M.Sc. Biochemistry Syllabus
Under credit system at the Department of Biochemistry
Dr. Bhimrao. Ambedkar University, Agra

Semester	**Papers**	Marks		**Total**	**Credit**
Semester I Course Code		CIE	End Semester examination		
BC 101C	Plant Biochemistry	25	75	100	4
BC 102C	Cell Biology and Cell Signalling	25	75	100	4
BC 103C	Biomolecules and Bioinstrumentation	25	75	100	4
BC 104C	Biostatistics and Computer Applications	25	75	100	4
BC 105	Practical			100	4
	IndustrialTraining/Survey/Research Project				
Total				**500**	**20**
Semester	**Papers**	Marks		**Total**	**Credit**
Semester II Course Code		CIE	End Semester examination		
BC 201C	Essential of Molecular Biology	25	75	100	4
BC 202C	Immunology	25	75	100	4
BC 203C	Advanced Enzymology	25	75	100	4
BC 204C	Intermediary Metabolism	25	75	100	4
BC 205	Practical			100	4
	Industrial Training/ Survey/Research Project			200	8
	Minor	25	75	100	4
	Total		800	32	
Semester	**Papers**	Marks		**Total**	**Credit**
Semester III Course Code		CIE	End Semester examination		
BC 301C	Microbial Physiology and Biochemistry	25	75	100	4
BC 302C	Nutritional Biochemistry	25	75	100	4
BC 303C	Clinical Biochemistry and Biosafety	25	75	100	4
BC 304E	Genetic Engineering	25	75	100	4
BC 305E	Pharmaceutical biochemistry				
BC 305	Practical		100	100	4
	Industrial Training/ Survey/Research Project				
Total				500	20
Semester	**Papers**	Marks		**Total**	**Credit**
Semester IV Course Code		CIE	End Semester examination		
BC 401C	Applied Biotechnology	25	75	100	4
BC 402C	Human Physiology	25	75	100	4
BC 403E	Environmental Biochemistry	25	75	100	4
BC 404E	Genomics and Proteomics				
BC 405E	Gene Expression and Regulation	25	75	100	4
BC 406E	Medical Biochemistry				
BC 407	Practical		100	100	4
	Industrial Training/ Survey/Research Projet		200	200	8
Total				700	28

M.Sc. BIOCHEMISTRY
SEMESTER – FIRST
BC-101 C (Core Course)
PLANT BIOCHEMISTRY

Course Outcomes

On the completion of the course, students will be able to:	
CO1	Students will be taught specific aspects of Plant Biochemistry that are not covered under general biochemistry
CO2	The course has been a specialty of the Department of Biochemistry and is designed to give the students comprehensive knowledge of molecular aspects of plant Biology.
CO3	Preparing a strong platform for a research career in the area
CO4	In this course, students will extend their knowledge of Biochemistry fundamentals and will learn about important metabolic processes taking place in plants. Acquire a detailed knowledge about photosynthesis, metabolism of polysaccharides, metabolism of nitrogen compounds and molecular mechanisms of signalization and regulation

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)

UNIT	Topic	No.of Lectures Hours 60
I	Structure and function of plant cell, cell wall, plasmodesmata, vacuoles, peroxisomes. Isolation of cell organelles, mechanism of the transport of water, inorganic and organic substances,Seed dormancy, growth and development.	15hrs
II	Photosynthesis: structure of organelles involved in photosynthesis in plants and bacteria, photo system I, II and their location, mechanism of quantum captures and energy transfers between photo system, reduction of CO_2, C_3, C_4 and CAM metabolism regulation of photosynthesis.Photorespiration and its significance.	15hrs
III	Biological nitrogen fixation: mechanism of nitrate uptake and reduction ammonia assimilation, sulphate uptake and transport. Mineral nutrition: micronutrients, macronutrients and their biological role in plants.	15hrs
IV	Secondary plant metabolites: biosynthesis of tannins, alkaloids (pyrrolidine, piperidine, coniine, quinolinate), flavonoids and surface waxes and their functions.Antioxidative defense system in plants.Plant hormones: Mode of action of auxins, gibberellins, cytokinins, ethylene, abscissic acid	15hrs

Reference Books

Plant Biochemistry, Goodwin Mercer
Plant Physiology, Salisbury Ross
Biochemistry and Molecular Biology of Plants, by Buchanan
Plant Biochemistry and Molecular Biology, by Lea and Leegood Plant Biochemistry, by Dey and Harborne

M.Sc. BIOCHEMISTRY
SEMESTER – FIRST
BC-102 C (Core Course)
CELL BIOLOGY AND CELL SIGNALLING

Course Outcomes

On the completion of the course, students will be able to:	
CO1	Learn about structural organization of prokaryotic and eukaryotic cells, ultra structure and functions of cell organelles.
CO2	Understand about cell division: mitosis and meiosis; Cell cycle: check points, role of cyclin and cyclin dependent kinases in cell cycle regulation
CO3	Acquire knowledge about basics of signal transduction
CO4	Understand about protein trafficking in cells, Protein sorting, vesicular transport and protein targeting.

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)		
UNIT	Topic	No. of Lectures Hours 60
I	Cell Membrane: Physicochemical Properties, Molecular Organization – asymmetrical organization of lipids, proteins and carbohydrates and functions.Transport across membranes: Types of transport (simple diffusion, passive-facilitated diffusion), active transport – primary and secondary group translocation, transport ATPases (V type, F type, P type, ABC type).	15hrs
II	Cell classification, cell variability (size, shape, complexity, and function). Structural organization of prokaryotic and eukaryotic cell. The ultrastructure of nucleus, mitochondria, endoplasmic reticulum (rough and smooth), Golgi apparatus, lysosomes and their function.The cytoskeleton: microtubules and microfilaments.The extra cellular matrix: collagen.	15hrs
III	Cell–cycle: phases of cell cycle, cell cycle check points, CdK, cyclins, MPF, p53, wait signal,Apoptosis. Cell division by mitosis and meiosis.Biochemistry of cancer: characteristics of cancer cell, carcinogenesis, carcinogens, oncogenes and tumor suppressor genes.	15hrs
IV	Cell signaling: Forms of intracellular signaling, hormone and their receptors (steroid and plant hormones) Pathways of intracellular signal transduction: c-AMP pathway, c-GMP pathway, phospholipids and Ca^{++} Ras, Raf and MAP kinase pathway JAK/STAT pathway	15hrs

Reference Books

Molecular Biology of the Cell, Alberts, et al
Molecular Cell Biology, Lodish, et al
Cell and Molecular Biology: Concepts and Experiments, Gerald Karp
The Cell: A Molecular Approach, G.M. Cooper
The Word of the Cell, Becker *et al*
Cell Proliferation and Apoptosis, Hughes and Mehnet
Essential Cell Biology, Alberts *et al*
Biochemistry and Molecular Biology of Plants, Buchanan *et al*
Harpers Biochemistry Murray *et al*

M.Sc. BIOCHEMISTRY
SEMESTER – FIRST
BC-103 C (Core Course)
BIOMOLECULES AND BIOINSTRUMENTATION

Course Outcomes

On the completion of the course, students will be able to:	
CO1	The knowledge of the structure of biomolecules, gives an understanding of their physical and chemical properties and the basis of their functions in living organisms.
CO2	It prepares students for more advanced studies in Biochemistry.
CO3	The course will help students to acquaint with basic instrumentation,
CO4	Principle and procedure of various sophisticated instruments like UV-visible spectroscopy, different types of centrifugation, chromatography, electrophoresis, NMR, CD, ORD in biological research..

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)		
UNIT	Topic	No. of Lectures Hours 60
I	Carbohydrates: Classification, structure of carbohydrates (monosaccharides, disaccharides polysaccharides- homo- and hetero-polysaccharides). Lipids: Classification, structure, properties and functions of fatty acids, essential fatty acids, fats, phospholipids, sphingolipids, cerebrosides, steroids, bile acids, prostaglandins and lipoproteins.	15hrs
II	Amino acids: Structure, classification, abbreviation, properties and functions of amino acids. Proteins: Classification, structure and functions of proteins, Ramachandran plot, Protein Sequencing. Nucleic acids: Structure and function of nucleotides. Primary, secondary and tertiary structure of nucleic acids. DNA forms (single stranded DNA, A, B and Z DNA) syn and anti conformations. Types of RNA (m RNA, t RNA, rRNA, hn RNA, micro RNA).	15hrs
III	Spectroscopy: Concept of spectroscopy, Laws of Photometry, Beer-Lambert's Law. Instrumentation and application of UV, Visible, and IR, Raman spectroscopy. Radioisotope Techniques: Units and measurement of radioactivity. Use of radioisotopes in Biomedicine and research.Electron Microscopy: Transmission and scanning, freeze fracture techniques.	15hrs
IV	Electrophoresis: Moving boundary zonal electrophoresis, paper and gel electrophoresis, isoelectric focusing. Chromatography: Paper Chromatography, Thin Layer Chromatography (TLC), Ion exchange, gel filtration and affinity chromatography, High Pressure Liquid Chromatography (HPLC) – Normal & reverse phase.Centrifugation techniques and their application. subcellular fractionation.	15hrs

Reference Books

Principles of Biochemistry by Nelson, Cox and Lehninger
Biochemistry by G.Zubay
Biochemistry, D Voet and JG. Voet , J Wiley and Sons.
Physical Biochemistry: Applications to Biochemistry and Molecular Biology, D Freifilder, W.H. Freeman & Company.
Practical Biochemistry, Wilson & Walker.

M.Sc. BIOCHEMISTRY
SEMESTER –FIRST
BC-104 C (Core Course)
BIOSTATISTICS AND COMPUTER APPLICATIONS

Course Outcomes

On the completion of the course, students will be able to:	
CO1	Define the principal concepts about biostatistics
CO2	Recognize the definition of statistics, its subject and its relation with the other sciences in the field of research and skill based knowledge.
CO3	Collect data relating to variable/variables which will be examined and calculate descriptive statistics from these data. Identify data relating to variable/variables.
CO4	Understanding the basics of computers and computational data analysis which in-turn can be used for interpretation of data analysis Access various global bioinformatics centers such as NCBI, EBI and Genome Net etc

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)		
UNIT	Topic	No.of Lectures Hours 60
I	Measures of central tendency (arithmetic mean, mode, median), measure of dispersion, standard deviation, coefficient of variance, group data and graphic methods, frequency & distribution. Probability: Definition of probability, multiplication, law of probability, addition, law of probability, random variable permutation & combination. binomial, normal & poisson distribution.	15hrs
II	Tests of significance hypothesis and errors, Student statistics- Population mean equal a specified value. Equality of two independent means, Equality of two means. Non-parametric test Chi square statistics, test of goodness of fit. Regression and correlation coefficient, partial & multiple correlation, Relationship between regression and correlation. Analysis of variance:- One way analysis.	15hrs
III	Computers: Basics of common application software packages for word processing (MS Word), spreadsheets (MS Excel) and presentation (MS Powerpoint). Introduction of Internet- LAN, MAN, WAN.	15hrs
IV	Introduction to Bioinformatics: Concepts of Bioinformatics, Accessing and retrieving sequence information from genome sequence databases, use of genome data, overview of comparative and functions genomics, application of computers in Biochemistry.	15hrs

Reference Books

Biostatistical analysis, Zar, Pearson
Biostatistics,Daniel, Wiley
Biostatistics, Norman, Decker
Fundamentals of Bioinformatics, Irfan Ali Khan, Ukanz
Fundamentals of Biostatistics, Irfan A. Khan and Khanum, Ukaz Publication
Fundamentals of Computers, V. Rajaraman, Prentice-Hall India
A Handbook of Agricultural Statistics, S.R.S. Chandel, Lal Prakshan

M.Sc. BIOCHEMISTRY
SEMESTER –SECOND
BC-201 C (Core Course)
ESSENTIALS OF MOLECULAR BIOLOGY

Course Outcomes

On the completion of the course, students will be able to:	
CO1	Learn about nucleic acid as genetic information carriers, Possible modes of replication, and roles of helicase, primase, gyrase, topoisomerase, DNA Polymerase, DNA ligase, and Regulation of replicationDefine the principal concepts about biostatistics
CO2	Understand the detailed mechanism and regulation of Eukaryotic DNA replication, along with Mitochondrial and Chloroplastic DNA Replication
CO3	Learn about mechanism and regulation of transcription in prokaryotes along with Reverse transcription.
CO4	Understanding about the classes of DNA sequences, Genome-wide and Tandem repeats, Retroelements, Transposable elements, Centromeres, Telomeres, Satellite DNA, Mini satellites, Microsatellites; Applications of satellite DNA and Split genes

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)

UNIT	Topic	No. of Lectures Hours 60hrs
I	Organization of Genetic materials in prokaryotes and Eukaryotes: Genetic material, Genome type, Size, Genome Organization - Structural Maintenance of Chromosomes (SMC) Protein, Eukaryotic Nucleosomes, Histones, Chromatin, Concept of Gene, mono-cistronic and poly-cistronic genes, Gene Structure with various functional units - replicon, muton, recon, C-value and C-value paradox; Unique sequences and Cot value, reassociation kinetics, Split genes: Exons and Introns.	15hrs
II	Replication: Modes of replication: Details of Meselson and Stahl experiment; Prokaryotic DNA replication:Origin and Initiation, elongation and termination; Roles, properties and mechanism of action of DnaA, Helicase, Primase, DNA gyrase,Topoisomerases,DNA Polymerases, DNA ligase, Leading and lagging strands; Okazaki fragments; RNA primers;Regulation of replication; Fidelity of replication; Viral replication, σ or Rolling circle replication in ϕX174 DNA damage and DNA repair**:** Types of DNA damages, Types of DNARepair systems, Photoreactivation.	15hrs
III	Eukaryotic DNA replication: Initiation, elongation and termination; Multiple replicons/initiation sites; Autonomously replicating sequence; Mechanism and significance of Origin recognition complex, Mini-chromosome maintenance proteins, DNA dependent DNA polymerases α, δ, ε, Nucleases, DNA ligase and Telomeres in eukaryotic nuclear DNA replication; Regulation of eukaryotic DNA replication; Mitochondrial and Chloroplast DNA replication.	15hrs
IV	Transcription in prokaryotes: Initiation, elongation and termination; Prokaryotic promoter; weak and strong promoters, DNA dependent RNA polymerase: Physical properties, Templet strand, non-template strand, coding strand, Subunits, σ factor, its types and function; Recognition of promoter; Transcription bubble, Direction of Transcription; Abortive initiations; Promoter clearance; Elongation factor Gre and its role, Rho dependent and Rho independent termination of transcription; Sigma cycle; RNA - dependent DNA polymerase and Reverse transcription.	15hrs

Reference Books

Genes XI , by Benjamin Lewin
Biochemistry – J. David Rawn – Neil Patterson publication, NC.
Cell and Molecular Biology: Concepts and Experiments, by Gerald Karp
Transcriptional Regulation in Eukaryotes, by Carey and Smale
Translational control of gene Expression, by Sonenberg *et al*
Chromatin and Gene Regulation, by Turner
An Introduction to Genetic Analysis, by Griffiths *et al*
Genome, by T. A. Brown

M.Sc. BIOCHEMISTRY
SEMESTER –SECOND
BC-202 C (Core Course)
IMMUNOLOGY

Course Outcomes

On the completion of the course, students will be able to:	
CO1	Learn the fundamental principles of immune response including molecular, biochemical and cellular basis of immune homeostasis.
CO2	Aid in understanding various aspects of immunological response and how its triggered and regulated.
CO3	Understand the rationale behind various assays used in immunodiagnostics of diseases and will be able to transfer knowledge of immunology in clinical perspective.
CO4	Develop understanding of principles of Graft rejection, Auto immunity and Antibody based therapy,develop the capacity for problem-solving about immune responsiveness, knowledge of pathogenesis of diseases and designing of immunology based interventions for effective treatment

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)		
UNIT	Topic	No. of Lectures Hours 60
I	Introduction to Immune System Memory, specificity, diversity, innate and acquired immunity, self Vs non-self discrimination. Structure and functions of primary and secondary lymphoid organs. Cells Involved in Immune Responses Structure and Functions: Mononuclear cells (phagocytic cells and their killing mechanisms), granulocytic cells (neutrophils, eosinophils and basophils), mast cells and dendritic cell. Lymphoid cells (B-lymphocytes, T-lymphocytes and Natural killer cells).	15hrs
II	Nature of Antigen and Antibody Antigen Vs Immunogen, Haptens Structure and functions of immunoglobulins . Istopic, allotypic and idiotypic variations. Generation of Diversity in Immune System. Clonal selection theory-concept of antigen specific receptor. Organization and expression of immunoglobulin gens: generation of antibody diversity. Immunization: Active immunization (immunoprophylaxis) Passive immunization (Immunotherapy) Role of vaccines in the prevention of diseases.	15hrs
III	Humoral and Cell-mediated Immune Responses .Kinetics of primary and secondary immune responses. Complement activation and its biological consequences. Antigen processing and presentation. Cytokines and co stimulatory molecules: Role in immune responses. T and B cell interactions. Major Histocompatability Complexes (MHC) Genes and Products Polymorphism of MHC g Role of MHC antigens in immune responses. MHC antigens in transplantation.	15hrs
IV	Measurement of Antigen- Antibody Interaction. Agglutination and precipitation techniques. Radio Immunoassay , ELISA and ELISPOT Immune fluorescence assays: Fluorescence activated cell sorter (FACS) technique. Hypersensitivity: Immediate (Type I), Cytotoxic (Type II), Immune complex-mediated (Type III), Delayed hypersensitivity (Type IV) Immune Responses in Diseases, Immune responses to infectious diseases: viral (HIV), bacterial (tuberculosis) and protozoal (malaria) infections Immunodeficiency disorders: congenital (SCID, Leuckocyte adhesion deficiency, Chronic granulomatous disease) and acquired (AIDS) immunodeficiencies. Autoimmunity	15hrs

Reference Books

Kubey, Immunology, R.A. Goldsby, Thomas J. Kindt, Barbara, A. Osbarne. (Freeman).
Immunology-Ashort Course, -Eli Benjamini, Richard Coico, Geoffrey Sunshine.
Immunology by Tizzard
Fundamentals of immunology by William Paul.
Immunology by Roitt *et al*
Immunology by Abbas

M.Sc. BIOCHEMISTRY
SEMESTER – SECOND
BC-203 C (Core Course)
ADVANCED ENZYMOLOGY

Course Outcomes

On the completion of the course, students will be able to:	
CO1	Acquire the knowledge of enzymes their properties and classification, Mechanism of action, Michaelis-Menten initial rate equation, methods for the determination of Km and Vmax.
CO2	Learn about enzyme kinetics, effect of enzymes concentration, pHand temperature on kinetics of enzyme reactions, enzyme inhibition and activation, and multi-substrate enzyme kinetics.
CO3	Learn different immobilization techniques
CO4	Industrial and Clinical scope of enzymes.

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)		
UNIT	Topic	No. of Lectures Hours 60
I	Properties & classification of enzymes. Kinetics of order of reactions, energy of activation, concept of ES complex, active site, derivation of Michaelis-Menten and Briggs-Haldane equations for uni- substrate reactions. Different plots for the determination of Km & Vmax (LB plot, Hanes plot, Eadie Hofstee plot, Eisenthal Cornish Bowden plot). Importance of Kcat/Km. Factors affecting the rates of enzymes catalyzed reactions- pH and temperature. Reversible and irreversible inhibition-competitive, non-competitive, uncompetitive inhibitor.	15hrs
II	Enzyme purification techniques: objectives and strategy, methods of homogenization, method of isolation and purification Mechanism of enzymes action: Chymotrypsin, Triose phosphate isomerase, aldoase, lysozyme – Methods to determine active site. Metalloenzymes.	15hrs
III	Proteins – ligand binding concept & measurement. Allosteric enzymes: Sigmoidal kinetics & their physiological signification. Hill and Scatchard Plots Symmetric and sequential modes of action of allosteric enzymes and their significance. Enzyme regulation: General mechanism of enzyme regulation. Feed back inhibition and substrate inhibition. Reversible and irreversible covalent modifications of enzymes.	15hrs
IV	Immobilized enzymes and their industrial applications. Effect of partition of kinetics and performance with particular emphasis on changes in pH and hydrophobicity. Multienzyme system: Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthetase complexes. Immobilized multienzyme system and their applications. Enzymes in medical diagnosis (aspartate aminotransferase, alanine aminotransferase, creatine kinase, lactate dehydrogenase) and enzyme therapy.	15hrs

Reference Books

The Nature of Enzymology by R.L. Foster
Enzymes by Dixon and Webb
Fundamentals of Enzymology by Price and Stevens
Enzyme Catalysis and Regulation by Hammes
Enzyme Reaction Mechanisms by Walsch
The Enzymes vol I and II by Boyer
Enzyme Structure and Mechanism by Alan Fersht
Enzyme Assays: A Practical Approach by Eisenthal and Danson
Enzyme Biotechnology by G. Tripathi
Practical Biochemistry by Plummer.
Practical Biochemistry by Sawhney and R. Singh
Enzymes – Dixon & Webb – Academic press

M.Sc. BIOCHEMISTRY
SEMESTER – SECOND
BC-204 C (Core course)
INTERMEDIARY METABOLISM

Course Outcomes

On the completion of the course, students will be able to:	
CO1	Learn Carbohydrate catabolism, and its association with cellular energy production,and carbohydrate anabolism in plants and animal cells.
CO2	Aquire the Knowledge of bioenergetics and energy transformation
CO3	Understand Lipid biosynthesis, Degradation of fatty acids and cholesterol, ketone bodies, acidosis, ketosis.
CO4	Understand about the Biosynthesis of purines and pyrimidine nucleotides, degradation of nucleotides, salvage pathways,biosynthesis and biodegradation of amino acids. Understand detailed mechanism of nitrogen metabolism

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)

UNIT	Topic	No.ofLectures Hours 60
I	Carbohydrates metabolism: Glycolysis, citric acid cycle and pentose phosphate pathway. Gluconeogenesis Glycogenesis & Glycogenolysis Regulation of blood glucose homeostasis by hormones.	15hrs
II	Lipids Metabolism: Biosynthesis- Triacyglycerols, phospholipids, cholesterol, fatty acids, prostaglandins and ketone bodies. Fatty acid oxidation: β- oxidation of saturated and unsaturated fatty acid. Metabolism of circulating lipids: chylomicrons, LDL, HDL, and VLDL, free fatty acids.	15hrs
III	Bioenergetics: Energy transformation, Laws of Thermodynamics, Biological oxidations, Gibb's energy, Free energy changes. Mitochondrial respiratory chain: ETC carriers (iron sulphur proteins, ubiquinone, universal carriers and cytochromes). ETC complexes I,II, III (Q cycle) & IV, the stochiometry of proton extrusion uptake, shuttle system. Oxidative phosphorylation (OP): Coupling of ETC and OP, uncouplers, ATP syntahse, proton motive force, chemiosmotic theory, : P/O and H/P ratios. Mechanism of ATP formation. Respiratory controls and inhibitors of oxidative phosphorylation.	15hrs
IV	Amino Acids Catabolism of tyrosine, phenylalanine, tryptophan, branched chain amino acids. Urea cycle and its regulation. Nucleic Acids Biosynthesis of Purines and Pyrimidines nucleotides. Degradation of Purines and Pyrimidines nucleotides. Regulation of Purine and Pyrimidine biosynthesis.	15hrs

References Books

Harper's Biochemistry – Murray, Granner, Mayes, and Rodwell – Prentice Hall International Inc.
Biochemistry – Lehninger – CBS Publishers.
Biochemistry – Stryer – W. H. Freeman & Co. – New York.
Text Book of Biochemistry – West, Todd, Mason, Bruggen – Amerind Publishing Co. Pvt., Ltd.

M.Sc. BIOCHEMISTRY
SEMESTER –THIRD
BC-301 C (Core Course)
MICROBIAL PHYSIOLOGY & BIOCHEMISTRY

Course Outcomes

On the completion of the course, students will be able to:	
CO1	Understand the basics of microbiology like Characterization and classification of microorganisms, cultivation, nutrition, physiology and growth of microbial cells, Learn and understand the basics of mycology, virology and production of mutants and their characterization.
CO2	Understand the basic microbial structure and functions of various physiological groups of prokaryotes and eukaryotes and also learn the theory and practical skills in microscopy handling and staining techniques.Know various Culture media and their applications and understand various physical and chemical means of sterilization and also learn various techniques for isolation of pure cultures
CO3	Comprehend the various methods for identification of unknown microorganismsand study microbial metabolism – Autotrophy and heterotrophy modes of nutrition. Understand the microbial physiology and know the various Physical and Chemical growth requirements of bacteria and get equipped with various methods of bacterial growth measurement
CO4	The students will be able to understand and predict the various metabolic reactions in microbial cell. Understand the architecture of viruses, their classification and the methods used in their study.Discern the replication strategies of representative viruses from the seven Baltimore classes and comprehend the intricate interaction between viruses and host cells

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)		
UNIT	Topic	No. of Lectures Hours 60
I	Types of microorganisms, general characteristics of main groups of microorganisms, Nutrition and growth of microbial cells with different growth curve- lag, log, stationary and decline phases. Synchronous growth, pure culture techniques and preservation methods	15hrs
II	Morphology and fine structure of eubacteria and archaebacteria cell wall, cytoplasmic membrane and other organelles. Staining methods: Gram staining, acid-fast, endospore and fungal staining Gram positive and gram negative organisms. Structure & function of peptidoglycan in gram positive and gram negative organisms. Functions of polymeric components in outer membrane and acidic polymers in gram negative organisms. Biosynthesis of bacterial cell wall and use of different inhibitors.	15hrs
III	Food spoilage, fermentation, food-borne infection (Staphylococcal, Clostridial, Salmonellosis, Shigellosis). Role of microorganisms in domestic and industrial sewage. Methods of sterilization in brief. Metabolism: EDP pathway, Xylose-5-phosphoketolase pathway	15hrs
IV	Virus structure, virus proteins, virus classification and methods of assay. Structure of bacteriophage, lytic and lysogenic life cycle Replication of RNA viruses–negative strand (VSV), positive strand (Polio), retrovirus (to include all events in the infectious cycle). Replication of DNA viruses (Adenovirus & SV 40). Virus–host interaction and prevention polio/AIDS, Hepatits	15hrs

Reference Books

Microbiology, Pelczar, M.J., Chan , E.C.S. and Kreig, N.R., Tata McGraw Hill.
Microbial Genetics, Maloy , S.R., Cronan, J.E.Jr and Freifelder, D. Jones, Bartlett Publishers.
General Microbiology – Stanier, Adelberg, Ingraham – The Macmillan Press – London.
Fundamental Principals of Bacteriology – Salle – TMH Pub. Co. Ltd. – New Delhi.
Microbiology-An Introduction – Tortora, Funke, Case, Benjamin – Cummings Publ. Co.

M.SC. BIOCHEMISTRY
SEMESTER –THIRD
BC-302 C (Core Course)
NUTRITIONAL BIOCHEMISTRY

Course Outcomes

On the completion of the course, students will be able to:	
CO1	The student will learn and understand the basic concepts of nutrition, and nutritional values of foods, and Basal metabolic rate and measurement of energy requirements
CO2	The student will also learn and understand the dietary requirement of carbohydrates, lipids and proteins and their biological significance
CO3	o aid to learn the nutritional requirement and significance of dietary minerals like calcium, phosphorus, magnesium, iron, iodine, zinc and copper and vitamins like vitamin B complex, C and A, D, E & K.
CO4	Understand the condition of malnutrition, its prevention, and Recommended dietary allowances.Understand the condition of malnutrition, its prevention, and Recommended dietary allowances

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)

UNIT	Topic	No. of Lectures Hours 60
I	Basic concepts – Function of nutrients. Measurement of the fuel values of foods. Direct and indirect calorimetry. Basal metabolic rate: factors affecting BMR, measurement and calculation of BMR. Measurement of energy requirements.	15hrs
II	Elements of nutrition – Dietary requirement of carbohydrates, lipids and proteins. Biological value of proteins. Concept of protein quality. Essential amino acids, essential fatty acids and their physiological functions.	15hrs
III	Minerals – Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper. Vitamins – Dietary sources, biochemical functions, requirements and deficiency diseases associated with vitamin B complex, C and A, D, E & K vitamins.	15hrs
IV	Malnutrition – Prevention of malnutrition, improvement of diets. Recommended dietary allowances, nutritive value of common foods. Protein-calorie malnutrition. Requirement of proteins and calories under different physiological states- infancy, childhood, adolescence, pregnancy, lactation and ageing. Obesity: Definition, Genetic and environmental factors leading to obesity.	15hrs

Reference Books

Tietz Fundamentals of Clinical Chemistry, Burtis Ashwood, Saunders
Clinical Chemistry, Kaplan
Clinical Chemistry (Organ Function Test), M.N Chatterjee, Jaypee
Normal and Therapeutic Nutrition,Robinson, Garwick, Macmillan
Nutrition, Paul Insel, Don Ross, Jones and Bartlett
Nutrition and Diet Therapy, Lutz, F. A. Davis
Nutrition And Dietetics, Joshi,Tata McGraw Hill
Practical Clinical Biochemistry, Varley, CBS Publisher's latest Edition

M.Sc. BIOCHEMISTRY
SEMESTER –THIRD
BC-303 C (Core Course)
CLINICAL BIOCHEMISTRY AND BIOSAFETY

Course Outcomes

On the completion of the course, students will be able to:	
CO1	The student will be able to clinically assess the laboratory indicators of physiological conditions and diseases.
CO2	They will know the biochemical and molecular tools needed to accomplish preventive, diagnostic, and therapeutic intervention on hereditary and acquired disorders.
CO3	The course will The course will also aid in understanding the Biohazard and Biosafety, Biosafety guidelines of Government of India; Definition of GMOs.
CO4	Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs and Bioethics.

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)		
UNIT	Topic	No. of Lectures Hours 60
I	Disorders of Carbohydrates Metabolism: Diabetes mellitus, glycatedhemoglobins, hypoglycemias, various types of glucose tolerance tests, glycogen storage diseases, galactosemia. Disorders of Lipid Metabolism: Tay-Sach's, Gaucher's and Niemann-Pick diseases, atherosclerosis and diagnosis tests. Disorders of Amino Acid Metabolism: phenylketonuria, alkaptonuria, tyrosinosis, albinism, maple syrup urine disease. Disorders of Nucleic Acid Metabolism: Lesch-Nyhan syndrome, gout orotic aciduria.	15hrs
II	Clinical and biochemical aspects of atherosclerosis, jaundice, diabetes, hepatitis, glomerular nephritis, gall stones, Addison's disease, Conn's syndrome, Cushing's syndrome, hypo & hyperthyroidism, Parkinson's disease and Alzheimer's disease	15hrs
III	Disorders of Erythrocyte: thalassemias and sickle cell anemia. Diseases and organ function test: liver diseases (jaundice, hepatitis, hemochromatosis, Reye's syndrome) and liver function tests, renal diseases (glomerulonephritis, nephrotic syndrome, urinary tract infection, urinary tract obstruction, renal failure) and renal function tests.	15hrs
IV	Biosafety: Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety guidelines - Government of India; Definition of GMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication. Bioethics: Introduction, necessity and limitation	15hrs

Reference Books

Tietz Fundamentals of Clinical Chemistry, Burtis Ashwood, Saunders
Clinical Chemistry, Kaplan
Clinical Chemistry (Organ Function Test), M.N Chatterjee, Jaypee
Normal and Therapeutic Nutrition,Robinson, Garwick, Macmillan
Nutrition, Paul Insel, Don Ross, Jones and Bartlett
Nutrition and Diet Therapy, Lutz, F. A. Davis
Nutrition And Dietetics, Joshi,Tata McGraw Hill
Practical Clinical Biochemistry, Varley, CBS Publisher's latest Edition

M.SC. BIOCHEMISTRY
SEMESTER –THIRD
BC-304 E (optional elective)
GENETIC ENGINEERING

Course Outcomes

On the completion of the course, students will be able to:	
CO1	Understand "Gene Regulation mechanism in Prokaryotes, Viruses and Eukaryotes
CO2	Differentiating between the different mechanisms involved, depending on the organism and the process involved in regulation.
CO3	Gain knowledge about Recombinant DNA technology by studying about various Vectors and Restriction Enzymes involve.Study of Various Expression Systems and Molecular Markers.
CO4	Clear & Lucid understanding of the Various Regulatory mechanisms and their Applications Screening of the libraries with the help of "Reporter Genes" and Molecular Markers such as RFLP, RAPD, and AFLP

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)		
UNIT	Topic	No .of Lectures Hours 60
I	Enzymes used in rDNA Technology: Outline of cloning procedure, Host controlled restriction and modification: Restriction endonucleases and cognate methylases, Class I, II & III restriction enzymes, Variants of Type II Restriction enzyme, Restriction digestion, Star activity, Restriction mapping, Formation of chimeric DNA, Homopolymer tailing, Synthetic Linkers, Adaptors and DNA ligase; Filling in and Trimming back; Significance of T4 DNA polymerase &Klenow Fragment, Alkaline phosphatase, Reverse transcriptase in cloning.	15hrs
II	Plasmids: Plasmid classification on basis of phenotypic traits: Relaxed and stringent control of copy number; Plasmid incompatibility; Plasmid host range, Mobilizable plasmids and Triparental mating; Plasmid as cloning vector (recombinant plasmids): Properties of ideal plasmid cloning vectors, pBR322, pUC& pGEM3Z series, Transcriptional and translational fusion vectors; Fusion proteins; Selectable markers; Reporter genes.	15hrs
III	Phage as a cloning vector: Advantage of using phage lambda vector, Genome map of phage lambda, In vitro packaging, Insertional and replacement vectors: Cosmid vectors; M13 phage and its role in single stranded DNA production, M13 series of vectors; Phagemids; Yeast as cloning vector: Basic principles of development of yeast vectors, 2μ plasmid, YEP, YRP YCP, YIP; Artificial chromosomes: YACs, BACs and PACs.	15hrs
IV	Screening and selection of recombinants: Functional (genetic) complementation (Blue-white screening, Red-white screening), Nutritional complementation, Gain of function, Colony hybridization, Plaque hybridization, Southern blotting and hybridization, Dot blot, Zoo blot, Plus-Minus screening, Northern blotting, Immunological screening, Western blotting, South-Western blotting, North-Western blotting, HART, HAT	15hrs

Reference Books

1. Smita Rastogi and Neelam Pathak (2009), Genetic Engineering, Oxford University Press.
2. Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell publishing (Oxford, Principles of Gene Manipulation and Genomics (2006) 7th ed., Primrose, S.B., and Twyman, R. M., Blackwell publishing (Oxford, UK)
3. Old & Primrose
4. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC),
5. Molecular Cloning: A laboratory manual (2014),4nd ed., Michael R Green and J. SambrookCold spring Harbor laboratory press (3vol.), ISBN: 978-1-936113-42-2

M.SC. BIOCHEMISTRY
SEMESTER – SECOND
BC-305E(Optional\Elective)
PHARMACEUTICAL BIOCHEMISTRY

Course Outcomes

On the completion of the course, students will be able to:	
CO1	Understand about monoclonal antibodies and its applications along with regulatory requirements
CO2	Understand about formulation of proteins and peptides, adult-phase drug delivery systems
CO3	Understand about injectable lipid emulsions, liposomes, polymeric systems for oral protein and peptide delivery.
CO4	Understand about the pulmonary drug delivery systems for biomolecules; Lipid based pulmonary delivery, Arosols etc. Understand about different polymers used for controlled drug delivery

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)		
UNIT	Topic	No. of Lectures Hours 60
I	Monoclonal antibodies: applications, generation, recombinant antibodies, production methods, Pharmaceutical, regulatory and commercial aspects.	15hrs
II	Formulation of proteins and peptides: making small protein particles, precipitation of proteins, quality control issues, multi-phase drug delivery system; Preparation of collagen, gelatin particles, albumin microparticles	15hrs
III	Proteins and phospholipids: structural properties of phospholipids, injectable lipid emulsions, liposomes, cochleal phospholipids structures; Polymeric systems for oral protein and peptide delivery.	15hrs
IV	Pulmonary drug delivery systems for biomacromolecules; Lipid based pulmonary delivery; Solid colloidal particles; Polycyanoacrylates; Poly (ether-anhydrides); Diketopiperazine derivatives; Poly ethylene glycol conjugates; Factors affecting pulmonary dosing. Aerosols, propellents, containers types, preparation and evaluation, intra nasal route delivery systems: Types, preparation and evaluation.	15hrs

References Books

Groves MJ 'Pharmaceutical Biotechnology', Taylor and Francis Group.
Crommelin DJA, Robert D, Sindelar 'Pharmaceutical Biotechnology'.
Kayser O, Muller R 'Pharmaceutical Biotechnology'.
Banga AK 'Therapeutic peptides and proteins'.
Molecular Cell Biology- by Lodish H., Berk A., Matsudiaira P., Kaiser C.A., Krieger M. and Scott M.P., W. H. Freeman and Company, New York.
Vyas S.P. and Kohli D.V., Pharmaceutical Biochemistry, 1st Edition, CBS Publishers & Distributors, New Delhi
Principles and Techniques of Biochemistry and Molecular Biology by Wilson K. and Walker J. , Cambridge University Press

M.SC. BIOCHEMISTRY
SEMESTER – THIRD
BC-401C (Core Course)
APPLIED BIOTECHNOLOGY

Course Outcomes

On the completion of the course, students will be able to:	
CO1	Understand principle and application of PCR, Rapid DNA and RNA sequencing techniques, High throughput Sequencing, and Microarray.
CO2	Learn about the principle& applications of Blotting and hybridization.
CO3	Introduced with DNA fingerprinting and Molecular Markers
CO4	Learn about application of recombinant microorganism, plant biotechnology & animal biotechnology to develop understanding of basics in protein engineering and bionanotechnology

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)		
UNIT	Topic	No. of Lectures Hours 60
I	Principle & applications of PCR; RACE, Degenerate PCR, Realtime PCR, Site Directed Mutagenesis: oligonucleotide directed, PCR based Mutagenesis, Antisense RNA technique, ribozymes, Microarray techniques for DNA	15hrs
II	Rapid DNA and RNA sequencing techniques: Sanger method, Maxam and Gilbert procedure, automated DNA sequencing, pyrosequencing; High throughput Sequencing Human Genome sequencing, and comparative genomics.Molecular Markers: RFLP, RAPD, AFLP, DNase I foot printing. Genome editing.	15hrs
III	Application of recombinant microorganism: Production of recombinant pharmaceuticals, therapeutic proteins, Production of Restriction Enzyme,Production of Antibiotics, Production of Biopolymer,Combating Human Diseases,Biopesticides, Bioremediation	15hrs
IV	Plant Biotechnology:Ti plasmid, Binary and Cointegrate vectors derived from Ti plasmid of Agrobacterium, plant virus vectors, Transgenic plants and their applications. Protein Engineering: Concept of designing of new protein molecule, Application of protein engineering. Basics of nanobiotechnology.	15hrs

Reference Books

Gene Cloning,T. A. Brown,Blakwell
Gene engineering, Joshi, Daya Publication
Gene Isolation and Mapping Protocol,,Jacqueline Boultwood,Humana Press
Molecular Biology and Biotechnology, C A Smith; Edward J Wood, Chapman & Hall
Molecular Biology and Biotechnology, Walker and Repley, Royal Society of Chemistry
Molecular biology and genomics, Cornel Mülhardt, Elsevier Academic Press
Molecular Biotechnology,,Bernard, Glick, ASM Press
Molecular Biotechnology, Primrose,Panima

M.Sc. BIOCHEMISTRY
SEMESTER –THIRD
BC-402 C (Core Course)
HUMAN PHYSIOLOGY

Course Outcomes

On the completion of the course, students will be able to:	
CO1	Describe the composition of blood and explain the process of erythropoisis and enlist various factors that regulate erythropiosis to explain two pathways that initiate blood clotting different types of blood groups and its importance during blood transfusion.
CO2	The knowledge of various body fluids such as blood and urine, their detail composition and alterations under various pathological conditions is of paramount importance.
CO3	To understand excretory system
CO4	Detailed Physiology of Nerve impulse transmission and muscle contraction is vital to our understanding of these important physiological processes.

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)		
UNIT	Topic	No .of Lectures Hours 60
I	Blood: Composition and functions of plasma, erythrocytes including Hb, leucocytes and thrombocytes, plasma proteins in health ad diseases. Blood coagulation mechanism and regulation, Fibrinolysis. Transfer of gases – oxygen and carbon dioxide. Bohr effect and chloride shift.	15hrs
II	Digestive system: Composition, function and regulation of saliva, gastric, pancreatic, intestinal and bile secretions–digestion and absorption of carbohydrates, lipids and proteins.	15hrs
III	Excretory system: Structure of nephron, formation of urine, glomerular filtration, tubular reabsorption of glucose, water and electrolytes, tubular secretion. Regulation of an electrolytes balance and regulation of kidney function by hormones	15hrs
IV	Nerve: structure of neuron, membrane potential, action potential, voltage gated channels, role of ions during action potential, transmission of action potential, synapse, synaptic transmission. Muscles: Structure of skeletal, smooth & cardiac muscles. Neuromuscular junction and transmission, excitation and contraction coupling	15hrs

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References

Human Physiology, Vol. I & II, - C. C. Chatterjee – Medical Allied Agency – Calcutta.
Concise Medical Physiology – Choudhary – New Central Book Agency – Calcutta.
TextBook of Medical Physiology – Guyton – Prism Books Pvt. Ltd. – Bangalore.

M.Sc. BIOCHEMISTRY
SEMESTER- FOURTH
BC-403 E (optional elective)
ENVIRONMENTAL BIOCHEMISTRY

Course Outcomes

On the completion of the course, students will be able to:	
CO1	Understand Microbiology of air and aquatic environments, Biological Oxygen Demand and pollution problems.
CO2	Students will be familiar with environmental pollution, Xenobiotic toxicity/ genotoxicity, Mode of action of pesticides, fungicides and insecticides; Bioaccumulation and bioremediation.
CO3	Students will become aware of recycling of organic waste, composting and vermi- composting and municipal solid waste treatment and management.
CO4	Students will get familiarized with Microbial biotransformation/ degradation of organic pollutants, xenobiotics, pesticides, herbicides, heavy metals and radio isotopic materials and biodeterioration.

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)		
UNIT	Topic	No of Lectures Hours 60
I	Environment: Basic Concept & Issues. Environmental pollution: Types of pollution. Air pollution & its control through biotechnology. Water pollution & its Control: Water as a natural resource, need for water management, measurement of water pollution, source of water pollution.	15hrs
II	Toxic effect: Basis for general classification & nature. Dose-Response relationship. Synergism & Antagonism. Determination of ED-50 & LD-50. Acute & chronic exposures. Factors influencing toxicity,. Xenobiotics metabolism: Phase-I reactions: Oxidation, reduction, hydrolysis & hydration. Phase-II reactions\conjugation: Methylation, glutathione & amino acid conjuctions, detoxifications.	15hrs
III	Pesticide toxicity: Insecticides- Organochlorines, Anti-cholinesterase- Organophosphates and Carbamates. Fungicides, Herbicides. Environmental consequences of pesticide toxicity. Biopesticides. Metal toxicity: Toxicology of Arsenic, Lead and Cadmium in target organs. Metabolism of CCl_4 & Paracetamol & their effect in liver & kidney.	15hrs
IV	Microbiology of degradation of xenobiotics in environment: Ecology considerations, decay behaviour and degradative plasmid. Hydrocarbons, substituted hydrocarbons, oil pollution surfactants. Global Environment problems: Ozone depletion, Green house effect and acid rain.	15hrs

Reference Books

Environmental Biology and Toxicology, P. D. Sharma, Rastogi
Textbook of Toxicology, BalramPani, IK
Casarett&Doull's Essentials of Toxicology, Klaassen, MGH
Toxicology: Principles and Applications, Niesink, CRC
Clinical Toxicology, FACMT, Saunders
Environmental Pollution and Toxicology, Johi, APH

M.Sc. BIOCHEMISTRY
SEMESTER- FOURTH
BC-404 E (Optional Elective)
GENOMICS AND PROTEOMICS

Course Outcomes

On the completion of the course, students will be able to:	
CO1	Understand Genome sequencing, various types of sequencing technologies and sequencing approaches.
CO2	Learn Pros and cons of different sequencing technologies. Major genome databases and methods of Genome analysis and their applications
CO3	Acquire Basics and application of structural genomics, comparative genomics and functional genomics
CO4	Learn various techniques of proteomics like 2D and MALDI. Methods of protein separation, detection and quantification. Various applications of genomics and proteomics in agriculture, human health and industry

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)		
UNIT	Topic	No .of Lectures Hours 60
I	Introduction Structural organization of genome in Prokaryotes and Eukaryotes; Organelle D NA-mitochondria l, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and pedigree analysis physical and genetic mapping.	15hrs
II	Genome sequencing projects Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics.Identification and classification using molecular markers-16s rRNA typing/sequencing, ESTS and SNPS.	15hrs
III	Microarray chips: Types of DNA chips and their production. Gene Therapy for Human Diseases. Protein Crystallization; Theory and methods: API Electrospray and MALDI-TOF. SNP's and GMS (Genome mismatch Signals)	15hrs
IV	L. Proteomics Protein analysis (includes measurement of concentration, amino-acid composition, N terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectricfocusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid systems. Functional Proteomics: Significance of Proteome research	15hrs

Reference Books

Genomics, Proteomics and Bioinformatics, 2nd Edition. Campbell AM & Heyer LJ, Benjamin Cummings 2007; CSH Press, NY. ISBN-10: 8131715590
Principles of Proteomics. R.M Twyman (2004). (BIOS Scientific publishers). ISBN-10: 1859962734
Principles of Gene Manipulation and Genomics- Primrose S & Twyman R, 7th Edition, Blackwell, 2006. ISBN-10: 1405135441
Principles of Genome Analysis and Genomics. Primrose SB & Twyman RM. 2007. Blackwell. ISBN-10: 1405101202
Introduction to Genomics. A.M Lesk, Oxford University press, 2007. ISBN-10: 0199557489
A Primer of Genome Science. Greg Gibson and Spencer V. Muse. 2nd ed. 2004. SINAUER Associates Inc. ISBN-10: 0878932364
Genome III – T.A. Brown Garland Science Publ. June 08, 2006. ISBN-10: 0815341385

M.Sc. BIOCHEMISTRY
SEMESTER- FOURTH
BC-405 E (Optional Elective)
GENE EXPRESSION AND REGULATION

Course Outcomes

On the completion of the course, students will be able to:	
CO1	Transcription in Eukaryotes, Transcription factors, Nucleosome modifiers, Mediator complexes, Chromatin remodellers, Elongation factors in transcription; Cleavage and polyadenylation.
CO2	Learn and understand Post - transcriptional / Co-transcriptional processing of RNA, End modifications, RNA splicing, RNAediting, Alternative splicing.
CO3	Understand the fundamentals of translation in prokaryotes and eukaryotes, properties of Genetic code, Ribosome binding site; Formation of initiation complex; Transpeptidation and Translocation; Ribosome cycle
CO4	Understand Post - translational processing, splicing, Chemical modification, Proteolytic cleavage, Zymogen activation to understand regulation of gene expression; Concept of operon, Significance of repressor, Attenuation; Inhibitors of transcription and translation.

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)		
UNIT	Topic	No. of Lectures Hours 60
I	Transcription in eukaryotes: Synthesis of pre-mRNA: Outline of process - Initiation, elongation and termination, RNA Pol II, promoter, Enhancer elements, Subunit structure of RNA Pol II, Roles of RNA polymerase II, Transcription factors, Nucleosome modifiers, Mediator complexes, Chromatin remodelers, Elongation factors in transcription; Synthesis & processing of pre-rRNA and pre-tRNA: Outline of process, RNA Pol I and III, promoters sequences.	15hrs
II	Co-transcriptional processing: Addition of 5` cap and 3' Poly A tail in mRNA; Post transcriptional processing: RNA splicing – Type 1 and Type 2 Intron splicing, Spliceosome mediated splicing and maturation of precursors of rRNA, mRNA, tRNA): Role of different ribonucleases in splicing, Covalent modifications, RNA editing, Alternative splicing, Histone mRNA processing	15hrs
III	Translation in prokaryotes and eukaryotes: Outline of the process - Initiation, elongation and termination; Adapter role of tRNA, Genetic code, Evidences for a triplet codon; Properties of Genetic code; Codon family and Codon pairs; Nonsense and Sense codons; Degeneracy: Significance of Isoacceptor tRNAs and Wobble hypothesis; Codon bias; Amino acyl tRNA synthetase: Classification, Specificity, Reaction catalyzed; A, P and E sites of ribosome; Start and stop codons, Ribosome binding site; Formation of initiation complex; Transpeptidation and Translocation; Ribosome cycle; Roles of Initiation factors, Elongation factors, Release factors, Ribosome recycling, Aminoacyl tRNA synthetases, catalytic role of GTP, Peptidyl transferase site and Factor binding site of ribosomes in translation. Proofreading activity of ribosomes and Fidelity of Translation	15hrs
IV	Regulation of prokaryotic gene expression; Concept of operon: Lac, Trp and Ara operons, Significance of repressor, Attenuation; Inhibitors of transcription and translation**.**	15hrs

Reference Books

Lehninger,Albert,Cox,MichaelM.Nelson,DavidL.(2017) Lehninger principles of biochemistry/NewYork:W.H.Freeman.
Lewin "Genes"
Freifelder, DM "Molecular Biology"
Brown, TA "Genomes"
Watson, JD "Molecular Biology of the cell"
Twyman, R.M.Advanced Molecular Biology"
Brown, TA"Gene cloning: An introduction"
Old & Primrose "Principles of Gene Manipulation"
Primrose, SB "Molecular Biotechnology"
Jose B. Cibelli, Robert P. Lanza, Keith Campbell, Michasel D. West "Principles of Cloning"

M.Sc. BIOCHEMISTRY
SEMESTER- FOURTH
BC-406 E (optional elective)
MEDICAL BIOCHEMISTRY

Course Outcomes

On the completion of the course, students will be able to:	
CO1	Discuss the fundamental biochemistry knowledge related to health and explain the clinical significance of the laboratory tests.
CO2	Diagnosis of clinical disorders by estimating biomarkers determining various substances including substrates, enzymes, hormones, etc and their use in diagnosis and monitoring of disease are applied.
CO3	Evaluate the abnormalities which commonly occur in the clinical field.
CO4	Review the information from each category of tests and develop a protocol for disease diagnosis to create awareness of different lifestyle diseases increasingly found in present day

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)		
UNIT	Topic	No.of Lectures Hours 60
I	**Disorders of Carbohydrates Metabolism** Diabetes mellitus, Glycated hemoglobins, Hypoglycemias. Various types of glucose tolerance tests. **Disorders of Thyroid** Hyperthyroidism, Hypothyroidism. Thyroid function Tests: T3, T4, TSH, TRH	15hrs
II	**Disorders of Lipids** Hypoliproteinemia, Hyperlipoproteinemia, Atherosclerosis Diagnostic tests for apolipoproteins, HDL – cholesterol, LDL – cholesterol and triglycerides. **Diagnostic Tests for Proteins** Total protein, albumin, globulin and fibrinogen	15hrs
III	**Liver Function Tests** Van den Bergh test for bilirubin, urine and fecal urobilinogen Determination of galactose, epinephrine test Detoxification and excretion tests Prothrombin Time Determination of blood ammonia **KidneyFunction Tests** Urea clearance test, Creatinine clearance test Renal plasma flow Concentration and dilution test	15hrs
IV	**Biochemical Aspects of Hematology** Complete blood count (CBC)- red blood cell, white blood cell, platelet counts, percent hemoglobin Bleeding time, clotting time Serum Aspartate aminotransferase, alanine aminotransferase, creatine kinase, gamma glutamyl transpeptidase, alkaline phosphatase	15hrs

Reference Books

Tietz Fundamentals of Clinical Chemistry, Burtis Ashwood, Saunders
Clinical Chemistry (Organ Function Test), M.N Chatterjee, Jaypee
Biochemistry, A.C. Deb,Central

M.Sc. BIOCHEMISTRY
SEMESTER –SECOND
Minor
ESSENTIALS OF MOLECULAR BIOLOGY

Course Outcomes

On the completion of the course, students will be able to:	
CO1	Learn about nucleic acid as genetic information carriers, Possible modes of replication and roles of helicase, primase, gyrase, topoisomerase, DNA Polymerase, DNA ligase and Regulation of replication
CO2	Understand the detailed mechanism and regulation of Eukaryotic DNA replication, along with Mitochondrial and Chloroplastic DNA Replication
CO3	Learn about mechanism and regulation of transcription in prokaryotes along with Reverse transcription
CO4	Understanding about the classes of DNA sequences, Genome-wide and Tandem repeats, Retroelements, Transposable elements, Centromeres, Telomeres, Satellite DNA, Mini satellites, Microsatellites; Applications of satellite DNA and Split genes

(TOTAL CREDIT -04,END SEMESTER MARKS-75,CIE-25)		
UNIT	Topic	No. of Lectures Hours 60
I	Organization of Genetic materials in prokaryotes and Eukaryotes: Genetic material, Genome type, Size, Genome Organization - Structural Maintenance of Chromosomes (SMC) Protein, Eukaryotic Nucleosomes, Histones, Chromatin, Concept of Gene, mono-cistronic and poly-cistronic genes, Gene Structure with various functional units - replicon, muton, recon, C-value and C-value paradox; Unique sequences and Cot value, reassociation kinetics, Split genes: Exons and Introns.	15hrs
II	**Replication:** Modes of replication: Details of Meselson and Stahl experiment; Prokaryotic DNA replication:Origin and Initiation, elongation and termination; Roles, properties and mechanism of action of DnaA, Helicase, Primase, DNA gyrase,Topoisomerases,DNA Polymerases, DNA ligase, Leading and lagging strands; Okazaki fragments; RNA primers;Regulation of replication; Fidelity of replication; Viral replication, σ or Rolling circle replication in ϕX174 **DNA** damage and DNA repair**:** Types of DNA damages,Types ofDNARepair systems, Photoreactivation.	15hrs
III	Eukaryotic DNA replication: Initiation, elongation and termination; Multiple replicons/initiation sites; Autonomously replicating sequence; Mechanism and significance of Origin recognition complex, Mini-chromosome maintenance proteins, DNA dependent DNA polymerases α, δ, ε, Nucleases, DNA ligase and Telomeres in eukaryotic nuclear DNA replication; Regulation of eukaryotic DNA replication; Mitochondrial and Chloroplast DNA replication.	15hrs
IV	Transcription in prokaryotes: Initiation, elongation and termination; Prokaryotic promoter; weak and strong promoters, DNA dependent RNA polymerase: Physical properties, Templet strand, non-template strand, coding strand, Subunits, σ factor, its types and function; Recognition of promoter; Transcription bubble, Direction of Transcription; Abortive initiations; Promoter clearance; Elongation factor Gre and its role, Rho dependent and Rho independent termination of transcription; Sigma cycle; RNA - dependent DNA polymerase.	15hrs

Reference Books

Genes XI , by Benjamin Lewin
Biochemistry – J. David Rawn – Neil Patterson publication, NC.
Cell and Molecular Biology: Concepts and Experiments, by Gerald Karp
Transcriptional Regulation in Eukaryotes, by Carey and Smale
Translational control of gene Expression, by Sonenberg *et al*
Chromatin and Gene Regulation, by Turner
An Introduction to Genetic Analysis, by Griffiths *et al*