SIES

College of Arts, Science & Commerce

RISE WITH EDUCATION

Sion (West), Mumbai – 400022.

(Autonomous)

Faculty: Science

Program: M.Sc.

Subject: BIOCHEMISTRY

Academic Year: 2022 – 2023

M.Sc.

Semester I, II, III and IV

Choice Based Credit System as approved by the Board of Studies in Biochemistry

with effect from 2020-2021

Contents:

MASTER OF SCIENCE IN BIOCHEMISTRY

Two-year Full Time Programme

(2018-19 onwards)

PREAMBLE

The two years Masters programme in Biochemistry endeavours to provide the Student with excellent training in Biochemistry. The course emphasizes on strengthening the fundamental concepts in the subject. At the same time, the programme aims to provide the student an exposure to the recent and emerging advancements in the field.

In addition to the theoretical knowledge, emphasis is also given to sharpen the practical skills of the student for gainful employment. Soft skills development component aims to provide the students with essential skills required for effective communication, and to apprise them of business communication and its role in corporate environment.

The programme also aims to impart competence in applying statistics to biological research and make the learner familiarized with the fast emerging field of Bioinformatics and applications of computers in Biochemistry.

Furthermore, the programme includes dissertation to be carried by every student during the second year under the supervision of a research guide or mentor. This not only provides the student an opportunity for hands-on training in research but grooms the learner in various aspects of research like the habit of scientific reading, research methodology, analytical ability, independent thinking and scientific writing.

In a nut shell the course aims to train the student for a career in industry/ research center and impart competence to qualify competitive exams in the subject.

Summary of Course-wise Units

SEMESTER I

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
SIPSBCH11 Biomolecules-I	I	Proteins	4	1
	II	Proteomics		1
	III	Carbohydrates		1
	IV	Lipids; Vitamins		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; Bio-statistics; Bioinformatics-I	I	Research And Research Design	4	1
	II	Data And Sampling		1
	III	Probability; Data Analysis		1
	IV	Bioinformatics – I		
SIPSBCHP11	Biomolecules I		2	4
SIPSBCHP12	Cell Biology I		2	4
SIPSBCHP13	Biophysical Techniques		2	4
SIPSBCHP14	Research methodology; Biostatistics; Bioinformatics; Soft skills-I		2	4

Summary of Course-wise Units

SEMESTER II

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
SIPSBCH21 Biomolecules-II	I	Nucleic acids	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-I		1
	IV	Biochemistry of Tissues-II; Techniques to Study Cell Biology		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	Biomolecules II		2	4
SIPSBCHP22	Cell Biology II		2	4
SIPSBCHP23	Industrial and Applied Biochemistry		2	4
SIPSBCHP24	Research methodology; Biostatistics; Bioinformatics; Soft skills-II		2	4

Summary of Course-wise Units

SEMESTER III

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	DNA damage and repair		1
SIPSBCH32 Immunology-I	I	The Immune System	4	1
	II	Antigen And Antibody		1
	III	Antigen-Antibody Interaction and Immuno-techniques		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		
SIPSBCHP31	Molecular Biology-I		2	4
SIPSBCHP32	Immunology I		2	4
SIPSBCHP33	Clinical Biochemistry		2	4
SIPSBCHP34	Nutritional Biochemistry		2	4

Summary of Course-wise Units
SEMESTER IV

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
SIPSBCH41 Molecular Biology-II; Biotechnology	I	Genetic Recombination	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 Response to 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	Immunology II		2	4
SIPSBCHP43	Clinical Biochemistry II		2	4
SIPSBCHP44	Pharmaceutical Biochemistry		2	4

MSc Theory Syllabus

SEMESTER I

Course Code	Paper1	Credits:4
SIPSBCH11	BIOMOLECULES I	No of Lectures

Learning Outcome: *The learner should be able to*

1. *Elaborate on the structure and function of proteins, carbohydrates and nucleic acids*
2. *Discuss the various aspects of proteomics i.e the methods and techniques employed and appreciate its application in biochemistry*

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, Corticotrophin, Oxytocin, Vasopressin, Gastrin, Angiotensin, Carnosine and Anserine, bradykinin, encephalin, Aspartame.

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. (Guided Self Study)

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 Lipids; Vitamins **15**

4.1 Lipids

4.1.1 Classification and types of lipids;
Storage lipids: Structure, nomenclature and properties of fatty acids; Triglycerides; waxes.
Structural lipids: Chemistry, properties and functions of membrane lipids- Glycerophospholipids, Plasmalogens, sphingolipids and sterols

4.1.2 Chemistry and functions of
Lipids as signals: phosphatidylinositol, eicosanoids, steroid hormones
Lipids as cofactors: vitamin E, K and ubiquinone
Lipids as pigments.
Composition and biological role of lipoproteins.
Outline of separation and analysis of lipids

4.2 Vitamins:
Classification of vitamins, chemistry, coenzyme form and physiological functions of Vitamin B-complex, A. D, E , K and C.

Course Code	**Paper 2**	**Credits:4**
SIPSBCH12	**CELL BIOLOGY-I**	**No of Lectures**

Learning Outcome: *The learner should be able to*

1. *Review the theories and experimental evidences that explain origin of life on earth and biological evolution*
2. *Discuss the organization, biochemistry and functions of the cell.*
3. *Describe the structure and function of biological membranes and explain mechanisms of solute transport*
4. *Describe the processes of transport and growth in plants.*
4. *Recall the basic concepts of thermodynamics and extend their application to energy production pathways in animals and plants*

Unit 1 Evolution And Cell Structure **15**

1.1 Biochemical Basis of Evolution

1.1.1 Timeline for early history of earth, formation of earth- early and late atmosphere.
Theories of origin of life: Theory of special creation, Cosmozoic theory, Theory of spontaneous generation and theory of biogenesis.
Oparin-Haldane theory of chemical origin:
Primitive atmosphere, formation of NH3, H2O, CO2, Miller-Urey experiment, Synthesis of organic compounds, formation of nucleic acids.
Formation of pre cells- Coacervate theory and Microsphere theory.

1.1.2 Biological evolution:
Darwin's theories- Natural selection, Struggle for existence, survival of the fittest; Limitations.
Hugo De Vries mutation theory, Modern Syntheses theory (Julian Huxley)
Genetic variation, gene pool, gene frequency, genetic drift, gene mutation.

1.1.3 Evidences of evolution: Paleontological, Anatomical Molecular - Evolution of proteins and nucleic acid (Stryer, 5th edition)

1.2 Cell Structure

1.2.1 Structure and components of prokaryotic and eukaryotic cell. Bacterial cell wall.
Sub-cellular components: endoplasmic reticulum, lysosomes, peroxisomes, Golgi apparatus, mitochondria, chloroplast, cytoskeleton, pili, and flagellum. Organelle marker enzymes. (Guided self study)

1.2.2 Eukaryotic cell division, mitosis and meiosis, cell cycle and regulation.

1.2.3 Plant cell wall, tissues, cell-cell communication- plasmodesmata (Darnell)
Extracellular matrix of animals- composition and function
Cell-matrix adhesion- integrins and laminin
Cell-cell adhesion – tight junctions, gap junctions, CAMs.

Unit 2 Membrane Biochemistry **15**

2.1 Biological membrane: Functions, Composition, assembly and properties: self- assembly, fluidity, asymmetry.

2.2 Specialized features like lipid rafts, caveolae and tight junctions.

2.3 Erythrocyte membrane- composition and function
Artificial Membranes- Liposomes, Preparation and applications.
Concept of Supra-molecular assembly –Biological membranes, Viruses and Ribosomes

2.4 Transport across membranes: Diffusion, Facilitated and active transport.
Membrane transport proteins: Channels, pumps and carriers/transporters (uniport, symport, antiport)
Mechanism and role of GLUT uniporter, Na^+-Glucose symporter, Na^+-Ca^{2+} antiporter, Na^+-K^+ ATPase and Ca^{2+} ATPase. (Darnell) ; Voltage and ligand gated channels

2.5 Specialised mechanisms of transport –Nuclear pores; Endocytosis and exocytosis

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 Plant growth: 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 Photosynthesis: Light independent reactions: Calvin cycle, Photorespiration, C4 plants, CAM plants. Glyoxylate cycle.

3.5 Nitrogen fixation:-biochemistry of symbiotic and nonsymbiotic nitrogen fixation.

Unit 4 Bioenergetics **15**

4.1 Basic concepts

4.1.1 Laws of thermodynamics as applied to biological systems, enthalpy, entropy, free energy, standard free energy.

4.1.2 Role of high energy phosphates in bioenergetics.

4.2 Energy generation in plants

4.2.1 Structure of chloroplast, Chlorophylls and accessory pigments

4.2.2 Photosynthesis-Light- dependent reaction, Cyclic and Non-Cyclic Photophosphorylation.

4.3 Energy generation in animals

4.3.1 Structure of mitochondria, Electron Transport Chain-Complexes and electron carriers, mechanism of oxidative phosphorylation.
Uncouplers and Inhibitors of energy transfer.

Course Code	Paper 3 BIOPHYSICAL TECHNIQUES	Credits:4 No of Lectures
SIPSBCH13		

Learning Outcome: *The learner should be able to*

1. Recall the concepts of osmosis, surface tension, and viscosity and recognize their application in the study of biochemistry
2. Discuss and explain the role of radioisotopes and the techniques used for their measurement.
3. Describe the various spectroscopic techniques and appreciate their application in biochemical study and research.
4. Explain the principle, working, application, and significance of these bioanalytical techniques.

Unit 1 Colligative Properties; Radioisotope Techniques; Centrifugation **15**

1.1 Colligative Properties

Definitions, Factors affecting , measurement of and physiological applications of Osmosis, Osmotic Pressure, Adsorption, Colloids, Surface Tension and Viscosity (Guided self study)

1.2 Radioisotope Techniques

1.2.1 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.

1.2.2 Isotope Dilution, Analysis, Autoradiography, Application of radioisotopes in Biological Science

1.2.3 Safety Measures in Handling Isotopes.

1.3 Centrifugation

1.3.1 Basic principles of sedimentation, relation between g, rpm and Svedberg constant.

1.3.2 Principle, instrumentation, working and applications of Preparative and Analytical Ultracentrifugation, Isopycnic centrifugation, Rate Zonal centrifugation, Density gradient.

Unit 2 Electrophoresis; Spectroscopy-1 **15**

2.1 Electrophoresis

2.1.1 Basic principle, factors affecting electrophoresis, support media used.

2.1.2 Instrumentation, working and applications of electrophoretic techniques-zone, Disc, Capillary, 2-D, Pulsed Field Gel, Diagonal, Isoelectric Focussing, immuno-electrophoresis.

2.2 Spectroscopy-1

2.2.1 Beer-Lambert Law, its verification and deviations(Guided self study), concept of absorption, transmission, scattering, phosphorescence, fluorescence, luminescence.

2.2.2 Principle, Instrumentation, working and applications of – UV/Visible spectroscopy, Turbidometry, Nephlometry, IR Spectroscopy, Flame photometry, Atomic Absorption Spectroscopy

Unit 3 Spectroscopy-2 **15**

3.1 Principle, instrumentation, working and applications of – Fluorescence spectroscopy; fluorescence spectra and the study of protein structure.

3.2 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)

3.3 Principle and applications of X-Ray Diffraction Spectra, Optical Rotatory Dispersion,(ORD), Circular Dichroism

Unit 4 Chromatography **15**

4.1 Basic Principles, Instrumentation, working and applications of partition chromatography (Paper), Adsorption chromatography (TLC, HPTLC, Column)(Guided self study)
Affinity, Ion Exchange and Gel permeation chromatography.

4.2 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)

Course Code	Paper 4	Credits:4
SIPSBCH14	RESEARCH METHODOLOGY; BIO-STATISTICS; BIOINFORMATICS-I	No of Lectures

Learning Outcome: *The learner should be able to*

1. *Employ standard methods in conducting research and develop skills for presenting it.*
2. *Compare and contrast the various designs of experiments and realize their importance in research*
3. *Employ statistical methods for analysis and interpretation of biological data.*
4. *Recognize and express the importance of biological databases and Retrieve biological data from them*
5. *Employ bioinformatics in nucleic acid and protein sequence and structure analysis*

Unit 1: Research & Research design **15**

1.1 Research

1.1.1 Meaning of research, Research Process, Types of research

1.1.2 Formulating research problem

1.1.3 Criteria for good research. Significance of research.

1.2 Research Design

1.2.1 Meaning, features of good research design, types of research designs

1.2.2 Basic principles of experimental Designs. Factorial design, Randomized design, Completely randomized design, Randomized block design, etc.

1.2.3 Prospective, retrospective, observational, clinical trials, RCT, Cohort, cross sectional and case controlled studies

Unit 2: Probability; Descriptive statistics **15**

2.1 Probability

2.1.1 Probability: Definition

2.1.2 Probability Distribution: Concept of Normal distribution and normal curve, Asymmetric distribution, Bayesian analysis.

2.1.3 Statistical problems on the above stated concepts

2.2 Application of statistics in biology

Data: Definition, Types and Sources of data, Presentation of data; Measurement and scales of measurement.

2.3 Descriptive statistics

2.3.1 Measures of central tendency : Mean, Median and Mode

2.3.2 Measures of dispersion: Range, percentiles, Mean deviation, Standard deviation, standard error variance, Coefficient of variation.

2.3.3 Simple correlation and linear regression

Unit 3: Sampling; Data analysis **15**

3.1 Sampling

3.1.1 Different Sampling techniques: Significance of correct sampling techniques, types of sample; Representative sample, sample bias

3.2 Data Analysis

3.2.1 Univariate and multivariate analysis.
Brief introduction to Parametric 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, F-test, ANOVA, Post-hoc test (eg., Tukey's post-hoc test)

Unit 4: Bioinformatics – I **15**

4.1 Introduction to Bioinformatics

4.1.1 Central dogma of molecular biology, Gene structure, features of gene and protein structure

4.1.2 Gene and Protein sequencing methods and the outcomes

4.1.3 Genome sequencing methods, concept of structural genome, functional genome, Introduction to Next-Generation Sequencing technology (NGS)

4.1.4 Human Genome Project- Applications

4.1.5 Introduction to Biological Databases- Classification,
Literature Database- Pubmed, Medline
Nucleotide Databases- Genbank, Unigene
Protein Sequence Databases- Swissprot, PIR
Protein Structural Databases- PDB, CATH
Metabolic pathway database- KEGG, Metacyc, reactome
Other databases- OMIM, Taxonomy, human atlas

4.1.6 Data submission and retrieval

4.1.7 Bioinformatics- Need and applications in various fields of Biology

4.2 Nucleotide and Protein sequence analysis

4.2.1 Nucleotide sequence databases and data retrieval, annotations – GenBank, EMBL

4.2.2 Nucleotide sequence analysis and importance – Intron exon finding, ORF finding, Motif finding, Gene finding

4.2.3 Genome analysis tools and importance

4.2.4 Protein sequence and structure databases: importance and types

4.2.5 Protein – sequence analysis

4.2.6 Enzyme databases, examples, metabolic pathway databases and applications

Syllabus of Practical of Semester I
(SIPSBCHP1)

Learning Outcome: *The learner should be able to*

1. *Solve problems on concentrations of solutions and prepare solutions and reagents of required concentrations*
2. *Employ volumetric and spectroscopic techniques for Qualitative and quantitative estimation of biomolecules*
3. *Apply the basic biochemistry knowledge in isolation of biomolecules and appreciate their commercial importance*
4. *Separation techniques like chromatography and electrophoresis*
5. *Appreciate research contributions of National and International Research institutes*
6. *Analyse and interprete the experimental data using basic statistics*
7. *Use databases to retrieve biological information*
8. *Express and communicate thoughts and ideas effectively*

SIPSBCHP11			**Biomolecules I**
	I		**Estimation of Biomolecules**
	1.		Preparation of standard solutions
	2.		Protein by Folin Lowry and Bradford method
	3.		Estimation of proteins at 280 nm
	4		Estimation of amino acid by Ninhydrin
	5.		Estimation of glucose by DNSA /GOD-POD
	6.		Estimation of vitamin C by DCPIP
	7.		Estimation of vitamin B1
SIPSBCHP12			**Cell Biology I**
	I		**Isolation of Biomolecules**
	1.		Starch from potato and purity determination by Willstatters method.
	2.		Casein from milk
	3.		Betalains from beet root
	4.		**Isolation of albumin from egg by ammonium sulphate precipitation. Quantification of isolated protein by Folin Lowry.**
	II		**Demonstration Experiment**
	1.		Determination of absorbance of proteins at 280nm.
	2.		Determination of membrane lipid composition of goat/sheep RBCs.

SIPSBCHP13			**Biophysical Techniques**
	I		**Chromatography and Electrophoresis**
		1.	Extraction of plant pigments from spinach leaves and their separation by column chromatography
		2.	Ascending and circular paper chromatography for amino acids and sugars
		3.	Thin layer chromatography of oils
		4.	2D TLC/ paper chromatography of amino acids
		5.	Separation of serum proteins by electrophoresis (PAGE/Agarose)
		6.	Separation of proteins by PAGE (seed extract/bacterial cell extract)
		7.	Separation of glucose and starch / separation of starch and casein by gel filtration (Demonstration)
SIPSBCHP14			**Research methodology; Biostatistics; Bioinformatics; Soft skills I**
	I		**Research Methodology**
			Review of research work carried out in any 5 National or International research center or institute.
	II		**Biostatistics:**
			One numerical problem each on: Measurement of central tendency (Mean, Median, Mode)
	III		**Bioinformatics:** Biological information retrieval from databases
		1.	Data retrieval from NCBI- Pubmed, Medline, Nucleotide, UniGene, Protein, Map viewer, SNP, OMIM
		2.	Data retrieval fromEBI- SwissProt,PIR, ENA,Taxon
		3.	Data retrieval using InterPro, SCOP
		4.	Half a day or one day visit to research institutes/ lab / industry is recommended for the students to get them acquainted with instruments and advanced techniques.
	IV		**Soft skills** Soft skills to be imparted in the form of interactive sessions/ case study/ role play/ quiz • Essentials of communication: Meaning, Definition, process and barriers. Emergence of communication as a key concept in the corporate and global world. • Methods and modes of communication: Verbal and nonverbal,

			• Listening: Importance of listening skills, cultivating good listening skills. • Written and Oral communication: Paragraph and Essay writing, Book reviews, Movie Reviews, Editorials and articles.

MSc Theory Syllabus
SEMESTER II

Course Code	Paper 1	Credits:4 No of Lectures
SIPSBCH21	BIOMOLECULES-II	

Learning outcome: *The learner should be able to*

1. *Elaborate the structure and function of biomolecules viz., nucleic acid and enzymes*
2. *Discuss classification of enzymes, their catalytic mechanisms and analyze kinetic parameters.*
3. *Appreciate and explore the applications of enzymes in industry, as diagnostics and as therapeutics.*
4. *Explain the mammalian endocrine system, its effector molecules and disorders related to abnormal production of hormones*

Unit 1 Nucleic acids **15**

1.1 Nitrogen bases, nucleosides, nucleotides, polynucleotide(guided self study);
DNA as genetic material; Experimental evidences.
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.

1.2 Organization of eukaryotic DNA: Histones, nucleosomes, structure of chromatin; Eukaryotic chromosomes, lampbrush& polytene chromosomes; movable genes, transposons &retroposons, invert repeats, overlapping genes, Cryptic genes.
RNA: Structure, function and types of RNAs; unusual bases in RNA, catalytic RNA

1.3 Genome of prokaryotes, viruses, mitochondria, chloroplasts

Unit 2: Enzymes-I **15**

2.1 Enzymes as biological catalysts:
IUB/EC Enzymes classification, active site identification and Conformation.

2.2 Factors affecting initial velocity of enzyme catalyzed reactions, requirement of metal, co-factor, coenzyme for activity, enzyme units
Principles of enzyme-catalysed reactions: Influence of enzymes on reaction rate, reaction equilibria; activation energy, binding energy.

2.3 Mechanism of enzyme reaction : Acid –Base, Electrostatic & Covalent catalysis. Mechanism of chymotrypsin (serine protease) and hexokinase/ enolase.

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; Enzyme kinetics in the presence of inhibitors; Determination of Ki;

Unit 3 Enzymes-II **15**

3.1 Regulatory enzymes:
Allosteric Enzymes- mechanism, kinetic properties,role in metabolic regulation.
Covalent modification: phosphorylation
Proteolytic cleavage- zymogen activation.

3.2 Multifunctional enzymes and multienzyme complexes; Isoenzymes; Ribozyme; Catalytic antibodies

3.3 Applications of enzyme: Clinical (Diagnostic tools and laboratory agents; therapeutic enzymes) and industrial

3.4 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 (Guided Self Study)

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,

4.2 Mechanism of Hormone action

4.2.1 General mechanism of hormone action: receptors, secondary messengers.

4.2.2 Regulatory pathways (positive, negative, feedback loops)

Course Code	Paper 2	Credits:4
SIPSBCH22	CELL BIOLOGY II	No of Lectures

Learning Outcome: *The learner should be able to*

1. *Discuss and co-relate different mechanisms of signal transduction.*
2. *Explain the process and stages of human and drosophila embryonic development.*
3. *Express the composition and function of connective tissue, muscle and nervous tissue.*
4. *Discuss the techniques and methods employed to understand the structural and functional aspects of cell.*

Unit 1: Cell Signaling **15**

1.1 Cellular Signaling:
General principles of signaling by cell surface receptors, endocrine, paracrine and autocrine signaling, components of intracellular signal-transduction pathways, types of cellular responses induced by signaling molecules,.
Extracellular messengers- amino acids and their derivatives, peptides and proteins, gases, steroids and eicosanoids.
Receptors: GPCRs, RTKs, ligand-gated channels, intracellular receptors and others.

1.2 Second messengers: cAMP, cGMP, IP3, diacylglycerol and Ca –their role and associated proteins
G-protein coupled receptor system: Mechanism of activation of effector molecules; Action of glucagon and epinephrine
Examples of physiologic processes mediated by GPCRs that activate phospholipase C, and GPCRs that regulate ion channels.

1.3 Signaling of insulin/EGF via activation of RTKs.
Cytokine/growth hormone signaling via JAK/STAT pathway. Ras proteins- MAPK pathway
Diseases related to defects in signaling pathways
(Stryer 5th edition)

Unit 2: Developmental Biology **15**

2.1 Basic concepts of development, identification of developmental genes.
Human embryonic development: Gametogenesis and fertilization.
Post fertilization events and their morphogenesis: cleavage and formation of blastula, gastrulation, neural tube formation and cell migration.

2.2 Experimental organisms or model systems :
Bacteria, viruses, yeast, roundworm (C. elegans), zebra fish,

2.3 Development of Drosophila: Early embryogenesis, Major stages in development, role of pattern regulating genes (maternal, segmentation, homeotic) (Lehninger, Darnell)

2.4 Cell-cell communication and molecular signaling in development : wnt and hedgehog pathway.

Unit 3 Biochemistry of Tissues- I **15**

3.1 Tissue level of organization

3.1.1 Types of tissues (Epithelial, Connective, Muscle and Nervous) and their origins.
Epithelial tissue: types and function

3.1.2 Connective tissue: Cells, matrix and types
Cartilage : types and functions
Bone tissue : function, histology and basic structure, growth and remodeling, role in calcium homeostasis
Blood (vascular tissue): basic composition

3.1.3 Disorders: Osteoporosis and Paget's disease

3.2 Muscle

3.2.1 Function, types and characteristics.
Skeletal muscles: motor unit, neuromuscular junction,

3.2.2 Microscopic anatomy of skeletal muscle: muscle fibres, myofibrils, muscle filaments.

3.2.3 Contraction and relaxation of muscle: Sliding filament mechanism, role of Ca and ATP. Rigor mortis

3.2.4 Disorders: Muscular dystrophies –Duchenne muscular dystrophy, Myasthenia gravis

Unit 4: Biochemistry of tissues –II; Techniques to study cell biology **15**

4.1 Biochemistry of tissues –II -Nervous tissue

4.1.1 Functions of the nervous system, divisions- CNS, PNS
Histology of nervous tissue: Types of cells-Neuroglia, neurons
Structure and classification of neurons, gray and white matter

4.1.2 Neurophysiology: membrane potential, ion channels
Mechanism of nerve impulse transmission, synapse and synaptic transmission
Examples of excitatory and inhibitory neurotransmitters

4.1.3 Disorders related to defects in neurotransmission– Parkinson's disease and Alzheimer's disease.

4.2 Techniques to study cell biology

4.2.1 Microscopy: Basic principles, instrumentation and application of Phase, and Fluorescence microscopy

4.2.2 Electron microscope – scanning emission microscopy, transmission emission microscopy (Karp)

4.2.3 Confocal and Fluorescence microscopy and Atomic force microscopy

4.2.4 Purification of cells and their parts: differential centrifugation.
Basic Principles, Instrumentation, working and applications of FISH, Flow Cytometry and Electroporation .

Course Code	Paper 3	Credits:4
SIPSBCH23	INDUSTRIAL AND APPLIED BIOCHEMISTRY	No of Lectures

Learning Outcome: *The learner should be able to*

1. *Discuss the parameters influencing a bioprocess/fermentation technology*
2. *Describe the upstream and downstream techniques in metabolite production*
3. *Justify the role of plants and microbial cells in mineral leaching and bioremediation and management and treatment of waste water*
4. *Apply the principles of quality control and techniques in food processing and preservation*
5. *Express the effect of industrial pollutants on environment and human health*
6. *Explain basic principles of ecology and environmental biochemistry.*

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 of plant pigments

2.1.2 Isolation and applications of non – catalytic industrial proteins – casein, whey proteins, Egg proteins, wheat germ proteins

2.2 Production of vaccines

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-transpiration system

2.3.3 Monitoring methods: COD, BOD, Total solid, heavy metals.

Unit 3 Techniques in Food Preservation 15

3.1 Tissue level of organization

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, radiation, 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 and Physical and chemical methods for their detection

3.4 QC, GMP and regulatory bodies

3.4.1 Monitoring food quality, General principles of Quality Control and Good Manufacturing Practices in food industry.

3.4.2 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 Science (Guided Self Study)

4.3.1 Air pollution : classification & effects of air pollutants on human health, Gases containing the oxides of carbon, sulphur and nitrogen, ozone and CFC. 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 of heavy metals (Pb, As, Hg, Cd), pesticides, polyaromatic hydrocarbons, dyes.

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

Course Code	Paper 4	No of Lectures
SIPSBCH24	RESEARCH METHODOLOGY, BIOSTATISTICS AND BIOINFORMATICS II	

Objectives: *The learner should be able to*

1. *Enable student to employ methods and skills of report writing and paper presentation.*
2. *Carry out hypothesis testing and apply statistics in analyzing, assessing and interpreting clinical and demographic data.*
3. *Employ bioinformatics tools for protein structure analysis and protein structure prediction.*

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 Sign test, Mann-Whitney test, Wilcoxon test, Kruskal-Wallis test.

2.1.3 Chi square test, Test of goodness of fit, contingency square, homogeneity of Chi square
Yate's correction, restrictions in applications of chi-square.

2.2 Measures of association

2.2.1 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

3.1.2 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 &
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 **15**

4.1 Genomic and Protein Sequence Analysis

4.1.1 Concept of sequence alignments, types, (Local and global sequence alignment)– Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues and
4.1.2 Scoring matrices: basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, PAM and BLOSUM

4.1.3 Nucleotide and Protein sequence analysis using BLAST and Variants

4.1.4 Introduction to multiple sequence alignment-Progressive algorithms-Clustal programs. Applications , Concept of phylogenetic analysis

4.2 In-silico Protein structure prediction

4.2.1 Introduction to protein structure, protein structure visualization, Protein structure and functional classification.

4.2.2 Computational methods in protein Secondary structure prediction

4.2.3 Computational methods in protein Tertiary structure prediction, Homology modeling

4.2.4 Protein-protein interaction

Syllabus of Practical of Semester II (SIPSBCHP2)

Learning Outcome: *The learner should be able to*

1. *Analyze and interpret kinetics of enzyme-catalysed reactions.*
2. *Analyse food samples for presence of common additives and adulterants*
3. *Acquire practical skills in microbiological techniques like enumeration, isolation and identification of microbes*
4. *Develop practical skills in isolation and characterization of plant metabolites*
5. *Design a research problem and frame a budgeted proposal for grants*
6. *Analyse and interprete the biological data using statistical tools and tests*
7. *Explore databases to retrieve biological information*
8. *Develop oral expression and presentation, and scientific writing skills*

SIPSBCHP21			**Biomolecules II**
	I		**Enzymology**
		i	Extraction and partial purification of amylase / transaminases/ alkaline phosphatases / /Proteases (precipitation by salts/solvent)
		ii	Determination of optimum pH, optimum temperature of amylase (or any other enzyme)from sweet potatoes/ Moong (from any other source)
		iii	Determination of Km and specific activity of amylase/transaminase/alkaline phosphatase
	II		**Food analysis**
		i	Detection of common food adulterants wheat/rice/milk/turmeric/tea powder/coffee/chilly powder
		ii	Estimation of sodium benzoate from Jam/ Jelly
SIPSBCHP22			**Cell Biology II**
	I		**Basic Microbial Techniques**
	1		Microscopy
		i	Stages of Mitosis and Meiosis/effect of cytotoxic agent on mitotic index
		ii	Staining : Gram, Capsule, Spore, and Negative
		iii	Staining of DNA and RNA (Demonstration)
	2		Preparation of media and Sterilization Methods
	3		Techniques for preservation of cultures: sub-culturing, glycerol stocks, lyophilization
	4		Enumeration of bacteria: opacity tube, optical density, Viable count
	5		Growth curve of *E. coli*/Yeast
	6		Isolation of bacteria from natural sources: air, water and food

	7		Study of pure cultures of *E. coli* and *S. aureus* on selective media
	8		Biochemical tests for identification of bacteria: IMViC, catalase, oxidase
	9		Antibiotic sensitivity by disc diffusion or well diffusion Method

SIPSBCHP23			**Industrial and Applied Biochemistry**
	I		**Extraction of phytoconstituents / bioactive compounds from plants**
	1		Curcumin from Turmeric
	2		Carotenes from carrots
	3		Lycopene from Tomato
	4		Caffeine from coffee beans

SIPSBCHP24			**Research methodology; Biostatistics; Bioinformatics; Soft skills-II**
	I		**Research Methodology:**
		1.	Preparation of research proposal of minor/major research projects for grants/funds from funding agencies.
	II		**Biostatistics:**
		1.	Statistical problems based on Chi-square, paired and unpairedt-Test and z-Test, simple regression analysis
	III		**Bioinformatics:**
		1.	Sequence and structural analysis
		2.	Database Similarity Search using BLAST variants
		3.	Multiple Sequence Alignments-Clustal Omega, T-Coffee
	IV		**Soft skills**
			Soft skills to be imparted in the form of interactive sessions/ case study/ role play/ quiz • Effective Business Writing: Letters, Reports. • Paper writing: Styles of paper writing: Short Communication, Review papers and Research papers, Referencing styles: MLA, Chicago Style and APA. • Presentations: Principles of effective presentation, power-point presentation, video and satellite conferencing. • Interviews and Group Activities: Personal interviews, group discussion and panel discussion

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MSc Biochemistry Theory Syllabus
Semester III
Paper1

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 dependent 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

3.5 Epigenetics: Chromatin remodeling; Histone modifications; histone variants; Silencing mechanisms; RNA-based silencing; DNA methylation/imprinting; Epigenetic regulation of transcription.

Unit 4: **DNA Damage and Repair** **15**

4.1 **Mutations**

4.1.1 Types of mutations; Physical, chemical and Biological agents causing mutation

4.1.2 Mutational hot spot, reverse mutations , Mutagenesis, Ames test

4.1.3 Site directed mutagenesis

4.2 **DNA Repair Mechanisms**

Photoreactivation, nucleotide excision, SOS repair, recombinational repair, mismatch repair

4.3 **Chromosomal abnormalities**

4.3.1 Chromosomal Aberration

4.3.2 Structural and numerical abnormalities

4.3.3 Euploidy and aneuploidy (Autosomal and sex chromosomes)

4.3.4 Monosomies (Turner syndrome) Disomies and trisomies (Down Syndrome) and their causes

Paper 2

Course Code	Title	Credits 4
SIPSBCH32	IMMUNOLOGY I	No of Lectures

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.*

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.

Paper 3

Course Code	Title	Credits 4
SIPSBCH33	**METABOLISM AND METABOLIC DISORDERS**	No of Lectures

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*

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 mucopolysaccharidoses.	
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).

Paper 4

Course Code	Title	Credits 4
SIPSBCH34	CLINICAL NUTRITION	No of Lectures

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***.**

Unit 1 **Basic concepts in nutrition** **15**

1.1 Digestion, Absorption and Excretion of Carbohydrates, Lipids and Proteins (Guided Self-study), Role of gut microflora;

1.2 **Macronutrients**

1.2.1 Carbohydrates, Glycemic Index, Sweeteners, RDA

1.2.2 Dietary lipids, synthetic lipids, RDA

1.2.3 Proteins, Essential and nonessential amino acids, RDA Nitrogen Balance.
Protein quality and methods of determination (BV, PER, NPU), Complementary proteins

1.2.4 Macronutrient use and storage in the fed state, macronutrient catabolism in fed state.

1.3 **Micronutrients**

1.3.1 Vitamins: Absorption, storage, transport, functions, DRI and deficiency disorders (Guided Self-study, assignment)

1.3.2 Other vitamin-like factors: Choline, Betaine, myo-inositol, ubiquinone, bioflavonoids

1.3.2 Minerals : Absorption, transport, storage, excretion, function and deficiency of Ca, Mg, Na, K, Fe, Zn, Cu, I and Se (guided self-study, assignment)

1.4 **Anti-nutritional Factors**: Trypsin Inhibitors, pressor amines, phytates, oxalates.

Unit 2 Nutrition Assessment **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, Doubly labeled water technique.
Estimating energy requirements: Mifflin-St. Jeor equation, from energy intake.
Estimating energy expenditure in physical activity: Prediction equations at four levels of physical activity (sedentary, low active, active and very active)

Calorific value and Calculation of food energy

2.3 Nutritional assessment

Tools for assessment of nutritional status:
Physical and Functional assessment: ABCD i.e Anthropometry: BMI, Hip-waist ratio, Circumference measurements, Bioelectrical impedence analysis, 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 Regulators of gastrointestinal activity- Nerves and neuropeptide hormones

3.2 Primary nutritional diseases

Protein energy malnutrition; Eating Disorders: Anorexia nervosa, Bulimia nervosa,
Obesity, Vitamin deficiency disorders; Biochemical basis, etiology and diagnosis of nutritional anemias.

3.3 Conditioned Nutritional disorders

Disorders of GI tract : Celiac disease, Lactose intolerance, IBS, alcoholic liver disease.

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

M.Sc. Semester III Practical (SIPSBCHP3)

SPISBCH31	**I**	**Molecular Biology**
	1.	Isolation of DNA (Crude) from germinating moong seeds/onion tissue/bacterial DNA & its detection.
	2.	Isolation of RNA (Crude) from Baker's Yeast & its detection.
		Demonstration experiments
	1	Isolation of Plasmid DNA
	2.	Staining of Cellular RNA & DNA and microscopic examination.
	3.	Study of bacterial conjugation
	4.	Study of bacterial transformation.
	5.	Study of mutation in *E.coli* by UV.
	6.	Cell free protein synthesis.
	7.	Tm of DNA.
	8.	AMES Test.
SIPSBCHP32	**I**	**Immunology-** Demonstration
	1.	ELISA
	2.	RIA
	3.	Hybridoma technology
	II	**Haematology**
	1.	Blood Grouping
	2.	CBC: RBC count, WBC count, differential WBC count, Hb by Sahli's method and Drabkin's method, PCV,
	3.	Immunodiffusion Kit
		Demonstration experiments
	1	Erythrocyte sedimentation rate

	2	Reticulocyte count
SIPSBCHP33		**Clinical Biochemistry**
	1.	Gastric Function Tests: Gastric Juice-Total and Free Acidity
	2.	Pancreatic Function Tests: i.Glucose Tolerance Test (GTT) ii. Estimation of Serum Amylase Activity.
	3.	Urine Analysis- Normal and Abnormal constituents, Microscopic examination
	4	CSF analysis: i.Protein (Folin Lowry/Bradford) ii.Glucose (GOD-POD) iii.Demonstration of lumbar puncture procedure for CSF tapping(Video)
	5.	Antioxidant status of serum – FRAP assay
		Demonstration experiments
	1.	Estimation of HbA1C
	2.	Estimation of serum lipase (Turbidimetric/ quinonimine dye test)
SIPSBCHP34		**Clinical Nutrition**
	1.	Problems on measurement of food energy
	2.	Estimation of energy requirement and energy expenditure
	3.	Problems on BMI, Hip:waist ratio
	4.	Characterization of a probiotic preparation (Gram staining, Colony characteristics and Biochemical tests)
	5.	Estimation of serum iron/serum ferritin
	6.	Nutritional profile of food (Processed/ Unprocessed/Natural)
		i.Moisture content
		ii.Carbohydrate content, gluten content

		iii.Protein content
		iv.Preparation of ash and determination of mineral content (Ca, P, Mg, Fe)

MSc Biochemistry Theory Syllabus
Semester IV
Paper 1

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:	**Genetic recombination**	**15**
1.1	Genetic recombination in bacteria: conjugation, transformation & transduction.	
1.2	Mapping of genes by conjugation, transformation & transduction	
1.3	Holliday & Messelson-Radding models of recombination; proteins and enzymes involved in genetic recombination	
1.4	Gene linkage & crossing over, tetrad analysis	
1.5	Transposable elements	
1.6	Model organisms: *S.cerevisiae, Arabidopsis, Mus musculus*	
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 and prokaryotic 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
In vitro amplification of DNA (PCR), designing of primers for PCR, types of PCR, applications

3.2.3 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 of secondary metabolites
4.1.4	Use of PTC in production of transgenics.

4.2 Animal Tissue Culture (ATC)

4.2.1	Principles, techniques, methodology and applications 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.
4.2.3	Frontiers of contraceptive research, cryopreservation of sex gametes & embryos, ethical issues in embryo research.

Paper 2

Course Code	Title	Credits 4
SIPSBCH42	**IMMUNOLOGY II**	No of Lectures

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.*

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

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 insulin dependent diabetes mellitus)

3.2.2 Diagnostic and prognostic value of auto antibodies- Treatment of autoimmune diseases

3.2.3 Role of CD4, T cell, MHC and TCR in autoimmunity

3.2.4 Proposed mechanisms for induction of auto immunity

Unit 4 Tumor Immunology and Immunodeficiencies

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 CD4 T cells; Clinical Diagnosis;

Paper 3

Course Code	Title	Credits 4
	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.*

SIPSBCH43		**No of Lectures**
Unit I:	**Water And Electrolyte Balance**	**15**
1.1	**Water and Electrolyte Balance**	
1.1.1	Importance of Water. Total Body Water (TBW) and its distribution, normal water balance. (Intake and output of water, osmolarity of extracellular fluid)	
1.1.2	Electrolytes. Distribution of electrolytes in body fluids. Water and Electrolyte balance. Regulation of Sodium and Water balance. (Aldosterone. Renin-Angiotensin system, aquaporins) Disorders of fluid and electrolyte balance. Expansion and contraction of ECF (isotonic, hypotonic, hypertonic)	
1.1.3	Acid Base balance : Role of Blood buffers, Kidney, lungs Acidosis & Alkalosis and Compensatory mechanisms	
1.1.5	Blood Gas Analysis (pH, pO2, pCO2, Bicarbonate) and interpretation	
Unit II:	**Hemostasis And Hemoglobin Metabolism**	**15**
2.1	**Hemostasis**	
2.1.1	Blood types, hemostasis and blood coagulation	
2.1.2	Conditions that cause excessive bleeding, thromboembolic conditions	
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 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)

Unit III: Pathophysiology; Organ Function Tests **15**

3.1 Pathophysiology of common diseases

3.1.1 CVD: Hypertension, angina, congestive heart failure, arthersoclerosis,

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 and Biochemical Assessments

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

4.2 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; Interventions to delay ageing.

Paper 4

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

15

Unit I General Pharmacology

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 **Methods for measuring drug effects**

1.2.1 Bioassay: General principles

1.2.2 Clinical Trials: Phases I to IV

1.3 **Measurement of Toxicity**

LD50, ED50, Therapeutic index, Number-needed-to-treat (NNT) principle

1.4 **Pharmacodynamics**

1.4.1 Drug absorption: routes of administration

1.4.2 Bioavailability and bioequivalence

1.4.3 Drug distribution: Translocation of drugs, bulk flow & diffusional transfer, binding to plasma protein.

1.4.4 Drug metabolism: Phase I & Phase II

1.4.5 Drug elimination: Renal & Biliary

1.5 **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 & pharmacological selectivity

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

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)
Ciprofloxacin
Antituberculosis- Isoniazid, Rifampicin

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)

4.2 Functional foods , Nutraceuticals and dietary supplements

4.2.1 Concept of Functional foods, Nutraceuticals and Dietary supplements

4.2.2 Dietary supplements in management of chronic diseases; Study of following herbs: Alfaalfa, Chicory, Ginger, Fenugreek, Garlic, Honey, Amla, Ginseng, Ashwagandha, Spirulina.

4.2.3 Bioactive proteins and peptides as functional foods

4.2.2 New Drug Investigation (NDI) and applications

M.Sc. Semester IV Practical (SIPSBCHP4)

SIPSBCHP41	**Research Project**	
SIPSBCHP42	**Immunology II**	
	I	**Serology**
		Serological tests- Rheumatoid Arthritis factor, C- reactive protein, widal, VDRL, Pregnancy test
		Demonstration experiments
	1.	Inflammatory markers: CRP, ferritin; Tumor markers
	2.	Polymerase chain reaction (PCR).
	3.	Restriction digestion & separation of DNA restriction fragments
	4.	Blotting Techniques a) Southern b) Western c) Northern
	5.	Plant tissue culture/Suspension culture
SIPSBCHP43	**Medical Biochemistry**	
	I	**Clinical Biochemistry**
	1.	Liver Function Tests:
		Estimation of serum ALT, AST, Total & direct bilirubin. alkaline phosphatase
		Estimation of serum Total Proteins, Albumin & A/G ratio.
	2.	Renal Function Tests:
		Urea and Urea Clearance Test
		Creatinine and Creatinine Clearance Test
	3.	Lipid Profile:
		Estimation of serum total cholesterol
		Estimation of HDL

		Estimation of Triglycerides
		Estimation of LDL by calculation
	4.	Estimation of serum acid phosphatase
	5.	Estimation of serum electrolytes (Na+, K+, Cl-).
		Demonstration experiments
	1.	Separation of LDH isoenzymes
	2.	Arterial Blood Gas Analysis
SIPSBCHP44	**Pharmaceutical Biochemistry**	
	1.	Preparation of Aspirin from salicylic acid
	2.	Estimation of Aspirin
	3.	Isolation of phytoconstituents like alkaloids and flavonoids from suitable source
	4.	Determination of LD50 of a cytotoxic drug – zebra fish embryo model
	5.	Protective effect of antioxidants (vitamin C/natural extracts/phytoconstituents) against drug induced cytotoxicity using chick embryo/zebra fish embryo

GUIDELINES TO CARRY OUT PROJECT WORK (SIPSBCHP41)

1. The main purpose of introduction Project Work at MSc Part II is to make the students familiar with Research Methodology i.e. reference work, experimental work, statistical analysis of experimental data, interpretation of results obtained, writing of project work and compilation of bibliography in proper order. This will not only help train the inquisitive minds of the students, but also inspire them to take up research- oriented higher studies and career.
2. **Duration of Project work:-**
   Development on the nature of the research problem and the infrastructure available in the respective Biochemistry Departments or Research Institutes or Industries, the duration of Project Work in recommended as follows:-

   a. 06 Months:-From May 01 to Oct 31 of the given calendar year (the project work will commence immediately after the conclusion of Semester II of MSc Part–I on April 30 of given academic year)

   b. 03 Months:-FromMay01toJuly31orfrommid-Junetomid-September (either in summer vacation up to July 31 of Semester III or immediately after the commencement of Semester III in mid-June up to mid-September

c. Entire Semester- III i.e. mid-June to Oct 31depending on the first and the last working days of Semester III.

3. Each student shall complete a small research project during his/her academic year of MSc Part-III However, the initial reference work can be started in MSc Part-I and summer vacation to MSc Part-II

4. **Nature of Research Project:-**

The following will be considered as the Research Project

a. Experimental based involving laboratory analytical work, or
b. Survey based Field work with statistical analysis of data collected, or
c. Industrial training based provided that the candidate has undergone actual hands on training in instrumental analytical techniques.

5. **Schedule for Submission of project Work:-**

a. Experiment work or Field work or Industrial training must be completed by October 31.

b. The duration of Diwali Vacation and the part of Semester IV up to December 31 shall be utilized for finalizing the written contents of the project work.

c. The final copy of the project work (2Copies) will have to be submitted to the respective HOD by January 15th of Semester IV.

6. The project containing about 50-100 pages should be divided into the following parts:-

a. Certification of completion of Project Work from the HOD.
b. Acknowledgement.
c. Introduction
d. Review of Related Literature
e. Aims and Objectives
f. Significance of research problem selected
g. Plan of work
h. Material and Methods
i. Results
j. Discussion
k. Bibliography

7. The project should be submitted at the time of Sem IV Practical Examination, and the same will be assessed in presence of an external examiner.

GUIDELINE FOR THE INTERNAL ASSESMENT OF PROJECT WORK

1. The practical 401 of Semester IV (Course Code No. SIPSBCHP41) shall be exclusively devoted for the project

2. Each student will complete the project (2 copies) and get both the copies certified by the guiding teacher and the Head of the Department (HOD) as scheduled by the Head of the department.

3. One copy of the certified project will be submitted to the HOD; while the other copy will be retained by the student for his/her personal record.

4. After the certification of the project, the HOD will invite a PG–Recognized Teacher of Biochemistry Dept of any other College/Institute/Research centre for the assessment of the Research Project.

5. The candidate is required to present the Research Project to the invited examiner followed by Viva-Voce examination based on the project work by the examiner.

6. The following Marking Scheme shall be considered while assessing the project work

Particular		Marks
a)	Project Work(contents submitted in the bound form)	30
b)	Presentation of project work to examiner	10
c)	Viva-voce Exam based on the project work	10
	TOTAL	50

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Pharmacology

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1. De Muro, M. A., Walker, J. M., & Rapley, R. (2008). Molecular Biomethods Handbook.
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Scheme of examination

M.Sc. Degree (by papers) in Theory & Practical in Biochemistry to be implemented with 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 60 Marks			Internal assessment (40 Marks)	
	No. of Units	Marks per Unit	Total Marks	Class test/ assignment/oral presentation/curriculumbased 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 II1:00 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.