><td colspan="2">Research Design</td></tr>
<tr><td></td><td>1.2.1</td><td>Meaning, features of good research design, types of research designs</td></tr>
<tr><td></td><td>1.2.2</td><td>Basic principles of experimental Designs.</td></tr>
<tr><td></td><td>1.2.3</td><td>Prospective, retrospective, prospective & retrospective, observational, clinical trials, RCT, Cohort, cross sectional and case controlled studies</td></tr>
</table>

Unit 2:	**Data and Sampling**		**15**
2.1	**Application of Statistics in biological sciences**		
	2.1.1	Data: Definition, Types and Sources of data, Presentation of data; Measurement and scales of measurement.	
2.2	**Descriptive statistics**		
	2.2.1	Measures of central tendency : Mean, Median and Mode	
	2.2.2	Measures of dispersion: Range, percentiles, Mean deviation, Standard deviation, standard error variance, Coefficient of variation.	
2.3	**Sampling**		
	2.3.1	Different Sampling techniques: Significance of correct sampling techniques, types of sample; Representative sample, sample bias	
Unit 3:	**Probability; Data Analysis**		**15**
3.1	**Probability**		
	3.1.1	Probability: Definition	
	3.1.2	Probability Distribution: Concept of Normal distribution and normal curve, Asymmetric distribution	
	3.1.3	Statistical problems on the above stated concepts	
3.2	**Data Analysis**		
	3.2.1	Univariate and multivariate analysis. Brief introduction to three main frameworks: Monte-Carlo analysis, Parametric analysis, Bayesian analysis	
	3.2.2	Hypothesis testing and method of hypothesis testing, Types of error ; Significance of difference in means: Standard error of mean, Z-test, t-test (paired and unpaired), Standard error of proportion	
	3.2.3	Numerical Problems based on above concepts	
Unit 4:	**Bioinformatics - I**		**15**
4.1	**Introduction to Bioinformatics**		
	4.1.1	Central Dogma of Molecular Biology	

	4.1.2	Human Genome Project- Ethical, legal and social issues	
	4.1.3	Bioinformatics- Need and applications on various fields of Biology	
	4.1.4	Introduction to Next-Generation Sequencing technology (NGS)	
	4.1.5	Introduction to Databases- Biological application and Classification	
4.2	**Biological Databases and retrieval techniques**		
	4.2.1	Nucleotide Databases- Genbank, Unigene	
	4.2.2	Literature Database- Pubmed, Medline	
	4.2.3	Protein Sequence Databases- Swissprot, PIR	
	4.2.4	Protein Structural Databases- PDB, SCOP, CATH	
	4.2.5	Metabolic pathway database- KEGG, Metacyc	
	4.2.6	Other databases- OMIM, Taxonomy	

Detail Theory Syllabus
SEMESTER II

Course Code		Title	Credits: 4
SIPSBCH21		**BIOMOLECULES-II** **Objectives**: 1. *To introduce to the student the Structure and function of biomolecules viz., lipids and vitamins,* 2. *To give student an in-depth knowledge of enzymes, their classification, catalytic mechanisms and kinetics.* 3. *To understand the importance of enzymes in clinical biochemistry and industry and study the methods of immobilization of enzymes.* 4. *To study the mammalian endocrine system, its effector molecules and disorders related to abnormal production of hormones*	No of Lectures
Unit 1		**Lipids; Vitamins**	**15**
1.1	**Lipids**		
	1.1.1	Classification and types of lipids	
	1.1.2	Structure, nomenclature and properties of fatty acids; Triglycerides	
	1.1.3	Properties and functions of phospholipids, sphingolipids and glycolipids	
	1.1.4	Composition and biological role of lipoproteins	
	1.1.5	Structure and functions of steroids and prostaglandins; Eicosanoids; ω3and ω6fatty	
1.2	**Vitamins**		
	1.2.1	Classification of vitamins, Structure, metabolic (coenzyme) and physiological functions of Vitamin A. D, E , K and B-complex	
Unit 2		**Enzymes-I**	**15**
2.1		IUB/EC Enzymes classification, active site identification and Conformation.	

2.2		Enzymes as biological catalysts: characteristics, nomenclature and classification; Factors affecting initial velocity of enzyme catalyzed reactions, Requirement of metal, co-factor, coenzyme for activity, enzyme units	
2.3		Multifunctional enzymes and multienzyme complexes; Isoenzymes and their analysis; Ribozyme; Catalytic antibodies	
2.4		Kinetics of enzyme catalyzed reactions; Steady-state hypothesis and derivation of Michaelis-Menten equation; Significance of Km and Vmax and their determination using different plots; Double reciprocal plot; Enzyme inhibition: competitive, noncompetitive, and uncompetitive inhibition; Excess substrate inhibition; Enzyme kinetics in the presence of inhibitors; Determination of Ki;	
2.5		Mechanism of enzyme reaction : Acid –Base, Electrostatic & Covalent catalysis. Mechanism of serine protease and lysozyme	
Unit 3	**Enzymes-II**		**15**
3.1		Allosteric Enzymes-kinetics, significance of sigmoidal behavior, role in Metabolic Regulation.	
3.2		Iso-enzymes – separation and significance	
3.3		Clinical Enzymology- Enzymes as therapeutic agents, Diagnostic tools and laboratory agents.	
3.4		Industrial applications of enzymes, Enzymes acting on carbohydrates, proteins, lipids and nucleic acids	
3.5		Enzyme immobilization- methods and applications; use of enzymes in biosensors.	
Unit 4	**Endocrinology**		**15**
4.1	**Endocrine System**		
	4.1.1	Organization of mammalian endocrine system, classification Of hormones	
	4.1.2	Biosynthesis, storage, secretion, transport and metabolic effects (including hypo and hyper conditions) of hormones of thyroid, pancreas, pituitary, hypothalamus, parathyroid, adrenal medulla, adrenal cortex, gonads, kidneys and G I Tract.	

4.2	**Mechanism of Hormone action**		
	4.2.1	Role of secondary Messengers-cAMP, cGMP, Ca and Calmodulin.	
	4.2.2	Cell membrane and intracellular receptors for hormones. Regulatory pathways (positive, negative, feedback loops)	
4.3	**Endocrine regulation**		
	4.3.1	Role of Secondary Messengers-cAMP, cGMP, Ca and Calmodulin.	
	4.3.2	Cell membrane and intracellular receptors for hormones. Regulatory pathways (positive, negative, feedback loops)	

Detail Theory Syllabus

SEMESTER II

Course Code		Title	Credits: 4
SIPSBCH22		**CELL BIOLOGY II** **Objectives**: 1. *To familiarize the student to different mechanisms of signal transduction.* 2. *To provide an insight to the process and stages of human embryonic development and comprehend the role of stem cells in it.* 3. *To understand the physiology of muscle, bone, nerve and connective tissue.* 4. *To study the techniques and methods employed to understand the structure and functional aspects of cell.*	No of Lectures
Unit 1		**Cell Signaling**	**15**
1.1		Cellular Signaling: General principles of signaling by cell surface receptors, endocrine, paracrine and autocrine signaling, types of cellular responses induced by signaling molecules, components of intracellular signal-transudation pathways.	
1.2		Short Term Signaling: G-protein coupled receptor system, General mechanism of the activation of effectors molecules associated with G-protein-coupled receptors, G- protein coupled receptors that activate or inhibit adenylate cyclase, G-protein coupled receptors that activate phospholipase C, and G-protein coupled receptors that regulate ion channels.	
1.3		Long Term Signaling: Signaling of growth factors (EGF and Insulin) via activation of receptor tyrosine kinases. Signaling of TGFβ by direct activating Smad proteins. Cytokine signaling via JAK/STAT pathway.	
1.4		Cell-cell communication and molecular signaling in development : Concepts of induction and competence, epithelial-mesenchymal interactions, role of FGF-RTK pathway, JAK-STAT, Hedgehog family, Wnt family, TGF-β superfamily, Notch pathway and developmental signals from extracellular matrix.	

1.5		Cell Survival and Death Signal: Programmed cell death and role of Caspase protein inapoptosis. Various pro-apoptotic and anti-apoptotic regulators and pathways, genes	
Unit 2	**Developmental Biology**		**15**
2.1 **2.2**		Basic concepts of development, identification of developmental genes. Human embryonic development: Gametogenesis and fertilization.	
2.3		Post fertilization events and their morphogenesis: cleavage and formation of blastula, gastrulation, neural tube formation and cell migration.	
2.4		Model systems A. *C. elegans*: Study of cell lineage, mosaic development and organogenesis(vulva formation). B. Drosophila: Pattern formation, polarity determination of embryo by maternal genes, formation of body segments and Homeotic genes. C. Mouse: Vertebrate development, determining function of genes during development by generation of knock-out and knock-in models.	
2.5		Stem cells in development: Definition, types and properties of stem cells, role of stem cells in development and applications of stem cells.	
Unit 3	**Biochemistry of Tissues**		**15**
3.1	**Muscle**		
	3.1.1	Muscles- Functions of muscular tissue, organization of a muscle fibre, structure and composition of muscle fibres.	
	3.1.2	Muscle proteins: myosin and actin, mechanismof muscle contraction and relaxation,	
	3.1.3	Muscle metabolism, muscle fatigue	
3.2	**Bone**		
	3.2.1	Functions of Bone and skeletal system, Structure and composition.	
	3.2.2	Bone formation and remodelling	
	3.2.3	Factors affecting bone metabolism, bone remodelling	
3.3	**Nerve Tissue**		

	3.3.1	Nerves- Functions of the nervous system, structure and classification ofneurons, classification ofneuron, Mechanism of nerve impulse transmission, synapse and synaptic transmission	
	3.3.2	Synthesis and actions of neurotransmitters(GABA, Acetylcholine, Dopamine), disorders relatedtodefects in neurotransmission–(Parkinson's disease, stroke, Alzheimer's disease).	
3.4	**ConnectiveTissue**		
	3.4.1	ConnectiveTissue- General features of connective tissue, connective tissue cells and extracellular matrix, Classification of connective tissue.	
	3.4.2	Metabolism of Collagen and its Disorders-Ehler's Syndrome (Type I to VII), Osteogenesis Imperfecta(Type Ito IV), Paget's disease	
Unit 4	**Techniques to study cell structure and function**		**15**
4.1	**Microscopy**		
	4.1.1	Basic principles, instrumentation and application of Phase, Ultraviolet, interference and Fluorescence microscopy	
	4.1.2	Electron microscope – scanning emission microscopy, transmission emission microscopy	
	4.1.3	Confocal and Fluorescence microscopy and Atomic force microscopy	
4.2	**Special Methods**		
	4.2.1	Basic Principles, Instrumentation, working and applications of FISH, Flow Cytometry and Electroporation	

Detail Theory Syllabus
SEMESTER II

Course Code	Title	Credits 4

SIPSBCH23		INDUSTRIAL AND APPLIED BIOCHEMISTRY **Objectives** 1. *To acquaint the student to bioprocess/fermentation technology* 2. *To study the production process of commercially important primary and secondary metabolites of microbes and plants* 3. *To familiarize the learner to the role of plants and microbial cells in mineral leaching and bioremediation and to understand management and treatment of waste water* 4. *To expose the students to the techniques in food preservation and principles of quality control* 5. *To study the effect of industrial pollutants on environment and human health* 6. *To introduce basic principles of ecology and environmental biochemistry*	**No of Lectures**
Unit 1	**Bioprocess Technology; Microbes In Industry**		**15**
1.1	**Bioprocess Technology**		
	1.1.1	Bioreactor/fermenter; types of bioreactors	
	1.1.2	Parameters for Bio process – Bio mass, Substrates, product, $O_2$and CO_2, Temperature, agitation.	
	1.1.3	Primary and secondary screening of microbes, inoculum preparation, fermentation media, industrial sterilization, strain improvement, Fermentation-Submerged and solid state fermentation, pure and mix culture fermentations.	
	1.1.4	Downstream processing, process for product recovery, recycling of residual raw, by- product recovery.	
1.2	**Microbes In Industry**		
	1.2.1	Products from microorganisms – enzymes (Amylases, Proteases, Pectinases), Primary metabolites (Glu,vit B12), Antibiotics (Penicillin),Beverages (wine, Beer), bacterial and fungal polysaccharides,	
	1.2.2	Microbes in mineral recovery - Bioleaching and Biosorption, Bioremediation: Phytoremediation and microbial remediation. Production of Biomass, Production of Single cell protein, Fuels from microbes and microbial steroid bio transformations.	
Unit 2	**Industrial Biochemistry; Waste treatment**		**15**
2.1	**Industrial Biochemistry**		

	2.1.1	Manufacturing and refining of cane sugar; Extraction and refining of vegetable oils; Extraction and applications of chlorophyll, carotene, lycopene, curcumin and essential oils.	
	2.1.2	Isolation and applications of non – catalytic industrial proteins – casein, whey proteins, Egg proteins, wheat germ proteins	
2.2	**Production of vaccines and hormones**		
	2.2.1	Vaccines, types of vaccines & anti – toxoid technology for measles, poliomyelitis, typhoid, Hepatitis B, AIDS, anti-tetanus.	
2.3	**Waste treatment**		
	2.3.1	Steps involved in waste water treatment - (i) primary (sedimentation, screening, coagulation, flocculation, dilution, neutralization, equalization); (ii) secondary and; (iii) tertiary (clarification, disinfections, disposal of treated water).	
	2.3.2	Treatment methods: Activated sludge treatment, Trickle filters, Anaerobic filters, Aerobic and anaerobic sludge digestors, Septic tanks, Imhoff tank, Constructed wetlands and aerated lagoons; Remediation with algal ponds and evapo-	
	2.3.3	Monitoring methods and criteria used for measure success of waste treatment, COD, BOD, Total solid, pH, temp, TDS, heavy metals.	
Unit 3	**Techniques in Food Preservation**		**15**
3.1	**Bio Chemistry of Food Spoilage**		
	3.1.1	Factors causing food spoilage, spoilage due to fruit ripening, vegetable maturation and their methods to control.	
	3.1.2	Post mortem changes in meat and their control.	
3.2	**Food Preservation**		
	3.2.1	General principles of food preservation	
	3.2.2	Preservation by use of high and low temperatures, drying, radiations, natural & chemical preservatives, inert gases, mechanical preservation techniques (vacuum packaging, tetra packs), pulse electric field special packaging.	
3.3	**Food Adulteration**		
	3.3.1	Common food adulterants, their harmful effects	
	3.3.2	Physical and chemical methods for their detection.	
3.4	**QC, GMP and regulatory bodies**		
	3.3.1	Monitoring food quality, General principles of Quality Control and Good Manufacturing Practices in food industry.	

	3.3.3	Role of ISI Agmark FDA & Food Safety and Standards Authority of India (FSSAI), Food and Agricultural Organization (FAO) in food industry.	
Unit 4		**Ecology and Environmental Biochemistry**	**15**
4.1	**Ecology**		
	4.1.1	**Introduction to Ecology:** Scope of ecology, Ecosystems, Definition and Components, Biological Communities, Terrestrial Biomes, Succession, Limnology, Population ecology	
	4.1.2	Ecosystem and Interactions, Structure and Function of Ecosystems. Aquatic and Terrestrial Ecosystems, Biotic and Abiotic Factors, Trophic Levels, Interactions: Commensalism, Ammensalism, Mutualism, Predation and Antibiosis, Parasitism, Altruism	
4.2	**Nutrient cycles and energy flow in ecological systems**		
	4.2.1	Nutrient Cycle and Biogeochemical Cycles: Water, Carbon, Oxygen, Nitrogen, Sulphur and Phosphorus.	
	4.2.2	Concepts of energy, primary productivity, energy in food chains, ecological pyramid	
	4.2.3	Biodiversity-status, management approaches Concept of - Endangered, Threatened, Vulnerable, Rare and Extinct species	
4.3	**Environmental biochemistry**		
	4.3.1	Air pollution : classification & effects of air pollutants on human health, Gases containing the oxides of carbon, sulphur and nitrogen, ozone andCFC. Measures to control air pollution and suspended particulate matters in air. Greenhouse effect & Global warming – sources, consequences & remedial measures.	
	4.3.2	Water Pollution: Sources and effects of water pollutants on human health, quality standards for drinking water.	
	4.3.3	Noise Pollution: Sources, measurement, health hazards, prevention & control of noise pollution.	
4.4	**Toxins in environment**		
	4.4.1	Chemical toxicology –Biochemical effects ofheavy metals (Pb, As, Hg, Cd), pesticides, insecticides, herbicides, weedicides, larvicides, polyaromatic hydrocarbons, dyes, monomeric and polymeric organics.	

	4.4.2	Emerging eco-friendly alternatives for chemical industry – Green chemistry and Green Technology.	

Detail Theory Syllabus
SEMESTER II

Course Code		Title	Credits 4
SIPSBCH24		**RESEARCH METHODOLOGY, BIOSTATISTICS AND BIOINFORMATICS II** **Objectives**: *This paper has three components.* • *The first part emphasizes on research methodology which intends to introduce the student to the methods and skills of report writing and paper presentation.* • *The subsequent unit provides an insight to hypothesis testing, application of statistics in clinical studies and demography.* • *The third component of this course i.e. Bioinformatics is meant to familiarize the student with the use of softwares and tools for protein structure analysis and protein structure prediction.*	**No. of Lectures**
Unit 1	**Report Writing & Presentation**		**15**
1.1	**Report Writing**		
	1.1.1	Significance of report writing, different steps in report writing, types of report	
	1.1.2	Mechanics and precautions of writing research reports for scientific journals, popular magazines, seminars/symposia/ conferences/workshops	
	1.1.3	Layout of research paper, Layout for poster	
1.2	**Presentation**		
	1.2.1	Presentation – Oral & written. Use of digital media..	

	1.2.2	Presentations in classrooms, scientific meets & public audience	
	1.2.3	Defense of research thesis.	
1.3	**Ethics in scientific communication**		
	1.3.1	Data manipulation and plagiarism	
Unit 2	**Estimation and testing of Hypothesis**		**15**
2.1	**Non-parametric tests**		
	2.1.1	Importance of non-parametric tests.	
	2.1.2	Hypothesis tests with ANOVA, ANOVA Tables, Analysis of categorical data, two way contingency tables.	
	2.1.3	Test of goodness of fit, calculation of chi square test & yate's Correction, restrictions in applications of chi-square	
2.2	**Measures of association**		
	2.2.1	Correlation and regression analysis. Simple correlation and regression. Multiple correlation and regression, partial correlation, logistic regression. Partial correlation analysis.	
	2.2.2	Yule's coefficient of association, Spearman's Rank correlation coefficient Importance of non-parametric tests.	
Unit 3	**Clinical Interventional Studies**		**15**
3.1	**Diagnostic Tests**		
	3.1.1	Importance of statistics in diagnostic tests	
		Sensitivity, specificity, positive predictive value, negative predictive value, accuracy, probability and odds ratio, likelihood ratio(LR), LR of positive test, LR of negative test Receiver operating characteristics (ROC) curves	
3.2	**Demography & Vital Statistics**		
	3.2.1	Collection of demographic data, vital statistics at state &	

		National levels, reports of special demographic surveys.	
	32.2	Measures of vital statistics: Rate of mortality, fertility, reproduction, morbidity, comprehensive indicators, indices of health population growth rates and density of population.	
Unit 4:	**Bioinformatics - II**		
4.1	**Genomic and Protein Sequence Analysis**		**15**
	4.1.1	Pair wise sequence alignment, gaps, gap-penalties, scoring matrices- PAM, BLOSUM, Local and global sequence alignment	
	4.1.2	Nucleotide and Protein sequence analysis using BLAST and Variants	
	4.1.3	Introduction to multiple sequence alignment- Progressive algorithms-Clustal programs.	
4.2	**In-silico Protein structure prediction**		
	4.2.1	Introduction to protein structure	
	4.2.2	Protein-protein interaction	
	4.2.3	Computational methods in protein Secondary structure Prediction	
	4.2.4	Computational methods in protein Tertiary structure prediction, Homology modeling	

Detail Theory Syllabus
SEMESTER III

Course Code	Title	Credits 4

SIPSBCH31		**MOLECULAR BIOLOGY-I** **Objectives:** 1. *To study Mendelian genetics* 2. *To provide an in-depth understanding of the mechanism of replication, transcription and translation in prokaryotes and eukaryotes.* 3. *To study regulation of gene expression* 4. *To understand epigenetics and implications in disease.* 5. *To familiarize the learner with recombination mechanisms in prokaryotes and eukaryotes.*	**No. of lectures**
Unit 1		**Classical Genetics; Replication of DNA**	**15**
1.1	**Overview of classical genetics**		
	1.1.1	Mendelian genetics: Mendelian laws and basis of inheritance, dominance, recessivity, genotype, phenotype. Problems based on Mendelian genetics	
	1.1.2	Extensions of Mendelian Genetics: Chromosomal theory of heredity, sex-linked inheritance, multiple alleles (ABO blood group, Drosophila eye color), extrachromosomal inheritance.	
	1.1.3	Modifications of dominance relationships, Gene interaction, epistasis, Essential genes and lethal genes	
1.2	**Replication of DNA**		
	1.2.1	Modes of replication; Meselson and Stahl's experiment Semi-conservative replication, Okazaki fragments, enzymes and proteins in DNA replication prokaryotic & eukaryotic DNA polymerases; types and their functions	
	1.2.2	Replication of circular DNA , bidirectional replication, replication bubble and fidelity of replication, Rolling circle replication	
Unit 2		**Transcription and Translation**	**15**
2.1	**Transcription of DNA**		

	2.1.1	DNA dependant RNA polymerases in prokaryotes and eukaryotes, in vitro assay, properties of the enzymes, subunit structure	
	2.1.2	Mechanism of transcription: template directed synthesis, sigma cycle, promoter recognition. Properties of promoter in prokaryotes and eukaryotes	
	2.1.3	Post-transcriptional processing; maturation of rRNA & tRNA, RNA splicing mechanism, poly A tail and 5 capping, noncoding sequences	
2.2	**Translation**		
	2.2.1	Mechanism of translation: activation, initiation (importance of Shine-Dalgarno sequence), elongation and termination:, nonsense codons, role of RF1 and RF2 and GTP; Eukaryotic protein synthesis	
	2.2.2	Post translational processing and modification, signal hypothesis, zymogen activation	
	2.2.3	Specific Inhibition of protein biosynthesis	
Unit 3	**Regulation Of Gene Expression**		**15**
3.1		Organization of gene: structural & regulatory elements; split genes	
3.2		Prokaryotic gene regulation; positive and negative control, induction and repression, attenuation. Example: lac, trp, his operons;	
3.3		Eukaryotic gene regulation: Role of upstream, downstream and enhancer, elements, cis-trans acting elements in gene expression, examples and experimental evidences	
3.4		Medical genetics: Genetic screening, Genetic diagnosis, Genetic counseling	
Unit 4	**Genetic recombination**		**15**
4.1		Genetic recombination in bacteria: conjugation, transformation & transduction.	

4.2		Mapping of genes by conjugation, transformation & transduction	
4.3		Holliday & Messelson-Radding models of recombination; proteins and enzymes involved in genetic recombination	
4.4		Gene linkage & crossing over, tetrad analysis	
4.5		Transposable elements	
4.6		Model organisms: *S.cerevisiae, Arabidopsis, Mus musculus*	

Detail Theory Syllabus
Semester III

Course Code		Title	Credits 4
SIPSBCH32		**IMMUNOLOGY I** **Objectives** 1. *To give an in depth knowledge about the immune system and its organization,* 2. *To study the effectors of adaptive and innate immunity* 3. *To understand the biochemical mechanisms involved in immune responses and immune-mediated diseases.* 4. *To familiarize the student to the various techniques employed in the study of immunology and diagnosis of diseases and other emerging areas in this field.*	No of Lectures
Unit 1		**The Immune system**	**15**
1.1		**Overview of immune system:** Types of immunity, effectors of innate and adaptive response.	
1.2		**Cells and organs of Immune systems**	
	1.2.1	Hematopoiesis, Cells of the immune system.	
	1.2.2	Primary and secondary Lymphoid Organs, Lymphocyte Traffic.	
	1.2.3	B cell maturation, activation and differentiation.	

	1.2.4	T cell subsets and their function: T cell receptor, structure, organization and rearrangement of TCR genes. T cell receptor complex- TCR-CD3. T cell accessory membrane molecule. Ternary TCR-Peptide-MHC Complex. T cell– Maturation, activation & differentiation. Regulation of Immune response.	
Unit 2	**Antigen and antibodies**		**15**
2.1	**Antigens**		
	2.1.1	Antigenic determinants, antigenicity and immunogenicity	
2.2	**Immunoglobulins**		
	2.2.1	Basic structure, classes, subclasses, function	
2.3	**B and T cell surface receptors**		
2.4	**Organization and expression of immunoglobulin genes**		
	2.4.1	Theories of antibody formation, Immunoglobulin variability	
	2.4.2	Antibody diversity- Genetic basis and mechanisms	
2.5	**Monoclonal antibodies**		
	2.5.1	Production and clinical uses	
	2.5.2	Engineered monoclonal antibodies, Chimeric and hybrid monoclonal antibodies	
Unit 3	**Antigen-Antibody Interaction and Immunotechniques**		**15**
3.1	**General principles of antigen-antibody interaction**		
		Strength of Ag-Ab Interaction, Antibody Affinity, Antibody Avidity, cross reactivity. Primary and Secondary Ag-Ab Interaction	
3.2	**Immunotechniques**		
	3.2.1	Application of antibodies in diagnostics: precipitation and agglutination reaction, Immunodiffusion, Immunoelectrophoresis	
	3.2.2	Principles and applications of RIA, ELISA, Immunofluorescence, Biotin-Avidin Ab Technique, Western blotting, Flowcytometry	
3.3	**Experimental Animal Models**		

	3.3.1	In Breed Strength, Adoptive Transfer Systems, SCID Mice and SCID Human Mice.	
3.4	**Cell Culture System**		
	3.4.1	Primary Lymphoid Cell Culture, Clone Lymphoid Cell Line, Hybrid Lymphoid Cell Line	
Unit 4	**MHC, antigen presentation and Complement system**		**15**
4.1	**Major Histocompatibility Complex (MHC)**		
	4.1.1	General organization and inheritance of MHC	
	4.1.2	Structure of Class I and Class II HLA molecules and organization of Class I and Class II HLA genes. Cellular distribution of MHC molecules	
	4.1.3	Regulation of MHC expression	
	4.1.4	MHC and susceptibility to disease	
4.2	**Antigen processing and presentation**		
	4.2.1	Self MHC restriction of T cell, role of antigen presenting cells	
	4.2.2	Pathways for antigen processing, cytosolic and endocytic pathway, clinical application	
4.3	**Complement System**		
	4.3.1	Components and function; Complement activation, classical and alternative pathways of membrane attack complex.	
	4.3.2	Complement receptor and biological consequences of Complement activation, cell lysis, inflammatory response, opsonisation of antigen, viral neutralization, solubilisation of immune complexes.	
	4.3.3	Complement deficiency.	

Detail Theory Syllabus

SEMESTER III

Course Code	Title	Credits 4

SIPSBCH33	**METABOLISM AND METABOLIC DISORDERS** **Objectives:** 1. *To study the pathways for metabolism of carbohydrates, lipids, amino acids and nucleic acids* 2. *To understand the regulation of metabolic pathways and its implications in disease* 3. *To study the inborn errors of metabolism*		**No of Lectures**
Unit 1	**Carbohydrate Metabolism & related disorders**		**15**
1.1		Introduction to metabolism. metabolic pathways, experimental approaches to study metabolism	
1.2		Digestion & absorption of Carbohydrates: an overview, Glucose metabolism: Glycolysis and its regulation, TCA and its regulation. Regulation of blood glucose level: by liver; renal regulation; hormonal regulation. Diabetes mellitus and its diagnosis – GTC, HbA1C Glycogen metabolism: Synthesis, breakdown, regulation, Glycogen storage disorder	
1.3		Gluconeogenesis; Cori cycle, Glucose-Alanine cycle, Regulation of gluconeogenesis, Rapoport-Luebering cycle & its significance. Shuttles- malate-aspartate shuttle & glycerol phosphate shuttle.	
1.4		Galactose metabolism; and fructose metabolism and fructose intolerance, essential fructosuria; lactose metabolism and lactose intolerance, glyoxylate pathway. Overview of glycosaminoglycan metabolism and mucopolysaccharioses.	
Unit 2	**Lipid metabolism and related disorders**		**15**
2.1		Digestion & absorption of Lipids: an overview	
2.2		Fatty acid oxidation: Oxidation of saturated, unsaturated, odd chain, even chain fatty acids. Disorders related to fatty acid oxidation: Genetic deficiencies in carnitine transport and AcylCoA dehydrogenase, Refsum's disease, Zellweger syndrome. Fatty acid biosynthesis, role of elongases & desaturases; synthesis of triacylglcerol	

2.3		Phospholipid metabolism: Synthesis of phosphatidic acid, lecithin, cholesterol, cardiolipin. Breakdown of phospholipids; action of phospholipases.	
2.4		Synthesis and degradation of sphingomyelins; Disorders related to sphingomyelin metabolism: Niemann-Pick disease, Faber's disease	
2.5		Glycolipid metabolism and related disorders: Cerebroside metabolism, metabolic disorders- Gaucher's and Krabbe's disease. Ganglioside metabolism and Tay Sach's disease; Sphingolipidoses.	
2.6		Cholesterol metabolism: Biosynthesis, control, transport, utilization; hypo and hypercholesterolemia; atherosclerosis, Cholelithiasis.	
2.7		Arachidonate metabolism: Prostaglandins, Prostacyclins, thromboxanes and leukotrienes, the cyclic pathway of prostaglandins, Prostacyclins, thromboxanes' the linear pathway of leucotrienes.	
2.8		Lipoprotein Metabolism: Metabolism of chylomicrons, VLDL, LDL, HDL. Disorders of lipoprotein metabolism: Hypo and hyper lipoproteinemias, fatty liver.	
Unit 3	**Protein metabolism and related disorders**		**15**
3.1		Digestion & absorption of protein	
3.2		Metabolism of amino acids: deamination, transamination, decarboxylation, ammonia formation, transport and detoxification in brain and liver. Urea cycle- regulation and disorder	
3.3		Biosynthesis and/or catabolism and disorders; Glycine; aromatic amino acids- phe and tyr, trp; Sulphur containing; cys and met; Branched chain amino acids- leu, ile, val, Alanine, Aspartic acid, Glutamic acid, Serine, Proline, Hydroxyproline,	
3.4		Formation of specialized products from amino acids and their functions- glutathione, creatine, creatinine, biogenic amines (dopamine, norepinephrine, tyramine, serotonin, melatonin, GABA, Histamine) polyamines (Putrescine, Spermodine, Spermine) Amino Acids as neuro-transmitters	
3.5		Nitrogen Balance, Biological Value of Protein, Protein Energy Malnutrition– PEM, Marasmus, Kwashiorkor.	

Unit 4	**Nucleoprotein Metabolism and related Disorders; Free radical Metabolism**		**15**
4.1	**Nucleoprotein Metabolism and related Disorders**		
	4.1.1	Digestion & absorption of Nucleic acid: an overview	
	4.1.2	Nucleotide Metabolism: Biosynthesis & degradation of purines & their regulation. Biosynthesis and degradation of pyrimidine and the irregulation. Inter-conversion of Nucleotides.	
	4.1.3	Disorders of Purine and Pyrimidine Metabolisms, Gout, Lesch-Nyhan Syndrome, Orotic aciduria, Immune Deficiency Diseases associated with Adenosine deaminase-ADA and Purine Nucleoside Phophorylase– PNP deficiencies	
4.2	**Free radical Metabolism**		
		Free radical metabolism: Generation of free radicals, damage produced by reactive oxygen species (ROS), free radical scavenger systems (enzymatic & nonenzymatic).	

Detail Theory Syllabus

SEMESTER III

Course Code		**Title**	**Credits 4**
SIPSBCH34		**CLINICAL NUTRITION** **Objectives:** 1. *To introduce the student to concepts in nutrition* 2. *To familiarize the student to the significance of macro and micro nutrients in diet* 3. *To study the various techniques employed in assessment of the nutritional and energy status and introduce food safety rules and laws and the associated governing bodies.* 4. *To study nutrition related diseases and disorders.* 5. *To give an insight of diet restrictions and planning and use of nutraceuticals in various disease states*.	**No of Lectures**
Unit 1	**Basic concepts in nutrition**		**15**
1.1	**Proximate principles and calorific value**		
1.2	**Macronutrients of Nutritional significance**		
	1.2.1	**Carbohydrates**: Dietary classification and their significance, Glycemic Index, Sweeteners, RDA	

	1.2.2	**Lipids**: Dietary classification and their significance, RD	
	1.2.3	**Proteins**: Dietary classification and their significance, RDA Nitrogen Balance, Protein quality and methods of determination (BV, PER, NPU), Protein energy malnutrition, Complementary proteins	
	1.2.4	**Anti-nutritional Factors**: Trypsin Inhibitors, pressor amines, phytates, oxalates.	
1.3	**Micronutrients of significance**		
	1.3.1	Vitamins: Biochemical significance, deficiency disorders	
	1.3.2	Minerals : Role of Ca, Mg, Na, K, Fe, Zn and Se	
1.4	**Importance of probiotics**		
Unit 2	**Techniques in Nutrition**		**15**
2.1	**Energy assessment**		
		Energy requirements, Components of energy expenditure: basal and resting energy expenditure (REE), Factors affecting REE; thermic effect of food.	
2.2	**Measurement of Energy expenditure**		
	Direct and indirect calorimetry, Respiratory quotient		
2.3	**Nutritional assessment**		
		Assessment of Nutritional Status: ABCD i.e Anthropometry: BMI, Hip-waist ratio, Biochemical indices, Clinical examination and Dietary assessment.	
2.4	**Food safety**		
		Role of National and International Agencies in combating malnutrition: WHO, FAO, UNICEF, ICAR, NIN, ICMR, Food Nutrition Board, CFTRI, NSI, IDA, ICDS	
Unit 3	**Nutritional diseases and disorders**		**15**
3.1	**Regulation of food intake and energy intake**		
		Neurotransmitters and hormones that stimulate or inhibit feeding.	
3.2	**Primary nutritional diseases**		
		Protein energy malnutrition; Eating Disorders: Obesity, Inanition, Anorexia and cachexia, starvation. Vitamin deficiency disorders; Biochemical basis, etiology and diagnosis of nutritional anemias.	
3.3	**Conditioned Nutritional disorders**		
		Disorders of GI tract, liver, biliary tract, pancreas and heart, Diabetes	

3.4	**Nutrient-Gene Interaction, Drug-Nutrient Interaction**		
Unit 4	**Diet in Health and Disease; Nutraceuticals**		**15**
4.1		Nutrition during pregnancy, lactation, infancy, childhood, adolescence, adulthood, ageing	
4.2		Nutrition for health & weight management	
4.3		Nutrition for Exercise and sport performance	
4.4		Nutrition for bone health	
4.5		Nutrition for therapeutic condition: Hypertension, CVD, GI disorders, (peptic ulcer. *H. pylori*), Diabetes mellitus, anemia, Renal disorders, CRF, ARF, Jaundice	
4.6	**Functional food and Nutraceuticals**		
	4.6.1	Bioactive proteins and peptides as functional foods	
	4.6.2	Nutraceuticals General aspects, Market, growth, scope and types of products available in the market. Health benefits and role of Nutraceuticals in ailments like Diabetes, CVS diseases, Cancer, Irritable bowel syndrome and various Gastro intestinal diseases.	

Detail Theory Syllabus
Semester IV

Course Code		Title	Credits: 4
SIPSBCH41		**MOLECULAR BIOLOGY II; BIOTECHNOLOGY** **Objectives:** 1. *To provide detailed understanding of types of DNA damage and the mechanisms involved in repair.* 2. *To study in depth the various types of vectors, hybridization technique and its application* 3. *To study the methods of cloning in bacteria, yeast, plant and animal cells.* 4. *To give an insight about the applications of recombinant DNS technology and to develop an understanding of advanced technologies like RFLP, Sequencing, various types of PCR etc.* 5. *To study the techniques for plant and animal cell and tissue culture*	**No. of lectures**
Unit I:	**DNA Damage And Repair**		**15**
1.1	**Mutations**		
	1.1.1	Types of mutations	
	1.1.2	Physical, chemical and Biological agents causing mutation	
	1.1.3	Mutational hot spot, reverse mutations , Mutagenesis, Ames test	
	1.1.4	Site directed mutagenesis	
1.2	**DNA repair Mechanisms**		
		Photoreactivation, nucleotide excision, SOS repair, recombinational repair, mismatch repair	
1.3	**Chromosomal abnormalities**		
	1.3.1	Chromosomal aberration	
	1.3.2	Stuctural and numerical abnormalities	

	1.3.3	Euploidy and aneuploidy (Autosomal and Sex chromosomes)	
	1.3.4	Monosomies (Turner syndrome) Disomies and trisomies (Down Syndrome) and their causes	
Unit II	**Recombinant DNA Technology-I**		**15**
2.1	**Gene cloning:**		
	2.1.1	General steps in gene cloning; Isolation of genes, obtaining genes from eukaryotic andprokaryotic organisms, problems of isolation of genes, isolation of gene fragments	
	2.1.3	Introducting DNA into cells, transformation, microinjection, electroporation, selection of recombinant clones, colony hybridization, Southern & Northern hybridization, use of probes	
2.2	**Cloning in eukaryotic cells**		
	2.2.1	Yeast vectors- Yeast episomal plasmids (YEp), Yeast replicative plasmids (YRp), Yeast integrative plasmids (YIp)	
	2.2.2	cloning in plant cells, suitable vectors – caulimoviruses, Ti plasmids	
	2.2.3	cloning in mammalian cells, viral vectors, shuttle vectors	
2.3	**Gene library**		
	cDNA synthesis, chemical synthesis of genes, shotgun experiments, gene bank, gene library		
Unit III	**Recombinant DNA Technology-II**		**15**
3.1	**Applications of rDNA technology**		
	3.1.1	Medical and Biological applications of recombinant DNA technology (RDT), Diagnostic probes for genetic and other diseases, Anti-sense technology and therapeutics.	
	3.1.2	Agricultural, industrial and commercial applications of RDT	
3.2	**Tools and techniques in nucleic acid analysis**		
	3.2.1	Enzymes that degrade DNA & RNA: DNAases, RNAases and phosphodiesterases	
	3.2.2	Modification and restriction of DNA; DNA methylases, restriction endonucleases – properties and mode of action	

	3.2.3	*In vitro* amplification of DNA (PCR), designing of primers for PCR, types of PCR, applications Restriction mapping, DNA sequencing methods: , RNA sequencing technique, Oligonucleotide synthesis , Allele specific oligonucleotide (ASO)	
	3.2.4	RFLP, SNPS, RAPD, Quantitative trait loci	
	3.2.5	Technique based on nucleic acid hybridization, Blotting techniques	
	3.2.6	Karyotyping , sex determination, pedigree analysis,	
Unit IV	**Cell And Tissue Culture**		**15**
4.1	**Plant Tissue Culture (PTC)**		
	4.1.1	Principles, techniques, methodology and applications of PTC	
	4.1.2	Micro-propagation and protoplast fusion	
	4.1.3	Suspension cultures for production and secondary metabolites	
	4.1.4	Use of PTC in production of transgenics.	
4.2	**Animal Tissue Culture (ATC)**		
	4.2.1	Principles, techniques, methodology: media requirements, preparation of medium and sterilization techniques, advantages & disadvantages of natural and synthetic media and application of ATC	
	4.2.2	Culture methods: hanging drop, suspension and mono layer. Behavior and characteristics of cells in culture, primary and established cell lines.	
	3.2.3	Frontiers of contraceptive research, cryopreservation of sex gametes & embryos, ethical issues in embryo research.	

Detail Theory Syllabus
Semester IV

Course Code		Title	Credits 4
SIPSBCH42		**IMMUNOLOGY II** **Objectives:** 1. *To study the role of cytokines* 2. *To give an insight about inflammatory response, hypersensitivity, immunological tolerance and transplantation immunology* 3. *To provide an in-depth understanding of autoimmunity and autoimmune diseases.* 4. *To understand the immunological surveillance and escape mechanisms in cancer.* 5. *To provide detailed study of immunodeficiencies and AIDS.*	No of Lectures
Unit 1	**Cytokines and immune response to infections**		**15**
1.1	**Cytokines**		
	1.1.1	General structure and functions	
	1.1.2	Cytokine receptors, cytokine antagonists	
	1.1.3	Cytokine secretion by TH1 and TH2 subsets	
	1.2.4	Cytokine related diseases	
	1.2.5	Therapeutic uses of cytokines	
1.2	**Immune Responses**		
	1.2.1	Inflammation mediators of inflammation and process of inflammation	
	1.2.2	Hypersensitivity Gell and coombs classification types I to IV with mechanisms`	
Unit 2	**Immune Response to infectious diseases and transplantation immunology**		**15**
2.1	**Immune Response to infectious diseases**		
		Viral, bacterial, fungal and protozoal diseases, helminthes (parasitic worms) infections- effector mechanisms	
2.2	**Immune Response in Transplantation**		
	2.2.1	Types of graft, immunological basis of graft rejection- 1st set, 2nd set rejection- role of T lymphocytes	
	2.2.2	Tissue typing and laboratory investigations- micro cytotoxicity test, mixed lymphocyte reaction (HLA Typing)	

	2.2.3	Clinical manifestation of graft rejection	
	2.2.4	General and specific immunosuppressive therapy.	
Unit 3	**Immunological Tolerance and autoimmunity**		15
3.1	**Immunological tolerance**		
	3.1.1	Pathways to B and T cell tolerance	
	3.1.2	General characteristics of B and T cell tolerance	
	3.1.3	Mechanisms of tolerance inductions self-tolerance	
	3.1.4	Potential therapeutic applications of tolerance	
3.2	**Autoimmunity and autoimmune Diseases**		
	3.2.1	Organ specific autoimmune diseases (Hashimoto's thyroiditis and	
	3.2.2	Diagnostic and prognostic value of auto antibodies- Treatment of autoimmune diseases	
	3.2.3	Role of CD_4, T cell, MHC and TCR in autoimmunity	
	3.2.4	Proposed mechanisms for induction of auto immunity	
Unit 4	**Tumor Immunology and Immunodeficiencies**		**15**
4.1	**Tumor Immunology**		
	4.1.1	Classification of tumors	
	4.1.2	Oncogenes and cancer induction	
	4.1.3	Tumor associated antigens Immune Response to tumor antigens	
	4.1.4	Immunosurveillance, Immunological escape mechanisms	
	4.1.5	Immunotherapy of tumors	
	4.1.6	Apoptosis and immune system	
4.2	**Immunodeficiencies**		
	4.2.1	Classification of immunodeficiencies: primary and secondary	
	4.2.2	Immunology of H I V /AIDS : Discovery, causes, structure, process of infection, destruction of CD_4 T cells; Clinical Diagnosis; Development of vaccine and preventive measures.	

Detail Theory Syllabus
Semester IV

Course Code		Title	Credits 4
SIPSBCH43		**MEDICAL BIOCHEMISTRY** **Objectives:** 1. *To understand the mechanism and significance of water, and electrolyte balance and associated disorders.* 2. *To study the role and metabolism of minerals like calcium and phosphorus* 3. *To study the process of hemostasis and pathways of hemoglobin metabolism.* 4. *To understand the pathophysiology of common diseases, cancer and ageing and the significance of organ function tests.*	**No of Lectures**
Unit I:	**Water And Electrolyte Balance; Mineral Metabolism**		**15**
1.1	**Water and Electrolyte Balance**		
	1.1.1	Importance of Water. Total Body Water (TBW) and its distribution,	
	1.1.2	Electrolytes. Distribution of electrolytes in body fluids. Water and Electrolyte balance. Regulation of Sodium and Water balance.	
	1.1.3	Acid Base balance : Role of Blood buffers, Kidney, Lungs	
	1.1.4	Acidosis & Alkalosis and Compensatory Mechanisms	
	1.1.5	Blood Gas Analysis (pH, pO2, pCO2, Bicarbonate) and interpretation	
1.2	**Mineral Metabolism**		
	1.2.1	Metabolism of Ca and P-role of vitamin D, PTH and calcitonin. Disorders related to Ca and P metabolism.	
Unit II:	**Hemostasis And Hemoglobin Metabolism**		**15**
2.1	**Hemostasis**		
	2.1.1	Blood types. hemostasis and blood regulation	
	2.1.2	Conditions that cause excessive bleeding, thromboembolic conditions	
	2.1.3	Laboratory tests: BT, CT, PT	
2.2	**Hemoglobin metabolism**		
	2.2.1	Hemoglobin synthesis and degradation, hemoglobin derivatives-oxy, reduced, Met, Carboxy, Carbamino	

	2.2.2	hemoglobinopathies: 1) haemolytic anemia Unstable Hb, 2) Hb with abnormal O_2 affinity-High affinity (Polycythemia)Low affinity (Cyanosis) 3) Hb with structural and synthetic Variation in globin chains : Sickle cell Anemia (Structural) Alpha and Beta Thalassemia (Synthetic)	
	2.2.3	Pathophysiology of anemia.	
Unit III:	**Pathophysiology; Organ Function Tests**		**15**
3.1	**Pathophysiology of common diseases**		
	3.1.1	CVD: Hypertension, angina, congestive heart failure, arthersclerosis,	
	3.1.2	Gastric disorders: peptic ulcers, gastritis, vomiting	
	3.1.3	Bilary tract: Cirrhosis of liver, jaundice, hepatitis	
	3.1.4	Kidney: acute and chronic renal failure	
	3.1.5	Intestinal disorders: ulcerative colitis and sprue	
3.2	**Organ Function Tests. Biochemical Assessments and Changes in Endocrine Disorders**		
	3.2.1	Liver Function test	
	3.2.2	Renal Function test including mechanism of urine formation	
	3.2.3	Gastric and Pancreatic Function test	
	3.2.4	Thyroid Function test	
	3.2.5	Cardiac Profile	
Unit IV:	**Pathophysiology Of Cancer; Ageing**		**15**
4.1	**Pathophysiology of cancer**		
	4.1.1	Types of cancer, cancer metastasis	
	4.1.2	Carcinogens	
	4.1.3	Proto-oncogenes, oncogenes, oncogenic viruses	
	4.1.4	Tumor markers	
	4.1.5	Cancer chemotherapy	
4.2	**Ageing**		
	4.2.1	Signs, theories (Free Radical theory, Glycation Theory).	
	4.2.2	Molecular Mechanisms	
	4.2.3	Mitochondria and ageing, protein damage & maintenance, neurodegeneration, DNA damage & repair, telomers, telomerase	
	4.2.4	Cellular senescence and apoptosis	
	4.2.5	Longeivity genes, Sirtuins, Deacetylases, hormones, biomarkers of ageing	
	4.2.6	Interventions to delay/prolong ageing- Pharmacological and dietary.	

Detail Theory Syllabus
Semester IV

Course Code	Title	Credits: 4
SIPSBCH44	**PHARMACEUTICAL BIOCHEMISTRY** **Objectives:** 1. *To introduce the basic concepts of drug absorption, distribution, metabolism and excretion.* 2. *To understand the chemistry of drugs with respect to their pharmacological activity, understand the drug metabolic pathways, adverse effects and therapeutic value of drugs* 3. *To study natural products as drugs and provide an overview of the steps in drug discovery.*	No of Lectures

Unit I	**General Pharmacology**		**15**
1.1	**Introduction to Pharmacology**		
	1.1.1	Sources of drugs	
	1.1.2	Drug binding, targets for drug binding, specificity, drug-receptor interaction, agonists, antagonists, partial agonists	
1.2	**Types of drug receptors**		
	1.2.1	Membrane: channel-linked, GPCR, kinase-linked	
	1.2.2	Soluble: Regulating gene transcription	
1.3	**Methods for measuring drug effects**		
	1.3.1 1.3.2	Bioassay: General principles Clinical Trials: Phases I to IV	
1.4	**Measurement of Toxicity**		
	1.4.1	LD50, ED50, Therapeutic index, Number-needed-to-treat (NNT) principle	
1.5	**Pharmacodynamics**		
	1.5.1	Drug absorption: routes of administration	
	1.5.2	Bioavailability and bioequivalence	
	1.5.3	Drug distribution: Translocation of drugs, bulk flow & diffusional transfer, binding to plasma protein.	
	1.5.4	Drug metabolism: Phase I & Phase II	

	1.5.5	Drug elimination: Renal & Biliary	
1.6	**Pharmacokinetics**		
		Parameters, rate constants for absorption and elimination, half-life, volume of distribution, clearance, steady state plasma drug concentration & factors affecting it.	
Unit II	**Mechanism of action of therapeutic drugs- I**		**15**
2.1	**General Mechanism**		
	2.1.1	Molecular basis of drug action & pharmacologicals electivity	
	2.1.2	Drug receptor theory, stimulus response, classification of receptors & strategy in receptor binding studies, receptor preparation & receptor binding kinetics	
	2.1.3	Structure function relationship with respect to proteins enzymes, ion, channels and other drug targets	
2.2	**Mechanism of action of therapeutic drugs- I**		
	2.2.1	Anti-inflammatory drugs: NSAID (Ibuprofen), salicylates (Aspirin)	
	2.2.2	CVS drugs: Cardiac glycosides, Ca channel blocker- Amlodipine & β blocker- Propranolol	
	2.2.3	Antacids: Proton pump blocker(Omeprazole), H2 receptor, antagonists (Ranitidine), antacids (Mg Hydroxide, Mg trisilicate, aluminium hydroxide), cytoprotective(Bismuth chelate, sucralfate)	
	2.2.4	Lipid lowering drugs	
	2.2.5	Anticoagulants	
	2.2.6	Hematinics	
Unit III	**Mechanism of action of therapeutic drugs- II**		**15**
	3.1	Antidiabetics	
	3.2	Antipsychotic drugs**:** Classical (typical) & atypical	
	3.3	Analgesics	
	3.4	Antibacterial **:** Sulphonamides, Penicillins, drugs inhibiting topoisomerase II and drugs affecting protein synthesis (Tetracycline, streptomycin)	

	3.5	Antiviral: DNA pol inhibitors (Aciclovir), reverse transcriptase inhibitor (Zalcitabin /ddc), protease inhibitors.	
	3.6	Cancer Chemotherapy: Cytotoxic drugs (Alkylating agents, antimetabolites, cytotoxic antibiotics, plant derivatives), hormones (glucocorticoids, estrogens, androgens a hormone antagonists) and miscellaneous agents.	
	3.7	Adverse drug reactions	
Unit IV	**Natural products and drug discovery**		**15**
4.1	**Phytochemicals**		
	4.1.1	Chemistry of natural products: Polyphenols (flavinols, tannins) Glycosides, alkaloids, saponins, terpenes, volatile oils.	
	4.1.2	Schematic of biosynthesis of natural products	
	4.1.3	Advantages of natural product as drug; pharmacologically important primary & secondary metabolites from living cells (Plants, bacteria, fungi and marine resources)	
	4.1.4	Dietary supplements in management of chronic diseases Study of following herbs as health food: Alfaalfa, Chicory, Ginger, Fenugreek, Garlic, Honey, Amla, Ginseng, Ashwagandha, Spirulina.	
	4.1.5	ADR: Botanical / Drug, toxicity of botanicals Herbal-Drug and Herb-Food Interactions: General introduction to interaction and classification. Study of following drugs and their possible side effects and interactions: Hypercium, kava-kava, Ginkobiloba, Ginseng, Garlic, Pepper & Ephedra.	
4.2	**Drug discovery**		
	4.2.1	Role of plants in drug discovery; steps in drug discovery	
	4.2.2	New Drug Investigation (NDI) and applications	

References

Cell Biology

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. Molecular Biology of the Cell (Garland, New York, 2002). *Google Scholar*.
2. Cooper, G. M., & Ganem, D. (1997). The cell: a molecular approach. *Nature Medicine*, *3*(9), 1042-1042
3. Lodish, H., Berk, A., Darnell, J. E., Kaiser, C. A., Krieger, M., Scott, M. P.. & Matsudaira, P. (2008). *Molecular cell biology*. Macmillan.

Enzymes

1. Dixon, M., & Webb, E. C. (1979). Enzymes (3rd edn). Longmans, London, 11
2. Eisenthal, R., & Danson, M. J. (Eds.). (2002). Enzyme assays: a practical approach (Vol. 257). Practical Approach (Paperback).
3. Leskovac, V. (2003). Comprehensive enzyme kinetics. Springer Science & Business Media.Palmer, T., & Bonner, P. (2001). Enzymes: Biochemistry, Biotechnology. *Clinical Chemistry*, 277-384.
4. Palmer, T., & Bonner, P. (2001). Enzymes: Biochemistry, Biotechnology. Clinical Chemistry, 277-384.
5. Price, N. C., & Stevens, L. (1999). Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic Proteins, edn 3, Chapter 4.

Molecular Biology

1. Lewin, B., & Genes, I. X. (2008). Jones and Bartlett Publishers. *Inc., Sudbury*.
2. Elliott, W. H., Elliott, D. C., & Jefferson, J. R. (2005). *Biochemistry and molecular biology*. Oxford: Oxford University Press
3. Clark, D. P., & Pazdernik, N. J. (2013). *Molecular biology*. Elsevier.
4. White, R. J. (2009). *Gene transcription: mechanisms and control*. John Wiley & Sons.
5. Lin, E. C., & Lynch, A. S. (2012). *Regulation of gene expression in Escherichia coli*. Springer Science & Business Media.

Protein and Proteomics

1. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). *Lehninger principles of biochemistry*. Macmillan.
2. Berg, J. M., Tymoczko, J. L., & Stryer, L. (2007). Biochemistry, ; W. H.
3. Shriver, J. W. (2009). *Protein structure, stability, and interactions*. Springer [distributor].
4. Carl, B., John, T., & Carl, I. (1999). Introduction to protein structure.

5. Eisenberg, D. (1985). Proteins. Structures and molecular properties, TE Creighton. WH Freeman and Company, New York (1984), 515, $36.95.

Metabolism- I

1. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). *Lehninger principles of biochemistry*. Macmillan.
2. Voet, D., & Voet, J. G. (2004). Biochemistry. Hoboken. *John Wiley & Sons*, *1*, 591.
3. Berg, J. M., Tymoczko, J. L., & Stryer, L. (2007). Biochemistry, ; W. H.
4. Etzler, M. E. (2009). Essentials of glycobiology. *Cold Spring Harbor Laboratory Press, New YorkWells L, Vosseller K, Hart GW (2001) Glycosylation of nucleocytoplasmic proteins: signal transduction and O-GlcNAc. Science*, *291*, 23762378Wisniewski.
5. Taiz, L., & Zeiger, E. (2006). Plant physiology. 4th. *Sinauer Associate, Sunderland, Mass., EUA*.

Biochemical and Biophysical Techniques

1. Van Holde, K. E., Johnson, W. C., & Ho, P. S. (2006). Principles of physical biochemistry.
2. Sheehan, D. (2013). *Physical biochemistry: principles and applications*. John Wiley & Sons.
3. Wilson, K., & Walker, J. (Eds.). (2010). *Principles and techniques of biochemistry and molecular biology*. Cambridge university press.
4. Freifelder, D. M. (1982). Physical Biochemistry: Application to Biochemistry and Molecular Biology (Life Sciences/Biochemistry).
5. Segel, I. H., & Segel, A. H. (1976). *Biochemical calculations: how to solve mathematical problems in general biochemistry* (No. 04; QD415. 3, S4 1976.). New York: Wiley.

Immunology

1. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2017). *Essential immunology*. John Wiley & Sons.
2. Khan, F. H. (2009). *The elements of immunology*. Pearson Education India
3. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2007). *Kuby immunology*. Macmillan
4. Chapel, H., Haeney, M., Misbah, S., & Snowden, N. (2013). *Essentials of clinical immunology*. John Wiley & Sons.

Genetic Engineering

1. Dale, J., Dale, J. W., von Schantz, M., Plant, N., & Plant, N. (2012). *From genes to genomes: concepts and applications of DNA technology*. John Wiley & Sons.
2. Glover, D. M. (2013). *Gene cloning: the mechanics of DNA manipulation*. Springer.
3. Brown, T. A. (2007). Genomes 3 Garland Science. *New York*.

Clinical Biochemistry

1. Carson, P. A., & Dent, N. J. (Eds.). (2007). *Good clinical, laboratory and manufacturing practices: techniques for the QA professional*. Royal Society of Chemistry
2. Beckett, G., Walker, S. W., Rae, P., & Ashby, P. (2010). *Lecture Notes: Clinical Biochemistry* (Vol. 23). John Wiley & Sons.
3. Burtis, C. A., Ashwood, E. R., & Bruns, D. E. (2012). *Tietz textbook of clinical chemistry and molecular diagnostics-e-book*. Elsevier Health Sciences.
4. Kathleen, M. L., Mahan, L. K., & Escott-Stump, S. (2004). *Krause's food, nutrition, and diet therapy*.
5. Hallberg, L., Sandström, B., Aggett, P. J., Garrow, J. S., & James, W. P. T. (1993). Human nutrition and dietetics.
6. Murray, R., Granner, D. K., Mayes, P. A., & Rodwell, V. W. (2003). Harper's illustrated biochemistry (LANGE basic science).

Biotechnology and Nanotechnology

1. Chirikjian, J. G., Kisailus, E. C., & Graf, K. M. (1995). *Biotechnology: Theory and Techniques* (Vol. 2). Jones and Bartlett Publishers.
2. Scragg, A. H. (2005). *Environmental biotechnology*. New York: OXFORD university press.
3. Hornyak, G. L., Tibbals, H. F., Dutta, J., & Moore, J. J. (2008). *Introduction to nanoscience and nanotechnology*. CRC press.
4. Bawa, R. Patenting Inventions in Bionanotechnology: A Primer for Scientists and Lawyers 309 (David E. Reisner ed., CRC Press, 2009); Raj Bawa. *Nanoparticle-based Therapeutics in Humans: A Survey*, *5*.
5. Vo-Dinh, T. (2007). *Nanotechnology in biology and medicine: methods, devices, and applications*. CRC Press.

Microbiology

1. Willey, J. M., Sherwood, L., & Woolverton, C. J. (2008). *Prescott, Harley, and Klein's microbiology*. New York: McGraw-Hill Higher Education.
2. Davis, B. D., Dulbecco, R., Eisen, H. N., Ginsberg, H. S., & Wood, W. B. (1967). Microbiology. Hoeber Medical Division.
3. Black, J. G. (2008). *Microbiology: principles and explorations*. John Wiley & Sons.
4. Joklik, W. K., Willett, H. P., & Amos, D. (1988). *Zinsser microbiology*. Appleton and Lange.

Biostatistics and Bioinformatics

1. Rosner, B. (2005). Principles and practice of clinical research. Fundamentals of biostatistics.
2. Bowers, D. (2008). Doing it right first time—designing a study. *Medical Statistics from Scratch*, 71-90.
3. Lesk, A. M. Introduction to Bioinformatics. 2005.
4. Attwood, T. K., & Parry-Smith, D. J. (1999). Introduction to Bioinformatics, Pearson Education.
5. Klipp, E., Liebermeister, W., Wierling, C., Kowald, A., & Herwig, R. (2016). *Systems biology: a textbook*. John Wiley & Sons.
6. Gollery, M. (2005). Bioinformatics: Sequence and Genome Analysis, David W. Mount. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press, 2004, 692 pp., $75.00, paperback. ISBN 0-87969-712-1. *Clinical Chemistry*, *51*(11), 2219-2219.
7. Ahuja, R. (2001). *Research methods*. Rawat.
8. Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International.
9. Singh, Y. K. (2006). *Fundamental of research methodology and statistics*. New Age International.

Plant Physiology

1. Verma, V. (1982). *A text book of Plant Physiology*. EMKAY publications.
2. Pandey, S. N., & Sinha, B. K. 1995. *Plant physiology, Vikas publishing house, Pvt. Ltd., New Delhi*, 533.
3. Lea, P. J., & Leegood, R. C. (1993). Plant biochemistry and molecular biology.
4. Hopkins, W. G. (1999). *Introduction to plant physiology* (No. Ed. 2). John Wiley and Sons.
5. Prajapati, N. D. (2003). *Handbook of medicinal plants*. Agrobios.
6. Dey, P. M. (2012). *Methods in plant biochemistry* (Vol. 1). Academic Press.

7. Buchanan, B. B., Gruissem, W., & Jones, R. L. (Eds.). (2015). *Biochemistry and molecular biology of plants*. John Wiley & Sons.

Lab Courses

1. Wilson, K., & Walker, J. (Eds.). (2010). *Principles and techniques of biochemistry and molecular biology*. Cambridge university press.
2. Mu, P., & Plummer, D. T. (1988). *Introduction to practical biochemistry*. Tata McGraw-Hill Education.
3. Fasman, G. D. (1989). *Practical handbook of biochemistry and molecular biology*. CRC press.
4. De Muro, M. A., Walker, J. M., & Rapley, R. (2008). Molecular Biomethods Handbook.
5. Sambrook, J., Fritsch, E. F., & Maniatis, T. (1989). Molecular cloning: a laboratory manual, Ed 2nd. *New York: Cold Spring Harbor Laboratory*.
6. Marshak, D. R., Kadonaga, J. T., Burgess, R. R., Knuth, M. W., Brennan Jr, W. A., & Lin, S. H. (1996). *Strategies for protein purification and characterization: a laboratory course manual*. Cold Spring Harbor Laboratory.

Scheme of examination for M.Sc. Degree (by papers) in Theory & Practical in Biochemistry to be brought in effect from 2018-2019 as Credit Based Semester and Grading System:

***A*. Distribution of Credits**

Credits for Theory		Credits for Practical	
Paper	Credits per Semester	Practical	Credit per Semester
Each	4	Each	2

Total Number of Semesters	Number of Theory Papers per Semester	Total Number of Theory Papers	Total Number of Credits
4	4	16	16 X 4 = 64 (a)
Total Number of Semesters	Number of Practicals per Semester	Total Number of Practicals	Total Number of Credits
4	4	16	16 X 2 = 32 (b)
Total Number of credits for MSc degree by papers in Biochemistry (a) + (b) = 96			

B. **Distribution of Marks**

Theory Paper	Theory 100 Marks per paper				Practical (50 Marks/Practical)
	Semester End Theory Exam. (60)			Internal Assessment (40)	
	No. of Units	Marks per Unit	Total Marks	Class test/ assignment/oral presentation/curriculum-based activity	Semester End Practical Exam.
Each	04	15	**60**	**40**	**50**

Year	Semester	Total Theory Marks (a)	Total Practical Marks (b)	Grand Total (a) + (b)
M. Sc. Part I	I	4 Papers X 100 = 400 Marks	4 Practical X 50 = 200 Marks	**600 Marks**
	II	4 Papers X 100 = 400 Marks	4 Practical X 50 = 200 Marks	**600 Marks**
M. Sc. Part II	I	4 Papers X 100 = 400 Marks	4 Practical X 50 = 200 Marks	**600 Marks**
	II	4 Papers X 100 = 400 Marks	4 Practical X 50 = 200 Marks	**600 Marks**
				2400 Marks

Use of a simple calculator shall be permitted for solving numerical and statistical problem at theory and practical examination.

Duration of Semester-end practical examination :

Two-Day practical examination with two sessions on one day and each session of three hours thirty minutes duration, i.e. Session I- 9am to 12:30 pm and Session II- 1:00 pm to 4:30 pm. With lunch break from 12:30pm to 1:00 pm

Each candidate is required to submit a certified journal for each of the semesters at the time of semester-end practical examination.