CBCS BASED CREDIT SYSTEM (TOTAL CREDIT =22+20+25+27=94)

ADAMAS UNIVERSITY								
FACULTY OF SCIENCE **DEPARTMENT OF BIOCHEMISTRY – M.Sc. PROGRAM** SEMESTER - **I**								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Semester**	**L**	**T**	**P**	**Credit**
CORE I	**SBC51101**	**Theory I** **Chemistry and Metabolism of Proteins and Lipids & Porphyrins**		**45**	**2**	**1**	**0**	**3**
CORE II	**SBC51103**	**Theory II** **Chemistry and Metabolism of Carbohydrates, Nucleic Acids and Vitamins**		**45**	**2**	**1**	**0**	**3**
CORE III	**SBC51105**	**Theory III** **Intermediary Metabolism**		**45**	**2**	**1**	**0**	**3**
CORE IV	**SBC51107**	**Theory IV** **Advanced Enzymology**		**45**	**2**	**1**	**0**	**3**
CORE PRACTICAL I	**SBC51201**	**Practical I** **Biomolecules**		**60**	**0**	**0**	**4**	**4**
CORE PRACTICAL II	**SBC51203**	**Practical II** **Enzymology**		**60**	**0**	**0**	**4**	**4**
FOUNDATION	**HEN51111**	**Environmental**		**30**	**2**	**0**	**0**	**2**
Total				**330**				**22**

ADAMAS UNIVERSITY								
FACULTY OF SCIENCE **DEPARTMENT OF BIOCHEMISTRY – M.Sc. PROGRAM** SEMESTER **- II**								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Semester**	**L**	**T**	**P**	**Credit**
CORE I	**SBC51102**	**Theory I** **Analytical biochemistry**		**45**	**2**	**1**	**0**	**3**
CORE II	**SBC51104**	**Theory II** **Bioenergetics and Cell Biology**		**45**	**2**	**1**	**0**	**3**
CORE III	**SBC51106**	**Theory III** **Molecular Biology**		**45**	**2**	**1**	**0**	**3**
CORE IV	**SBC51108**	**Theory IV** **Gene Regulation and Genetic Engineering**		**45**	**2**	**1**	**0**	**3**
CORE PRACTICAL I	**SBC51202**	**Practical I** **Analytical biochemistry**		**60**	**0**	**0**	**4**	**4**
CORE PRACTICAL II	**SBC51204**	**Practical II** **Molecular Biology**		**60**	**0**	**0**	**4**	**4**
Total				**330**				**20**

ADAMAS UNIVERSITY								
FACULTY OF SCIENCE **DEPARTMENT OF BIOCHEMISTRY – M.Sc. PROGRAM SEMESTER - III**								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Semester**	**L**	**T**	**P**	**Credit**
CORE I	**SBC52101**	**Theory I** **Immunology**		**45**	**2**	**1**	**0**	**3**
CORE II	**SBC52103**	**Theory II** **Bioinformatics**		**45**	**2**	**1**	**0**	**3**
CORE III	**SBC52105**	**Theory III** **Advanced Endocrinology**		**45**	**2**	**1**	**0**	**3**
CORE IV	**SBC52107**	**Theory IV** **Plant biochemistry**		**45**	**2**	**1**	**0**	**3**
CORE ELECTIVE I	**SBC52109/ 11/13/15**	**Theory**	**SELECT ONE TOPIC**	**45**	**3**	**0**	**0**	**3**
CORE PRACTICAL I	**SBC52201**	**Practical I** **Immunology**		**60**	**0**	**0**	**4**	**4**
CORE PRACTICAL II	**SBC52203**	**Practical II** **Recombinant DNA technology**		**60**	**0**	**0**	**4**	**4**
FOUNDATION I	**SBC52601**	**Interaction with Industries and National Research Laboratories**		**30**	**0**	**0**	**2**	**2**
Total				**375**				**25**

ADAMAS UNIVERSITY								
FACULTY OF SCIENCE **DEPARTMENT OF BIOCHEMISTRY – M.Sc. PROGRAM SEMESTER - IV**								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Semester**	**L**	**T**	**P**	**Credit**
CORE	**SBC52102**	**Theory I** **Biotechnology**		**45**	**2**	**1**	**0**	**3**
CORE	**SBC52104**	**Theory II** **Research methodology**		**45**	**2**	**1**	**0**	**3**
Core Elective (Discipline Specific)II	**SBC52106/ 08/10/12**	**SELECT ONE TOPIC**		**45**	**3**	**0**	**0**	**3**
CORE	**SBC52702**	**Project Work I**		**90**	**0**	**0**	**8**	**8**
CORE	**SBC52402**	**Project Work II**		**120**	**0**	**0**	**10**	**10**
Total				**375**				**27**

*Tutorial Classes

CORE ELECTIVE I (choose any one paper in Sem III)*		**CORE ELECTIVE II (choose any one paper in Sem IV)***	
1	Cancer Biology	1	Synthetic Biology
2	Human Physiology	2	Population Genetics
3	Host-Pathogen Interaction	3	Advances in Stem Cell Research
4	Epigenetics	4	Molecular & Cellular Biophysics

* Offering of subjects will vary from year to year, subject to the availability of faculty

Adamas University

M.Sc. Biochemistry Detailed Syllabus

SEMESTER I

Biomolecules, Structural Biology. **Contact hours 60, Credit – 4**

1. **Bonding and interactions**: Structure of atoms, molecules and chemical bonds, Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction etc).
2. **Carbohydrate:** Concepts of stereo-chemistry, Monosaccharides and derivatives of sugars, polysaccharides, glycosaminoglycans, proteoglycans, protein glycosylations and its significance
3. **Amino acids and Proteins**- Structure and functional group properties, peptides and covalent structure of proteins, elucidation of primary and higher order structures, conformation of proteins, Ramchandran Plot, Evolution of protein structure, Structure and functional relationship in model proteins like ribonuclease A, myoglobin, haemoglobin, collagen etc.
4. **Dynamics of protein structure:** Structural stability of proteins, globular proteins and maintenance of specific confirmation, structural motifs commonly found in various proteins and their functional relevance. Basic concepts of protein folding and its kinetics, Chaperones and folding pathways, role of accessory proteins in protein folding.
5. **Lipids**: Fattyacids, triacylglycerols, glycerophospholipids sphingolipids, cholesterol, lipid bilayers
6 . **Method of conformational analysis and prediction of conformation**: Structure determination using Circular Dichroism, Spectroscopy, X-ray diffraction.

7. **Centrifugation:** Principle of centrifugation and different types of centrifuge. Differential & density gradient centrifugation
8. **Chromatography Techniques**—TLC, HPLC, HPTLC & FPLC, Size-exclusion Chromatography, Affinity chromatography, Ion-exchange Chromatography

Biophysical chemistry **Contact hours 60, Credit – 4**

Unit II Biophysical chemistry

1. **Thermodynamics:** Thermodynamic state, state functions and thermodynamic systems. Recapitulation of 1st and 2nd laws of thermodynamics ,Concepts of enthalpy, entropy and free energy. Gibb's free energy; Bioenergetics, Application of thermodynamics in coupled reactions and biological systems. **(8L)**
2. **Physico-chemical properties of water :** Ionic product of water; pH - definition, effect of pH in enzyme catalyzed reaction. Acids, bases and buffers in biological system; Arrhenius, Bronsted-- Lowry theories of acid and bases. Polyprotic acids, ampholytes, dissociation of polyprotic acid; titrable and true acidity. Surface tension, viscosity: application to biomolecules. **(6L)**
3. **Reaction Kinetics:** Rates and rate equations of chemical reactions. Standard states, steady states. Activation energies, equilibrium constants. Microscopic reversibility. Fast reactions and transient kinetics **(6L)**
4. **Fundamental in Quantum mechanics:** Electromagnetic spectrum and transition energies. Quantum mechanical postulates ,Operators, Eigenvalue and Eigenfunction, Schrodinger Equation, Set up of Hamiltonian in Particle in box , simple harmonic oscillator: energy quantization and wave functions, Approximate methods , Central concepts in spectroscopy. Scattering absorption and dispersion **(10L)**
5. **Spectroscopy I:** Concept of electromagnetic radiations - UV, visible, IR, microwave region. Molecular Orbital theory: Bonding and antibonding ; UV Visible Absorption Spectroscopy, Fluorescence Spectroscopy. Absorption and Emission spectroscopy of biomolecules; Basics of Rotation and Vibration spectroscopy, Raman Spectroscopy: application to biomolecules. **(16L) Spectroscopy II** Magnetic Resonance Spectroscopy, Basic principles and instrumentation in NMR Spectroscopy, Application to structure of biomolecules ; Basics of ESR Spectroscopy and Application **(8L)**
6. **Radioactivity--**: Radioactive & stable isotopes; Units of radioactivity; Measurement of radioactivity; Measurement of stable isotopes; Falling drop method; Radiotracer techniques; Distribution studies; Isotope dilution technique. **(6L)**

AUBCH193 Enzymology and Physiological Biochemistry Marks 50, Contact hours 60, Credit – 4

Enzymology (30L)

1. Historical aspect: Remarkable properties cofactors Nomenclature and classification, isoenzymes, multienzyme.
2. Isolation, purification, criteria's of purity.
3. Enzymes kinetics: One substrate reactions, effect of pH, temperature and inhibitions. Two substrate reactions. Theory, order analysis, pre-steady state kinetics, stopped flow technique, Relaxation methods.
4. Mechanism of enzymes action: Theoretical background, Factors leading to rate enhancement of enzyme catalyzed reactions: Acid-base catalysis, proximity and orientation effects, covalent catalysis, strain or distortion and change in environment. Experimental approaches of determination of enzymes mechanism: Kinetics studies, detection of intermediates, X-ray crystallographic studies, Chemical modification of amino acid side chain and affinity labeling, site directed mutagenesis. Examples of chymotrypsin, triose phosphate isomerases, aldolase etc.
5. Control of enzyme activity: Control of activities of single enzyme: inhibitor molecules, availability of substrate or cofactor. Product inhibition. Control by changes in covalent structure of enzymes:
   a) Reversible Change
   b) Irreversible change
6. Zymogen activation and phosphorylation dephosphorylation ligand induced changes: Allosteric enzymes, Therotical models, Hill equation, Adair equation, M.W.C. and K.N.F. Models, usefulness of the models. Significance of allosteric and cooperative behavior in enzymes.
7. Control of metabolic pathways: Amplification of signals, substrate cycles and Interconvertible enzyme cycles.
8. Multienzyme complex: Properties, pyruvate dehydrogenase system, (*E. coli* and mammalian), Tryptophan synthetase, multienzyme complex from E.coli, fatty acid synthetase, glycogen particle.
9. Enzyme turnover: Kinetics of enzyme turnover. Measurement of enzyme turnover, Ks and Kd. Correlation between the rates of enzyme turnover and structure and function of enzymes. Mechanism of enzyme degradation. Significance of enzyme turnover.
10. Clinical aspects of enzymology: LDH isozymes, SGOT, SGPT, creatine kinase, alpha amylase, phosphatase, inborn errors.
11. Ligand binding

Physiological Biochemistry : (30L)

1. Blood: Blood composition, plasma proteins and their diseases, blood counting and its significance, leucocyltes, thrombocytes and erythrocytes.
2. Chemistry of respiration: Gas transport and pH regulation, need for a carrier of oxygen in blood, transport of oxygen, carbon dioxide and H by Hb, buffer systems of plasma, interstitial fluid, carbon dioxide-bicarbonate buffer system, acid- base balance and it's maintenance, compensatory mechanisms, measures of acid base imbalance, significance of Anion gap.
3. The kidney: Formation and acidification of urine, abnormalities of acid- base balance regulation by kidney, mechanism of action of diuretics, tests of renal function, composition of urine and hormones of the kidney.
4. Water and mineral metabolism.
5. Liver function and its disorders.

Reference Books:

1. Text-book of Biochemistry with clinical correlations by Thomas M. Devlin, 2nd Edition, J. Wiley and Sons (1986).
2. Physiological chemistry by Harper.
3. Textbook of Medical Physiology by Guyton. A.C., H. Sanders Philadelphia. 1988.
4. Physiological basis of Medical practice, West J.B., Best and Taylor.
5. Introduction to Physiology by Davidson H and Segal M.B. Academic Press.
6. Fundamentals of Enzymology by Price and Stevens
7. Enzymology by Dixon and Webb
8. Enzymes by Palmer

AUBCH194P Lab in Biophysical and Analytical Biochemistry Marks 50, Contact hours 100, Credit – 8

Unit I - Biophysical Biochemistry

1. Concept of pH, preparation of buffers, measurement of pH.
2. pH metry: Acid base titration curves. Measurement of pKa of amino acids.
3. Ion exchange chromatography: Nature of exchanger, capacity of column, Separation of amino acids.
4. Gel filtration: Determination of void volume, Determination partition coefficient, Separation of two components in a sample.
5. Viscosity: Viscosity of hydrolyzed, partially hydrolyzed and unhydrolyzed starch. Determination of relative viscosity, Specific viscosity and intrinsic viscosity.
6. Electrophoresis: Paper electrophoresis, Agar electrophoresis for separation f low mol. Wt. Dyes. Separation serum proteins by Agarose gel electrophoresis. Polyacrylamide Gel electrophoresis (PAGE). Single cell electrophoresis
7. UV and Visible Spectrophotometry: Absorption spectra, Demonstration of Beer's Law, UV absorption of proteins and amino acids, Determination of Molar extinction coefficient. Absorption spectra of hemoglobin derivatives – oxyhemoglobin, carboxyhemoglobin and methemoglobin.
8. Dialysis, reverse dialysis and membrane filtration.
9. High performance Liquid Chromatography (HPLC)
10. Osmotic fragility.
11. Measurement of Refractive Index.
12. Fluorescence spectroscopy : Determination of Quantum yield of Fluorescence of a fluorophore and a protein, Emission of Protein, Quenching of emission of protein by acrylmide and KI, Protein Ligand Interaction.

Unit II - Analytical Biochemistry

1. Amino acid detections (Paper chromatography) and estimations.
2. Comparative evaluation of different methods of protein analysis: Lowry, Biuret, Kjeldahl, UV.
3. Specific reactions for Carbohydrate and estimations.

4. Isolation of amino acid and proteins: cystine, Egg albumin, globulin, milk casein .
5. Starch preparation and characterization.
6. Alpha and Beta amylolysis.

SEMESTER II

General Microbiology , Food and Dairy Microbiology, Contact hours 60, Credit – 4

Unit I – General Microbiology (20L)

1. **The beginning of Microbiology**: Discovery of the microbial world by Anthony van Leeuwenhoek. Controversy over spontaneous generation. Development of culture and disinfection strategies. Endosymbiotic concepts and evidences.

2. **Unicellular eukaryotes:** Yeasts, parasitic protozoa (like trypansosmes, apicomplexans) and slime-moulds.

3 Microbial Growth and Metabolism: Principles of microbial growth- growth phases, factors affecting microbial growth, Batch, fed-batch, continuous kinetics, synchronous growth, yield constants, concept of biomass and methods of growth estimation. Prokaryotic cell division- Cell cycle and regulation, Programmed cell death in bacteria.

Bacterial Nutrition, Basics of sugar and amino acid metabolism in microorganisms (novel pathways), Energy storage compounds. Stringent response, Carbon Catabolite repression. Control of Microbial Growth- Physical and Chemical agents, Concepts of Chemotherapy, antibiotics: Mode of action and mode of resistance, Assay. Strategies to develop and screen antimicrobial drugs.

4. **Virology**: Bacteriophage–structure; Assay; T and Lambda phages – genetic map, lysogenic and lytic cycles; Filamentous phages such as M13. Classification and modes of propagation of plant and animal viruses. Assay of viral particles, viral enzymes, nucleic acids. Antiviral agents. Viroids, Virusoids and Prions.

5. **Microbial Diversity & Systematics:** Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Classification of Bacteria according to Bergey's manual; Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project. Diversity of prokaryots, Physiological adoption and life style of Prokaryotes; Extremophiles.

6. **Microbes and Environment:** Ecological impacts of microbes; Aquatic microbiology, Bacterial biofilm-regulation of formation and dispersion. Microbes and Nutrient cycles; Microbial communication system: quorum sensing.

7. **Soil microbiology and microbial application:** Nitrogen fixation. Biofertilizers, Microbial fuel cells; Prebiotics and Probiotics; Metagenomics: concepts, strategies and applications.

Unit II : Food Microbiology (20L)

1. Importance of microbes in food
2. Sources of microbes in food
3. Normal microbiological quality of food
4. Factors influencing microbial growth in food
5. Microbial stress response in food
6. Starter cultures
7. Microbiology of fermented foods General method of production Cheese – Swiss and Blue cheese

   Fermented meat product – Sausage

   Fermented vegetable products – Pickles, soy product , Sauerkraut

   Bread and Idli

8. Control of access

9. 3.2 Control by physical removal, heat, low temperature, reduced aw, low pH and organic acids, modified atmosphere,
10. antimicrobial preservatives, irradiation
11. Novel emerging techniques of food preservation
12. Control by combination of methods (Hurdle concept
13. Use of biosensors,and enzymatic/ thermal techniques for food analysis
14. Food additives and ingredients :Food additives-definitions, classification and functions, (Preservatives, antioxidants, colors, emulsifiers, sequesterants natural and microbial flavors)
15. Toxicological evaluation of food additives.

Dairy Microbiology (20L)

- Microbial flora of Milk, Normal and Abnormal flora, their sources and changes induced by them.
- Milk Borne Pathogens.
- Processing and analysis of Milk, Grading of Milk, Platform test, Dye reduction test, DMC, SPC, LPC, Thermoduric count, Psychrophilic count, Pasteurization, HTLT, LTHT and Phosphatase test

- Shelf life, Packaging, Storage and Distribution.
- Milk products: Preparation of powdered and sweetened condensed milk, butter, cheese (types and production of cheddar and cottage cheese.)Yogurt (Types and production).Other milk products and names of organisms associated with them.

Bioenergetics and Metabolism **Contact hours 60, Credit – 4**

Unit I : Bioenergetics (30L)

1. Survey of metabolism: Carbon, oxygen, nitrogen cycle catabolism, use of mutants and isotopes in the study of metabolism, compartmentation, food chain and energy flow.
2. Cell bioenergetics: standard free energy change of a chemical reaction and redox potentials, ATP and high energy phosphate compounds.
3. Glycolysis: Anaerbic pathway of glucose metabolism, two phases of glycolysis. Detailed study of all the reactions, entry of other carbohydraes in Glycolytic pathway, energy balance sheet regulation of glycolytic sequence by enzymes and hormones, alcoholic fermentation.
4. Citric acid cycle: Aerobic pathway of glucose metabolism, historical background, details of the cycle, use of isotope for the study of citric acid cycle, interconversion of hexoses, Pasteur Effect.
5. Alternate pathways of carbohydrate metabolism: Pentose phosphate pathway, glyoxalate cycle, glucuronic acid cycle, inter conversion of hexoses, Pasteur effect.
6. Lipid metabolism: Fatty acid metabolism, Beta oxidation of saturated and unsaturated fatty acids, the phases of fatty acid oxidation, energetics of beta oxidation. Oxidation of fatty acids with odd number of carbon atoms, formation of ketone bodies, other types of fatty acid oxidation.
7. Integration of carbohydrate and lipid metabolism.
8. Biosynthesis of lipids: Requirements of carbon dioxide and citrate for biosynthesis, fatty acid synthase complex, regulation of biosynthesis. Biosynthesis of triglycerides, cholesterol and phospholipids.
9. Electron transport chain and oxidative phosphorylation.
10. Glycogen metabolism: Biosynthesis and degradation of glycogen and it's regulation. Starch and cellulose biosynthesis.
11. Gluconeogenesis
12. Photosynthesis : Intracellular organization of photosynthetic system, fundamental reactions of photosynthesis, light and dark reactions, photosynthetic pigments, role of light, Hill reaction and it's significance. Photophosphorylation, light reactions, cyclic and non-cyclic photoinduced electron flow, energetics of photosynthesis, photosynthetic phosphorylation photorespiration, dark phase of photosynthesis, Calvin cycle, C4 pathway, Bacterial photosynthesis.

Unit II : Metabolism : Nitrogen Metabolism (30L)

1. Oxidative degradation of amino acids : Proteolysis, Transamination, oxidative deamination, acetyl CoA, Alpha ketogutarate, acetoacetyl CoA, succinate, fumarate and oxaloaccetate pathway, decarboxylation, urea cycle, Ammonia excretion.
2. Biosynthesis of amino acids: Amino acid biosynthesis, Precursor functions of amino acids, Biosynthesis of aromatic amino acids, Histidine, One carbon atom transfer by folic acid (Biosynthesis of glycine, serine, cysteine, methionine, threonine.)
3. Peptides, polyamines, Porphyrins, gamma glutamyl cycle, glutathione biosynthesis, Nonribosomal Protein Biosynthesis.
4. Purine pyrimidine degradation.
5. Biosynthesis of Purine and pyrimidine nucleotides, Regulation, Biosynthesis of nucleotide coenzymes.
6. Nitrogen fixation: historical background, nitrogen cycle in nature, symbiotic nitrogen fixation, nitrogenase system, nitrate reductase.

Membrane Biochemistry and Nucleic acid, Contact hours 60, Credit – 4

Unit I: Membrane Biochemistry (30L)

1) Biological membrane, structure, and assembly: constituents, bacterial cell envelope, asymmetry flip flop, protein lipid interaction, factors affecting physical properties of membranes.
2) Membrane models: biological and physical models: energetics and transduction phenomena, biochemical chemiosmotic hypothesis of Mitchell.
3) Membrane transport: diffusion, passive, active and facilitated, transport role of proteins in the process, exocytosis, receptor mediated endocytosis, osmoregulation.
4) Na, H dependent processes and phosphotranferase synthesis, specialized mechanism for transport of macromolecules, gap junctions, nuclear pores, toxins, control of transport processes, binding proteins, hormone effects and the role of lipids.
5) Role of Na, K ATPase and the passive permeability of the plasma membrane to Na, K and Cl, voltage and ligand gated ion channels, ATP-ADP exchanger.
6) Molecular mechanisms, ion translocating antibiotics, valinomycin, gramicidin, ouabain, group

translocation, ionophores, electrical gradient, energy coupling mechanism.

7) Penetrating the defenses: how antimicrobial agents reach their targets, cellular permeability barrier to drug penetration, some examples of modes of penetration of antimicrobial agents, the exploitation of transport systems in the design of new antimicrobial agents.

8) Assembly of virus membrane receptor

Unit II : Nucleic Acids (30L)

1. Molecules of Heredity: Structure of DNA and RNA, DNA as genetic, material, Double helix. Semi conservative mechanism of replication. Nearest neighbor analysis.

Denaturation and renaturation A, B, and Z forms of DNA.

2. Nearest neighbor analysis, Denaturation and renaturation, A, B and Z forms of DNA.
3. Laws of Haredity : Genotype, Phenotype Mendelian Laws of inheritance.
4. Basis of Biochemical genetics: One gene one cistron complementation tests, Co-linearity.
5. Auxotroph, prototroph, conditional mutants, Mutant isolation and selection. Transformation. Conjugation, Transposition.
6. Sex factors and Plasmids: Fertility factor, Hfr, Mapping of E, coli chromosome, other plasmids, cosmids, Introduction to Operon.
7. Genetic Code: Biochemical and genetic analysis of the genetic code.
8. Bacteriophages: Life cycle, use of bacterial viruses in genetic studies.
9. Genetic disorders, of chromosomal origin, gene origin –mutation.
10. Specialized genetic systems of fungi: Tetrad Analysis.

Microbiology, and analytical biochemistry II, Contact hours 100, Credit – 8

Microbiology

1. Preparation of stains and reagents
2. Preparation of various culture media
3. Preparation of broth and slants
4. Sterilization of culture media by autoclave method
5. Sterilization of glassware by hot air oven
6. Isolation and propagation of bacteria
7. Staining of bacteria – Simple staining, differential staining, staining of spores and capsules
8. Determination of growth curve of bacteria
9. Biochemical tests and motility for the identification of bacteria
10. Isolation of bacteria from various samples by enrichment techniques and their identification by conventional biochemical and molecular methods as well as by BIOLOG system
4. Evaluation of bacterial growth in liquid media: Diauxic growth curve.
5. Enrichment and isolation of members of Rhodospirillaceae : Analysis of photopigments.
6. Induction of β-galactosidase in *E.coli.*
7. Sugar transport in yeast
8. Endospore formation in *Bacillus subtilis*: Requirements for germination and out growth of spores, correlation between sporulation and protease activity.
9. Study of dimorphism in yeast.

Analytical Biochemistry II

7. Cholesterol and lecithin from egg.
8. Vitamin C estimation.
9. Lipid isolation detection and estimations.
10. Estimation of DNA by diphenylamine method
11. Estimation of RNA by orcinol method

SEMESTER III
Molecular Biology & Recombinant DNA Technology

Contact hours 60, Credit – 4

Unit I : Molecular Biology (30L)

1. **Genome organization:** Organization of bacterial genome. Structure of eukaryotic chromosomes, Chromatin organization & packaging. Heterochromatin and Euchromatin; DNA reassociation kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA; DNA melting and buoyant density; Nucleosome phasing; DNase I hypersensitive regions; DNA methylation
2. **DNA replication and repair:** Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms in prokaryotes and eukaryotes.
3. **RNA synthesis and processing:** RNA world and RNA replication; Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation, structure and function of different types of RNA, RNA transport.
4. **Protein synthesis and processing:** Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post- translational modification of proteins.
5. **Protein localization**: Chaperones, SRP, translocons, protein transport, ubiquitination
6. **Control of gene expression at transcription and translation level:** Regulation of phages, viruses, prokaryotic and eukaryotic gene expression; Role of chromatin in regulating gene expression and gene silencing; RNA interference. Analysis of gene expression at protein and RNA level.
7. **Molecular Evolution:** Concepts of neutral evolution, molecular divergence and molecular clocks; molecular tools in phylogeny, classification and identification; protein and nucleotide sequence analysis; origin of new genes and

proteins; gene duplication and divergence. Speciation; allopatricity and sympatricity; convergent evolution; sexual selection; co-evolution.

8. **Recombination:** Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/Lox recombination.
9. **Cancer biology:** Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

Unit II: Recombinant DNA Technology (30L)

Introduction, Basics of DNA cloning: Simple cloning and cloning using linkers and adaptors. Cloning into various kinds of vectors – plasmids, phages lambda and M13, phagemids, cosmids, P1 phage, PACs, BACs and YACs. Selection and screening of clones.

Methods of DNA and protein analysis: Agarose, polyacrylamide and pulsed field gel electrophoresis of DNA. Southern and Northern Blotting. Radiolabelling probes. Isolation and purification of DNA. RFLP analysis. DNA fingerprinting and its application in forensics, in disease diagnosis and in identification of strains. Native PAGE, SDS-PAGE and two-dimensional PAGE analysis of proteins. Western Blotting analysis.

Polymerase Chain Reaction: Concept of PCR and various thermophilic enzymes used in PCR. Gradient PCR versus Touchdown PCR. Designing primers. Cloning PCR products. Long PCR, Inverse PRC, Vectorette PCR, RT-PCR, 5' and 3' RACE, qPCR, Real Time PCR using SYBR Green, Scorpion primers and TaqMan probes, MOPAC, Multiplex PCR, Differential Display PCR, RAPD fingerprinting of micro- organisms, Ligation Chain Reaction, Overlap PCR, Rolling Circle Amplification Technology.

Construction of cDNA and genomic DNA libraries: Vectors used in the construction of cDNA versus genomic DNA libraries. Steps and enzymes involved in the construction of cDNA versus genomic DNA libraries. Screening libraries by colony hybridization and colony PCR. Screening expression libraries. Enriching for clones in cDNA libraries by positive selection and subtractive hybridization. Identifying genes in complex genomes by direct selection of cDNA and exon trapping.

Genome sequencing: Concept and methods.

Transcriptional analysis of gene expression and transcriptomics:

Immunology and Medical Biochemistry , **Contact hours 60, Credit – 4**

Unit I : Immunology (30L)

1) Cellular basis of immunity: immunological memory, specificity, diversity, discrimination between self and non self, primary and secondary lymphoid organs, cell mediated and humoral immune responses, T and B lymphocytes, autoimmune reactions.
2) Antigen and antibody: antigen, antigenic determinant, immunopotency, structure of antibody, constant and variable regions, Fab, F(ab2) and Fc fragments, different classes of antibodies and their functions, fine structures of antibodies, X ray diffraction studies, isotypes, allotypes and idiotypes,
3) Measurement of antigen- antibody interaction, diffusion, immunodiffusion, immunoelectrophoresis, radioimmunoassay, immunoflorescence, ELISA, Western blotting
4) Clonal selection theory of antibody production, monoclonal and polyclonal antibodies, poly reactive antibodies, catalytic antibodies, abzymes.
5) Complement system: classical and alternate pathway
6) T lymphocytes and cell mediated immunity, T cell sub populations, immune response genes, MHC gene complex, polymorphism, graft rejection, graft versus host response
7) Hypersensitivity, immunodeficiency diseases
8) Vaccines, interferon, AIDS
9) Blood antigens: blood group substances and Rh factor

Unit II : Medical Biochemistry (30L)

1) Mechanism of action at molecular level of selected antibiotics, anti metabolites, analgesics, hallucinogens and other drugs, mechanism of resistance to antibiotics and other drugs.
2) Lysosomes and their physiological role.
3) Cerebrospinal fluid, composition in health and disease.
4) Blood coagulation, clotting factors, mechanism of coagulation, fibrinolysis, abnormal hemoglobin's,

fibronectins. Diseases of cardiovascular system.

5) Cancer causative agents and control theories of cancer and carcinogenesis, viral etiology, control of cancer and carcinogenesis, viral etiology, control of cancer –basic approaches.

6) Counseling for genetic diseases.

7) Ageing and apoptosis

Nutritional Biochemistry, Contact hours 60, Credit – 4

1. Transport of nutrients, study of active and passive transport mechanism, the glucose transporter as unique family of proteins, the role of specialized heavy metal ATP assessed as transporter, energy requirements, BMR, SDA, RQ, Quantitative problems, the effect of physical activity on energy consumption. N-balance, estimation of protein quality, protein score, assessment of protein status, protein calorie, malnutrition states, deficiency of amino acids and their effects on the developing offspring, specially on of amino acids in several physiological processes e.g., suppression of pain, stimulation of appetite, the role of metals and non metals in nutritional biochemistry, with emphasis on the interaction with enzymes, protein and nucleic acids, food toxins.

2. Analysis of food including genomic analysis of GM food. Energy balance- respiratory quotient- use of double labelled water –factors affecting energy balance-BMR and RMR- numerical problems.

3. Genomics of protein nutrition-high protein and restricted protein diets. Determination of protein quality using *in vivo* and *in vitro* methods, genomics of leptin mediated responses obesity and its regulation, dietary influence of food and the influence of genes on diet-nutrigenomics and nutrigenetics, synthetic triglycerides and gene regulation. The regulation of mRNA processing: G6PDH as a case study, nutriceuticals and their appraisal in terms of gene expression and metabolite formation. Spice derived nutraceuticals and their molecular targets

Molecular biology and immunology, **Contact hours 70, Credit – 5**

Unit I : Molecular Biology

1. Isolation of DNA from E. coli/ liver/ plant/ plasmid
2. Determination of base composition (spectrophotometry)
3. Agarose gel electrophoresis of DNA
4. PCR amplification of desired gene
5. Restriction digestion and ligation of DNA, Endonuclease mapping of DNA
6. Transduction
7. Transformation
8. Expression analysis
9. Plasmid mapping

Unit II : Immunology

1. To perform immunoelectrophoresis.
2. To perform radial immunodiffusion assay.
3. To perform rocket immunoelectrophoresis.
4. To stain a tissue by immunohistochemical reaction
5. To study quantitative precipitation assay
6. To perform dot-ELISA.
7 To perform latex agglutination test

8. To perform western blotting.
9. To study morphological and staining characteristics of lymphocytes, neutrophils, monocytes, eosinophils, and basophils.

Clinical Biochemistry &Clinical Biophysics , **Contact hours 70, Credit – 5**

1. Separation and isolation of serum and plasma from blood
2. Determination of i) blood group and ii) Rh factor
3. Determination of i) Hemoglobin content, ii) total count and differential count (TC/DC). iii)erythrocyte sedimentation rate (ESR), iv) packed cell volume (PCV)
4. Determination of number of RBC per mm^3 in blood with standard error using a hemocytometer
5. Measurement of viscosity and specific gravity of blood
6. Estimation of blood glucose, Determination of serum i) Urea, ii) Creatinine, iii) Uric acid, iv) Bilirubin (total and conjugated), v) Na^+, K^+, Mg^{2+} and Ca^{2+} content, vi) glycosylated haemoglobin
7. Determination of lipid profiles; total cholesterol,LDL. HDL,Triglycerides and VLDL
8. Estimation of serum i) Alkaline phosphatise, ii) LDH, iii) GPT, iv) GOT and v) Creatine kinase
9. Analysis of ECG pattern
10. Measurement of Blood pressure under normal and stress condition.
11. Demonstration of exposed plates of Xray, USG, Echocardiography, CT scan, MRI, PET scan
12. Determination of electrical axis of the heart from ECG tracing
13. measurement of cell diameter by Ocular micrometer
14. Demonstration of fertilization process through CCTV arrangement
15. Demonstration of biosensors through polygraph

SEMESTER IV

A) Nano Science and Nanotechnology; Advanced Biophysical Chemistry

B) IPR and Bio-entrepreneurship Bio-safety and Bio-ethics,

Contact hours 60, Credit- 4

Group A

Nano Science and Nanotechnology ; Imaging Techniques: (20 L)

1. **Introduction to Nano Science, Nano materials: Preparation and characterization, Idea of Quantum Dot and application**
2. **Nano Biotechnology and Drug delivery**
3. **Biosensor: Mechanism and Activity, Imaging techniques in disease diagnosis , Green Fluorescent Protein and its use as marker.**

Biophysical Chemistry (Advanced) (20 L)

1. **Fundamentals of microscopy, elementary idea of SEM,TEM,AFM, application.**
2. **Light scattering phenomena, Dynamic Light scattering : size and shape of molecules.**
3. **Basics of Crystallography and crystal structures of biomolecules.**
4. **Laser and Laser Spectroscopy.**
5. **Mass Spectrometry.**

Group B

IPR and Bio-entrepreneurship Bio-safety and Bioethics (20L)

1. **Intellectual Property Right (IPR):** Concept and provisions of IPR; Patents, Trademarks, Copyright, Conditional information, Breeder's right. Patent; importance, types, scope, criteria, applying for a patent. Protection of Biotechnological inventions.

2. **Agreements and Treaties** History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT;

3. **Safety in Biotechnology---** Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines , Overview of Biotechnology Regulations and relevant International Agreements including Cartegana Protocol.

4. **Bioethics:** Biotechnology information, communication and public perception, Future prospects of consumers and social acceptance.

5. **Bioentrepreneurship:** Support mechanism for entrepreneurship in India; Leadership skills; Managerial skills; Team building; teamwork;. Taking decision on starting a venture; Assessment of feasibility of a given venture/new venture; Approach a bank for a loan; Sources of financial assistance; Making a business proposal/Plan for seeking loans from financial institution and Banks. Information technology for business administration, E-business setup and management.

Contact hours 60, Credit – 4 Unit I: Cell Biochemistry

Cell and Plant Biochemistry (30L)

1. Cell classification, cell variability, size, shape and complexity, function
2. Theory, phase contrast microscopy, fluorescence microscopy.
3. Electron microscopy: theory, specimen preparation, freeze etching, freeze fracture,shadow casting, electron microscopy of nucleic acids, TEM, SEM.
4. Staining of cells
5. Plant cells: Cell wall and its function, xylem, phloem and epidermal cells. The interaction and communication between the cells, cell-cell reorganization in plants,
6. Germ cells and fertilization stem cells, cell differentiation, organogenesis, functional and biochemical maturation of tissues.

Unit II: Plant Biochemistry (30L)

1. **Electron transport system in plants,** oxidative phosphorylation, mitochondrial respiratory complexes, order and organization of electron carriers, electrochemical gradient, chemiosmotic theory, ATP synthase and mechanism of ATP synthesis.
2. **Nitrate assimilation,** structural features of nitrate reductase and nitrite reductase, incorporation of ammonia into organic compounds, regulation of nitrate assimilation.
3. **Photosynthesis –** Photosynthetic apparatus, pigments of photosynthesis, role of carotenoids, photosystems I and II, their location; Hill reaction, photosynthetic electron transport and generation of NADPH & ATP, cyclic and non-cyclic photophosphorylations, complexes associated with thylakoid membranes; light harvesting complexes, path of carbon in photosynthesis – C_3 and C_4 pathway of carbon reduction and its regulation, Photorespiration.

5. **Toxins of plant origin –** mycotoxins, phytohemagglutinins, lathyrogens, nitriles, protease inhibitors, protein toxins.
6. **Stress metabolism in plants –** Environmental stresses, salinity, water stress, heat, chilling, anaerobiosis, pathogenesis, heavy metals, radiations and their impact on plant growth and metabolism, criteria of stress tolerance.
7. **Antioxidative defence system in plants –** reactive oxygen species and their generation, enzymic and non-enzymic components of antioxidative defence mechanism.
8. Special features of secondary plant metabolism, terpenes (classification, biosynthesis), lignin, tannins, pigments, phytochrome, waxes, alkaloids, biosynthesis of nicotine, functions of alkaloids, cell wall components.

Diversity of life forms & Ecological principles, Contact hours 60, Credit – 4

Unit I : Diversity of life forms (30L)

A. Principles and methods of taxonomy:Concepts of species and hierarchical taxa, biological nomenclature, classical and quantititative methods of taxonomy of plants, animals and microorganisms.

B. Levels of structural organization: Unicellular, colonial and multicellular forms; levels of organization of tissues, organs and systems; comparative anatomy.

C. Outline classification of plants, animals and microorganisms:Important criteria used for classification in each taxon; classification of plants, animals and microorganisms; evolutionary relationships among taxa.

D. Natural history of Indian subcontinent: Major habitat types of the subcontinent, geographic origins and migrations of species; common Indian mammals, birds; seasonality and phenology of the subcontinent.

E. Organisms of health and agricultural importance: Common parasites and pathogens of humans, domestic animals and crops.

Unit II: Ecological principles (30L)

1. The Environment: Physical environment; biotic environment; biotic and abiotic interactions.
2. Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
3. **Population ecology:** Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.
4. **Species interactions:** Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.
5. **Community ecology:** Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.
6. **Ecological succession:** Types; mechanisms; changes involved in succession; concept of climax.
7. **Ecosystem:** Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).
8. **Biogeography:** Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.
9. **Applied ecology:** Environmental pollution; global environmental change; biodiversity-status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.
10. **Conservation biology:** Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Review/ Project work. Students Seminar & Comprehensive viva Marks

100, Contact hours 180 Credit 12