

**Course structure and Syllabus
for
M.Sc. Biochemistry**

Semester-I				
Sl. No.	Course Code	Course Title	Credits	(L-T-P)
1.	BCBE 708	General Biochemistry	3(2-0-1)	(2-0-2)
2.	BCBE 706	Techniques in Biochemistry & Instrumentation	3(2-0-1)	(2-0-2)
3.	CHEM 710	Quantitative Analytical Methods	3 (2-0-1)	(2-0-2)
4.	MAS 511	Statistical Methods	3(2-0-1)	(2-0-2)
5.	MCE-717	Molecular Biology	3 (2-0-1)	(2-0-2)
6.	IM 720	General Microbiology	4 (3-0-1)	(3-0-2)
Total Credits:				19

Semester-II				
Sl. No.	Course Code	Course Title	Credits	(L-T-P)
1.	BCBE 702	Intermediary Metabolism-I	3 (2-0-1)	(2-0-2)
2.	BCBE 813	Enzymology	3 (2-0-1)	(2-0-2)
3.	COMP 705	Computer Orientation	3 (2-0-1)	(2-0-2)
4.	MAS 815	Experimental Design	3 (2-0-1)	(2-0-2)
5.	MCE 715	IPR & Biosafety	3 (3-0-0)	(3-0-0)
6.	BCBE 780	Seminar-I	1 (0-0-1)	(0-0-2)
7.	BCBE 899	Dissertation	2	(0-0-4)
Total Credits:				18

Semester-III				
Sl. No.	Course Code	Course Title	Credits	(L-T-P)
1.	BCBE 705	Intermediary Metabolism-II	3 (3-0-0)	(3-0-0)
2.	BCBE 801	Immunology & Clinical Biochemistry	3 (2-0-1)	(2-0-2)
3.	BCBE 803	Plant Biochemistry	3 (2-0-1)	(2-0-2)
4.	BCBE 804	Animal Biochemistry	3 (2-0-1)	(2-0-2)
5.	BCBE 805	Nutritional Biochemistry	3 (2-0-1)	(2-0-2)
6.	CBBI 801	Bioinformatics	3 (2-0-1)	(2-0-2)
7.	BCBE 880	Seminar-II	1 (0-0-1)	(0-0-2)
8.	BCBE 899	Dissertation	6	(0-0-12)
Total Credits:				25

Semester-IV				
Sl. No	Course Code	Course Title	Credits	(L-T-P)
1.	BCBE 899	Dissertation	22	(0-0-44)
Overall Credits:				84

Semester-I

BCBE 706

Techniques in Biochemistry and Instrumentation

3(2-0-1)

Centrifugation Techniques: Differential, zonal and density gradient, ultra, types of centrifuges and applications.

Chromatography: Adsorption, partition, exclusion, ion exchange, affinity, H.P.L.C., G.L.C., column.

Electrophoresis: Principles and applications, paper, gel, S.D.S., P.A.G.E., P.F.G.E., Isoelectric focusing.

Molecular Biology Techniques: Isolation and purification of DNA, RNA, plasmid DNA, sequencing of proteins and nucleic acids, chemical synthesis of nucleotides, competent cell preparation and transformation, DNA foot printing, DNA fingerprinting, PCR.

Immunological Techniques: RIA, ELISA, flow cytometry.

Radio isotopic and tracer techniques: Detection and measurement of isotopes (GM and scintillation counters), autoradiography.

Biosensors: Types and uses.

Practical:

Determination of pH using indicators.

The separation of amino acids by paper electrophoresis.

The validity of Beer's law for the colorimetric estimation of creatinin.

Total chlorophyll estimation from the plant sample.

Protein estimation- A. Biuret method, B. Lowry's method.

Estimation of nucleic acid by electrophoresis.

BCBE 708

General Biochemistry

3 (2-0-1)

Scope and importance of biochemistry in agriculture; fundamental principles governing life. structural and functional origination of prokaryotic and Eukaryotic cells; Cell organelles their functions and fractionations

Proteins: amino acid and peptides, Primary, secondary, tertiary and quaternary structures, structure function and evolutionary relationships, protein folding; allosteric proteins.

Carbohydrates: monosaccharide, oligosaccharide, polysaccharide, proteoglycans, and glycoproteins;

Lipids: fatty acids, acylglycerol, phospholipids, sphingolipids, cholesterol, and membranes; isoprenoids, eicosanoids, and their biological importance.

Nucleic acids: bases, nucleotides, RNA and DNA; Different structural forms of DNA; denaturation, renaturation, and hybridization of DNA; different types of RNA;

Definition, Classification, structures and functions of Vitamin, deficiency disorder

Membranes- Transport phenomenon: bio-membranes, diffusion- passive and facilitated and active transport processes. Mechanism of ATP synthase and its regulation, malate aspartate shuttle.

Practical:

Preparation of buffers,

Nitrogen estimation by different methods,

Separation of amino acids by TLC,

Estimation of reducing and non-reducing sugars,

Estimation of oil, iodine value,

Saponification value and acid value, estimation of ascorbic acid,

Estimation of riboflavin and thiamine.

IM 720

General Microbiology

4(3 – 0 – 2)

History and scope of Microbiology

General characteristics, classification, morphology and reproduction of Bacteria, Mycoplasma, Chlamydia, Rickettsiae, and Actinomycetes

General characteristics, classification, morphology and reproduction of Fungi, Algae, Protozoa

Control of microorganisms by physical and chemical agents

Practical:

Familiarity with equipment and apparatus used in Microbiology
Methods of isolation, purification and maintenance of microorganisms
Staining techniques (Simple, Differential, Special) in bacteria
Preparation of media and reagents and their sterilization
Study of cultural and morphological characteristics of important groups of: Fungi, Algae, Protozoa
Effect of physical agents (viz. temperature, osmotic pressure, UV radiation etc.) on microorganisms
Effect of chemicals (viz. alcohol, phenol, halogens, heavy metals etc.) on microorganisms

MCE 717 **MOLECULAR BIOLOGY** **3(3-0-0)**

Structure of DNA and RNA: Replication, transcription and translation. Post-transcriptional and translational modifications. Transcriptional and translation control of prokaryotes and eukaryotes. Features of genetic code in prokaryotes and eukaryotes.

Gene expression: operon model, induction and repression, control of gene expression in prokaryotes and eukaryotes. Chloroplast and mitochondrial genomes.

Replication of viruses: Mutagens, oncogenes and carcinogenesis.

General principles of recombinant DNA technology, restriction enzymes.

Methods of gene transfer- plasmid and viruses as vectors. Methods for the development of transgenic organisms.

DNA and protein sequence analysis, oligonucleotide synthesis, genomic and cDNA library construction, site-directed mutagenesis, transposon tagging, chromosome walking. Basis of genome organization and mapping, functional genomics. Gene silencing

MAS 511 **Statistical Method** **3(2-0-2)**

Statistic, population parameter, frequency distribution frequency polygon, histogram, bar chart Arithmetic Weighted geometric and harmonic mean mode, median for grouped and ungrouped data, standard deviation, mean deviation and coefficient of variation, simple and multiple correlation coefficient, regression line, fitting equations to data by least square method, curve linear regression line, fitting equation to data by least square method. Test of significance, t, F, χ^2 test Distribution: Normal, Binomial and Poisson distribution, confidence interval Analysis of Variance; Definition, assumption, one way and two way classification with one per cell, probability theory.

Reference Books:

1. Introductory Statistics - P.S. Mann
2. Fundamental of Mathematical Statistics- Gupta to Kapoor
3. Fundamental of Mathematical Statistics – Gun Gupta & Das Gupta.

CHEM-710 **QUANTITATIVE ANALYTICAL METHODS** **Credits:3(2-0-1)**

Unit I: Introduction of Quantitative Analytical Methods.

Unit II: Errors, Precision & Accuracy in Analytical Methods.

Unit III: Classical Methods of Analysis- Gravimetric, Volumetric:- Neutralization titrations,, Complexometry & Iodometry.

Unit IV: Electrochemical Methods- Redox Titrations, Potentiometry, Thermogravimetry, Voltammetry.

Unit V: Colorimetry, Spectrophotometry.

Unit VI: Chromatography-Adsorption, Partition, Gel Filtration, Ion Exchange, Column Chromatography.

Practicals-

1. Volumetric Analysis- Neutralization Titrations, Redox Titrations, Complexometry, Iodometry, Potentiometry.
2. Gravimetric Analysis
3. Colorimetric and Spectrophotometry Analysis
4. Column Chromatography, Ion Exchange Chromatography, Paper Chromatography, TLC.

Books Recommended-

1. Instrumental methods of Instrumental Analysis- B.K. Sharma.
2. Fundamentals of Analytical Chemistry-Skoog, West, Holler, Crouch.
3. Quantitative Organic / Inorganic Analysis – Vogel.
4. Quantitative Analysis-Day & Underwood.
5. Instrumental Methods of Analysis- Willard, Merritt, Dean & Settle.
6. Analytical Chemistry- Gary Christian.

Semester-II

BCBE 702

Intermediary Metabolism I

3 (2-0-1)

Bioenergetics: Energy & its- transformation in living systems ; Thermodynamic principles; concept of free energy changes in biochemical reactions, Electro-chemical gradient, energy rich compounds. Introduction to metabolism: methods to study metabolism.

Carbohydrate metabolism: Introduction to digestion and absorption of carbohydrates. Catabolism of carbohydrates: Glycogenolysis, glycolysis, fermentation. TCA, ETS, Energy aspects, HMPS. Anabolism: Biosynthesis of structural polysaccharide. Eg.- peptidoglycon, chitin. Anabolic role of TCA cycle (anapleurotic reactions), gluconeogenesis, glycogenesis, glyoxalate cycle, regulation of carbohydrate metabolism.

Lipid metabolism: Introduction to digestion and absorption, oxidation and biosynthesis of fatty acids. Phospholipids: energy aspects, importance and regulation Biosynthesis of biologically important lipids: biosynthesis of sterols, glycolipids, prostaglandins, prostacyclins, and thromboxins. Energy aspects, regulation and importance.

Oxidative phosphorylation, introduction to electron transport, chain structure localization. Components, oxidative phosphorylation, ATP formation.

Practical:

- Determination of lactic acid from milk.
- Estimation of total carbohydrates from potato by anthrone method.
- Extraction of glycogen from liver.
- Extraction of starch from potato.
- Determination of citric acid from citrus fruits.
- Determination of lactose from milk.
- Determination of fat in milk.
- Determination of acid value/peroxidation/ saponification no. of fats.
- Separation of carbohydrate lipid by TLC.

BCBE 813

Enzymology

3 (2-0-1)

Introduction of enzymes: General properties and significance, classification and nomenclature. Terms and definition in enzymology, co-factors, coenzymes, active site concept, isoenzymes, allosteric enzymes, marker enzymes, multienzyme complex, ribozyme, abzyme, synzyme, extremozyme, therapeutic enzymes and immobilized enzymes etc.

Enzyme kinetics: steady rate kinetics, Derivation of Michaelis-menten equation using steady state/equilibrium kinetics, plots of lineweaver- Bruke, Hanes, Eadie- Hofster etc. Mechanism of bisubstrate and multisubstrate enzyme catalyzed reaction, Enzyme inhibitors, mechanism of enzyme action-lysozyme, chymotrypsin, alcohol DH.

Regulation of enzyme activity: Covalent modification, allosteric model concerted and sequential, cooperativity. Feedback inhibition.

Enzyme Technology: Commercial production of enzymes, immobilization of enzymes, example of enzyme engineering, application of enzyme(therapeutic uses, analytical uses, manipulated uses *etc.*), uses of enzyme reactors.

Isolation, purification and localization of enzymes. Various methods to estimate the enzyme activity.

Practical:

Effect of temperature, pH, substrate concentration and enzyme concentration and enzyme concentration on enzyme activity.

Action of salivary amylase on starch.

Determination of acid phosphatase activity in sample.

Determination of alkaline phosphatase activity in sample.

Determination of SGOT in serum.

Determination of SGPT in serum.

Determination of urease in plant sample.

Assay of protein by Lowry method.

Assay of catalase in vegetables.

Hydrolysis of egg protein by pepsin.

MCE 715

IPR and Biosafety

3(3-0-0)

Unit 1: Introduction to Intellectual Property: Intellectual property and its Classifications: Patents, Copyright, Trademarks and Related Rights, Industrial Design, Geographical Indications, Traditional Knowledge, Protection of New GMOs; International framework for the protection of IP. Intellectual Property as a factor in R&D; IPs of relevance to Biotechnology; Case Studies of Diamond vs Chakravarty, Harvard Oncomouse; Introduction to History of GATT, WTO, WIPO and TRIPS.

Unit 2: Basics of Patents: Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty and Implications; Role of a Country Patent Office; Procedure for filing a PCT application. Concept of ‘prior art’; Patent databases; USPTO, EPO., etc.

Unit 3: Patent filing and Infringement: Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; International patenting-requirement, procedures and costs; Publication of patents-gazette of India, status in Europe and US Patenting by research scholars, lecturers and scientists University/organizational rules in India and abroad. Financial incentives, Patent infringement-meaning, case studies e.g. Basmati rice, neem and turmeric Patents.

Unit 4: Biosafety: Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs and LMOs; 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; Overview of National Regulations and relevant International Agreements including Cartagena Protocol

MAS 815

Experimental Design

3 (2-0-2)

Analysis of variance technique: Definition & assumptions, One way classification, Two way classification with more than one observation per cell.

Designs of Experiment: Principles of Experimental Design, Randomized Block Design(R.B.D), Latin Square Designs (L.S.D). CRD, Missing Plot Technique in R.B.D & L.S.D. Critical-difference (C.D), Split plot design.

Factorial Experiments: 2^2 , 2^3 , 3^2 , & 3^3 , factorial-designs. (Yates method of Analysis), 2×3 & 2×4 factorials. Durcan’s Multiple Range Test. Newman’s Kuel’s Test

Sampling Techniques : Simple Random Sampling, Stratified Random Sampling & Systematic Sampling.

Reference Book:

1. Fundamentals of Applied Statistics (Volume II:-Gupta & Kapoor
2. Agricultural Statistics: S.R.S Chandel

Semester-III

BCBE 705

Intermediary metabolism II

3 (3-0-0)

Amino acid catabolism: introduction to digestion and absorption, amino acid degradation pathways and their mode of degradation- Transamination, oxidative deamination, deamination and importance. Urea cycle, formation of excretory products, linking to TCA cycle and regulation.

Amino acid biosynthesis: overview, biosynthesis of essential amino acids- tryptophan, tyrosine, valine, lysine.

Biosynthesis of non-essential amino acids: glycine, serine, cystine, threonine, phenylalanine, histidine, proline, arginine.

Purine & Pyrimidine nucleotide metabolism: introduction, *denovo* and salvage pathways of purine and pyrimidine nucleotide biosynthesis. Catabolism of purine and pyrimidine nucleotides. Biosynthesis of nucleotide coenzymes.

Practical:

Parametric analysis of section of protein-dye.

Determination of protein from milk.

Fractionation of egg proteins.

Quantification of serum proteins by honey method.

Estimation of protein from leaf tissue.

Isolation of DNA from plant /bacterial sample.

Quantification of DNA.

Isolation of RNA from bacterial/ plant tissue.

BCBE 801

Immunology & Clinical Biochemistry

3 (2-0-1)

Fundamental Immunology: Basic terminology: Antigen, antibody, lymphokines, cytokines, hapten, adjuvant, immunogen, pathogen, epitopes, paratopes, etc. specific and nonspecific immune response, humoral and cell mediated immunity. Cells of adaptive immune response- B & T cell. Cells of innate immune response- macrophages, phagocytes, mast cells, dendritic cells, granulocytes, agranulocytes.

Organ of immune system- 1. Primary lymphoid organs, 2. Secondary lymphoid organs

Defense mechanisms- 1. Inflammation, 2. Phagocytosis

Generation of antibody diversity, clonal selection hypothesis definition idiotopes, idiotypes, allotypes, structure and function of M.H.C(both class 1 & class 2), chemistry of antigen – antibody interaction, precipitation & agglutination.

Structure and function of natural killer cells, super antigens, cells-mediated cytotoxicity(A.D.C.C), the complement system (both classical & alternative pathways). experimental assessment of A.D.C.C i.e. by C.M.L, M.L.R and graft vs. host reaction .

Primary B&T-cells immunodeficiencies, auto immunity hypersensitivity, structure of t-cells receptor and comparison with antibody molecule.

Techniques of immunology, immunoelectrophoresis (one dimensional and two dimensional), ELISA, RIA, Immunofluorescence, western immuno blotting, biochemistry of cancer & AIDS.

Practical:

Preparation of blood smears
Separation of serum & plasma
Qualitative test for assessment of different constituent of plasma/seven
Separation of plasma proteins (*i.e.* fibrinogen, globulin and albumin)
Determination of E.S.R of the given blood sample
Preparation of antigens from blood
Determination of the blood group
Determination of the haematocrit value of any blood sample
Use the widal kit for rapid quantitative slide test.

BCBE 803

Plant Biochemistry

3 (2-0-1)

Photosynthesis: significance of photosynthesis, ultra structure of chloroplast, photosynthetic pigments. Light absorption phenomenon, Photosynthesis in C₃ and electron transport, photophosphorylation: photo respiration, CAM.

Bacterial Photosynthesis, photochemistry and electron transport and CO₂ fixation.

Nitrogen metabolism: Metabolism of N-compounds in plants, biological nitrogen cycle, nitrogenase structure and function, nitrate reduction, nitrification, denitrification, symbiotic and non-symbiotic nitrogen fixation, function and regulation, Assimilation of fixed nitrogen by plants.

Plant Hormones: Definition of phyto hormones, Auxins, biochemistry and mode of action of Auxins, Gibberellin, Cytokinins and other natural growth hormones in plants (ethylene, abscissic acid) Signaling Pathways, Phytochrome .

Plant disease and defense mechanism: Biochemistry of bacterial and viral and fungal diseases, Micro and Macro nutrients deficiency in plants. (Biochemical role of inorganic ions in plants). Secondary metabolism in plants: Phenolic metabolism shikimate, and phenyl propanoid pathways, flavonoids, lignins, and anthocyanins. Isoprenoid metabolism, terpenoids and carotenoids, alkaloids, cyanogenic glycosides and non protein amino acids.

Practical:

Analysis of plants and plant product for various constituents.

Extraction and identification of sugars from plants, fruits and vegetables.

Extraction and determination of amino acid and protein.

Determination of lipids, phospholipids, cholesterol in food, fruits and vegetables.

Determination of various plants nutrients.

Biochemistry of Blood and Body fluids-Biochemical composition of blood groups, path way of blood clotting, physiological function of blood, buffering action of blood, kinds other body fluids and their chemistry.

Biochemistry of Blood tissue-Connective tissue, collagen, elastin muscle protein, muscle construction, lens proteins.

Biochemistry of Fat in adipose tissue , steroids-structure and biochemical function cholesterol-Structure and biochemical synthesis, plasma lipids, transport of lipids, lipo-protein, chylomicrons, VLDL, HDL, LDL, and Lp(a), free fatty acids, non- esterified fatty acids.

Gastrointestinal physiology-Digestion of food ruminants and non-ruminants absorption of food, biochemical role of liver, bile acids and bile salt.

Anti-oxidant-Generation of free radicals, damage produced by reactive-oxygen species(ROS), free-radicals, and scavenging enzyme system.

Animal Hormones-Origin, site of action, biochemical mechanism of hormone action, feed-back mechanism of hormonal secretion.

Practical:

Separation of plasma and serum.

Determination of haematocrit value of blood.

Calculation of density of blood.

Determination of bleeding and clotting time of human blood.

Determination of blood typing.

Determination of hemoglobin.

Preparation of human blood film and study of different type of cells.

Determination of glucose in sample.

Determination of cholesterol in sample.

Determination of qualitative analysis of urine- normal sample, pathological sample.

Determination of colour index and volume index of blood.

Determination of mean corpuscular hemoglobin and MCHC of blood.

BCBE 805**Nutritional Biochemistry****3 (2-0-1)**

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. Specific dynamic action of proteins.

Elements of nutrition: Dietary requirement of carbohydrates, lipids, proteins and dietary fibers. Biological value of proteins. Concept of protein quality. Protein sparing action of carbohydrates and fats. Essential amino acids, essential fatty acids and their physiological functions. Anti Nutritional Factors and Food Toxins

Minerals: Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper.

Vitamins: Dietary sources, biochemical functions Biologically active forms of vitamins, deficiency diseases associated with vitamin.

Detoxification: Definition site phases, of detoxification. Biochemical role of water.

Biochemical features some diet related disorders like protein-calorie malnutrition diabetes , cardiovascular disease goiter anemia etc.

Practical:

Determination of moisture in food sample

Determination of total ash in the food sample

Quantitative analysis in ash for mineral constituent *eg* calcium, phosphorus *etc.*

Determination of crude fat in the given food sample

Determination of total carbohydrate by anthrone method

Determination of protein by lowery method in the food sample

Determination of ascorbic acid in food sample

Identification of phenols carotenoids etc in blood samples

CBBI-801**Bioinformatics****3(2-0-2)**

Introduction to Bioinformatics, philosophical, directional and application oriented background of bioinformatics.

HGP - influence area in Bioinformatics, Application in different industries, and its Indian scenario, as a business, problem and future aspects.

Information network - Internet, web Browser and address (NCBI, EBI etc).

Databases - information resources for Proteins and Genomics.

SRS, Algorithms, Alignment.

Phylogenetic Analysis: Fundamental of Phylogenetic model, Tree interpretation -

Paralogues and orthologues, Tree building and tree evaluation, Phylogenetic

software. Comparative Genome Analysis: Introduction, application, genome analysis and annotation.

Molecular structure Predication and visualization (X-ray crystallography/ NMR/Bioinformatics).

Micro array data analysis.

Different analysis packages and other Miscellaneous Tools etc.

Practicals:

1. Understanding Linux Operating System and Commands.

2. Introduction to NCBI.

3. Using Entrez to search Literature Databases.

4. Retrieving DNA sequence from GenBank and analyzing various formats of the data stored.

5. Retrieving Protein sequence from GenPept (NCBI) and Expasy.

6. Analyzing Protein Sequences.

7. Analyzing DNA sequence.

8. Sequence alignment using BLAST (Basic Local Alignment Search Tool).

9. Sequence alignment using FASTA.

10. Multiple sequence alignment using ClustalW.
11. Introduction to the structure database PDB.
12. Visualization of the protein structure using VMD.
13. Secondary structure prediction using GOR algorithm.