# Biochemistry

## TRIMESTER WISE DISTRIBUTION OF COURSES

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### Core Courses

- **M.Sc.:** BIO 501, BIO 502, BIO 503, BIO 504, BIO 601, BIO 605, BIO 606 and BIO 607
- MBB 501, PP 501
- **Ph.D.:** BIO 701, BIO 702
BIOCHEMISTRY

Major Fields : Biochemistry
Nutrition

Minor Fields : Ph.D. student shall take two minors (9 credits of course work in each) from any of the other fields outside his/her own.
M.Sc. student shall take one minor (9 credits of course work) from any of the other fields outside his/her own.

DESCRIPTION OF COURSES

BIO 501 BASIC BIOCHEMISTRY (4L+1P) I

Objective
To provide basic knowledge/overview of structure and functional and metabolism of biomolecules.

Theory
UNIT I
Scope and importance of Biochemistry in Agriculture; Fundamental principles governing life; Structure and properties of water; Acid base concepts, pH and buffers; Intra- & inter-molecular forces in biomolecules; General introduction to physical techniques for determination of structure of biopolymers.

UNIT II
Classification, structure and function of carbohydrates, lipids, amino acids, proteins, nucleic acids and vitamins.

UNIT III
Fundamentals of thermodynamic principles applicable to biological process, bioenergetics; respiration and oxidative phosphorylation.

UNIT IV
Classification of enzymes and their mechanism of action, regulation and kinetics.

UNIT V
Plant and animal hormones; Metabolism of carbohydrates, lipids & proteins, DNA replication, transcription and translation.

Practicals
Suggested Readings


**BIO 502 NUTRITIONAL BIOCHEMISTRY**

(3L+1P) I

**Objective**

To provide knowledge about the fundamentals of human nutrition and the significance of various nutrients, present in food and their role in preventing diseases.

**Theory**

UNIT I
Fundamentals of human nutrition; concept of balance diet; calorific value of foods, energy requirement, expenditure and basal metabolic rate.

UNIT II
Biochemical composition and utilization of carbohydrates, proteins and fats; Dietary requirements of carbohydrates, proteins and fats.

UNIT III
Nutritional significance of dietary minerals; Biochemical function and specific deficiency diseases associated with vitamins; Protein-energy malnutrition.

UNIT IV
Antinutritional factors; Role of diet and nutrition in the prevention and treatment of diseases. Antioxidants; Food allergy.

UNIT V
Biochemical composition, energy and food value of various food grains including cereals, pulses, oil seeds, fruits and vegetables. Biochemical changes during processing and storage of food grains, fruits and vegetables; Food additives and contaminants.

**Practicals**

Estimation of tryptophan; Estimation of starch; Estimation of amylose; Estimation of crude fiber; Estimation of oil content in oilseeds; Estimation of carotenoid pigments; Estimation of ascorbic acid (Vitamin C); Assessment of rancidity of oils and fats; Determination of phytin phosphorus; Estimation of Glucose; Protein Estimation.

**Suggested Readings**


BIO 503 PLANT BIOCHEMISTRY  
(3L+2P) II

Objective

To provide insight into various biochemical and molecular processes in plants and their regulation

Theory

UNIT I
Structure and function of plant cell organelles; Photosynthesis in higher plants; Light and Dark reactions; C_3, C_4 & CAM pathways and their regulation.

UNIT II
Biosynthesis of structural carbohydrates, storage proteins and lipids; Sucrose-Starch interconversion; Photorespiration.

UNIT III
Proteins: post-translational modifications, folding, stability, transport and degradation.

UNIT IV
Cellular metabolism of oligosaccharides and polysaccharides; Secondary metabolites- isoprenoids, alkaloids and phenolics, cyanogenic glycosides and glucosinolates

UNIT V
Biochemistry of Plant hormones; signaling pathways; Phytochromes.

Practicals

Soluble Protein Estimation by Lowry’s Method; Fractionation of Cell Organelles; Estimation of Starch; Assay of ADPG Pyrophosphorylase; Assay of Starch Synthase; Estimation of Amylolytic Activity; Assay of Isocitrate Lyase; Assay of Isocitrate Dehydrogenase; Assay of Ribulose-1,5-Bisphosphate Carboxylase; Assay of Phenylalanine Ammonia Lyase; Assay of Pectin Methyl Esterase; Assay of Superoxide Dismutase; Assay of Polyphenol Oxidase; Assay of Lipoxygenase; Estimation of Proline; Estimation of Carotenoid Pigments; Determination of Polyphenols in Pulse Grains, Fractionations of storage proteins

Suggested Readings


BIO 504 TECHNIQUES IN BIOCHEMISTRY  
(2L +2P) III

Objective

To impart theoretical and practical knowledge about various biochemical techniques used in biochemistry for isolation and characterization of cellular components.
Theory

UNIT I
Principles of enzyme assays and analysis of biomolecules; Centrifugation techniques-theory, types and applications.

UNIT II
Principles and applications of Spectrophotometry, Mass spectroscopy.

UNIT III
Chromatographic techniques-TLC, ion-exchange, gel-filtration, affinity, GLC and HPLC.

UNIT IV
Electrophoresis techniques – native and SDS-PAGE, Isoelectric focusing, capillary electrophoresis and agarose gel electrophoresis.

UNIT V
Concept of radioactivity, tracer techniques and their applications in biology, Scintillation counters, autoradiography, radiation hazards and safety measures.

UNIT VI
Polymerase Chain Reaction (PCR); Immunochemical techniques, MALDI-TOF.

UNIT VII
Ethical issues and professional responsibilities in research.

Practicals

pH and buffer preparation; Fractionation of cell organelles; Soluble protein estimation by Lowry’s Method; Isolation, purification and distribution of polysomes; Gel Chromatography; polyacrylamide gel electrophoresis; Separation of proteins by iso-electric focusing. Isolation of plant DNA, Agarose gel electrophoresis; Estimation of fatty acids by gas-liquid chromatography, Radioisotope analysis by liquid scintillation counter, PCR.

Suggested Readings


BIO 601 NUCLEIC ACIDS

Objective

To provide knowledge about structure and function of nucleic acids and the role of modification enzymes
Theory

UNIT I
History of nucleic acids; DNA as genetic material.

UNIT II
Chemistry of nucleic acids; Chromatin structure and function; Structure and conformation of DNA and RNAs.

UNIT III
DNA topoisomerases, nucleases, endonucleases and related enzymes.

UNIT IV
Biosynthesis of nitrogenous bases, nucleotides and their regulation.

Practicals

Isolation and purification of RNA and DNA from plant tissue; Spectrophotometric analysis and agarose gel electrophoresis; Restriction analysis of DNA; Isolation of total RNA and Ribosomal RNA; Spectrophotometric quantification; agarose gel electrophoresis; Isolation of messenger RNA.

Suggested Readings


BIO 602 PROTEIN BIOSYNTHESE (3L+0P) II

Objective

To impart knowledge about the various components and processes involved in protein biosynthesis its regulation and the significance of post-translational modifications.

Theory

UNIT I
RNA world; Diverse RNA functions in living cells and its significance.

UNIT II
Structure and function of tRNA, rRNA, mRNA; Pre mRNA splicing, tRNA processing, modification and transport.

UNIT III
Structure and function of amino acyl tRNA synthetases; tRNA identity; recognition and charging; proof reading mechanisms.
UNIT IV
Protein synthesis: structure and function of ribosomes; Genetic code: Elucidation, nature and properties; Initiation, elongation and termination cycles in prokaryotes and eukaryotes, Protein synthesis inhibitors and regulation.

UNIT V
Secretion and maturation of polypeptides: Signal sequences and secretion; Spontaneous and Chaperone mediated folding and transport to organelles like chloroplast, mitochondria and nucleus; Post translational modifications and their significance.

Suggested Readings

BIO 603 GENETIC ENGINEERING – PRINCIPLES AND METHODS (3L +1P) I

Objective
To provide knowledge about the basics of recombinant DNA technology and its applications

Theory
UNIT I
Introduction and historical perspectives; Properties and applications of Restriction Enzymes; Characteristics of vectors; DNA cloning strategies.

UNIT II
Methods of gene isolation, Construction and screening of genomic and cDNA libraries, PCR; Site directed mutagenesis; Gene silencing Methodologies:– Anti-sense RNA Technology, Ribozyme technology; DNA sequencing.

UNIT III
Plant transformation methods and transgene analysis, Potential applications of genetic engineering in agriculture; Transcriptional and post transcriptional gene silencing, gene targeting and gene therapy.

UNIT IV
Bioethics and biosafety issues and IPR in Recombinant DNA research.

Practicals
Isolation of Plant, plasmid and phage DNA and purification; Restriction of Plant DNA; Southern blotting; Elution of DNA from agarose gel; Radioactive labeling of DNA; Southern hybridization, autoradiography. Preparation of vector for cloning; Ligation of vector with insert DNA; Preparation of competent cells; Transformation of E.coli cells and selection of recombinants by antibiotic or blue/white selection; PCR, Preparation of plant RNA, RT-PCR.
Suggested Readings


**BIO 604 GENE REGULATION**  
(3L+0P) III

**Objective**

To provide knowledge about the genome organization, gene expression and regulation in prokaryotes and eukaryotes.

**Theory**

**UNIT I**


**UNIT II**


**UNIT III**

RNA editing; RNA-interference; Signal transduction and gene regulation in plant development and stress responses.

**UNIT IV**

Epigenetic control of gene expression.

**Suggested Readings:**


Objective
To impart knowledge about the catalytic role of enzymes, their structure, Physico-chemical, kinetic and regulatory properties, mechanism of action and their importance in agriculture and allied sectors.

Theory

UNIT I
Enzymes: structure and conformation; classification, assay, isolation, purification and characterization.

UNIT II
Specificity, mechanism of action, steady state and pre-steady state kinetics; Active site mapping, regulation and enzyme activity.

UNIT III
Immobilized enzymes and their applications.

UNIT IV
Enzyme engineering in Agriculture and allied sectors.

Practicals
Soluble protein Estimation by Lowry’s Method; Estimation of Urease activity in Soybean; Crystallization of Urease from soybean meal; Alternate method for Urease extraction; Determination of pH optima for Urease; Determination of the optimum temperature Q_{10} value and activation energy of Urease; Study the effect of substrate concentration on enzymatic activity of Urease and determination of K_m and V_max; Study of the effect of inhibitor on the activity of Urease; Estimation of ADH and alkaline phosphatase activities; Purification of peroxidase from wheat seedlings.

Suggested Readings

BIO 606 INTERMEDIARY METABOLISM

Objective
To provide knowledge about various metabolic pathways, their regulation and engineering
Theory

UNIT I
Intermediary metabolism of carbohydrates and its regulation.

UNIT II
Bioenergetics; Electron transfer and oxidative phosphorylation; Mechanism of oxidative phosphorylation.

UNIT III
Lipid metabolism – degradation and biosynthesis of fatty acids, sterol biosynthesis, metabolic regulation.

UNIT IV
Amino acid metabolism – general reactions, degradation and biosynthesis of amino acids.

UNIT V
Metabolism of nucleic acids – degradation and biosynthesis of purines and pyrimidines.

UNIT VI
Metabolic pathway engineering.

Suggested Readings


BIO 607 INORGANIC NITROGEN METABOLISM (3L+1P)

Objective

To impart knowledge of biochemistry and molecular mechanism of biological nitrogen fixation mechanism and regulation of nitrate assimilation and denitrification processes.

Theory

UNIT I
Biochemistry of nitrogen cycle. Biological nitrogen fixation; Structure, function and regulation of nitrogenase; Structure, function and regulation of nif genes in Klebsiella pneumoniae and Clostridium.

UNIT II
Biochemical basis of legume-Rhizohium symbiosis; Genes involved in symbiosis. Different types of hydrogenases and role of uptake hydrogenase in N\textsubscript{2} fixation; Chemoautotrophy in rhizobia. Biochemistry of ferredoxin and other non-haem iron proteins.

UNIT III
Biochemistry of nitrate assimilation and mechanism of its regulation; GS/GOGAT and GDH pathways; Ureides and amides as nitrogen transport compounds.

UNIT IV
Practicals

Estimation of nitrate content by hydrazine sulphate reduction method; Estimation of protein by Lowry’s Method; In vivo assay of nitrate reductase activity; In vitro assay of nitrite reductase activity; In vitro assay of glutamine synthetase activity; In vitro assay of glutamate synthase activity; In vitro assay of glutamate dehydrogenase activity; Assay of nitrogenase activity by acetylene reduction method; Estimation of hydrogen evolved by legume nodules.

Suggested Readings


BIO 608 BIOCHEMISTRY OF BIOTIC AND ABIOTIC STRESSES (3L+0P) II

Objective

To provide knowledge about the biochemical basis of biotic and abiotic stresses in plants.

Theory

UNIT I
Plant- pathogen interaction and disease development, changes in metabolism of cell wall composition and vascular transport in diseased plants, Expression, structure and activity of gene products caused by genetic mutation, epigenetic phenomena and environmental agents leading to diseases.

UNIT II
Plant defense response, antimicrobial molecules, hypersensitive response and cell death, systemic and acquired resistance, pathogen derived resistance, antipathogenic principles.

UNIT III
Plant viruses, host virus interactions, disease induction, virus movement and host range determination; viroids.

UNIT IV
Biochemical basis of abiotic stresses namely: drought, salinity, temperature, heavy metals, and water pollutants, synthesis and function of proline and glycine betaine, stress tolerance, stress adaptation, interaction between biotic and abiotic stresses.

UNIT V
Reactive oxygen species, antioxidants, enzymes of defense system. Molecular strategies for imparting tolerance against biotic and abiotic stresses.
BIO 609 BIOCHEMISTRY OF PLANT CELL ORGANELLES (3L+0P)

Objective

To impart knowledge about structure and function of plant cell organelles and various signaling pathways.

Theory

UNIT I
Cell wall - structure, biogenesis and expansion; Cell membrane - structure and functions, membrane trafficking; Cytoskeleton - Microtubules, microfilaments, and intermediate filaments.

UNIT II
Structure, functions and biogenesis of cell organelles- Endoplasmic reticulum, Golgi Body Complex, Mitochondria, Chloroplast, Ribosome, Lysosome, Peroxisomes, Nucleus (Nuclear envelope with nuclear pore complex, nucleolus, nucleoplasm & chromatin), vacuoles and protein bodies.

UNIT III
Cell division- mitosis, meiosis; cell cycle and its regulation; Cell senescence and programmed cell death; Organization, expression and manipulation of organellar genomes, and their cross-talk with nuclear genome.

UNIT IV
Cell-cell and inter-organellar signaling- Role of plasmodesmata in intercellular transport; intracellular trafficking; signal transduction pathways.

Suggested Readings


BIO 701 CURRENT TOPICS IN BIOCHEMISTRY (2L+0P)

Objective

To acquaint the students with recent advances in various fields of Biochemistry and to inculcate the habit of searching and reading the topics of current importance.
Theory

UNIT I
Advanced topics related to nutrition and metabolism.

UNIT II
Advanced topics related to enzymology and industrial biochemistry

UNIT III
Advanced topics related to molecular biochemistry

UNIT IV
Advanced topics related to metabolic engineering and bioprospecting.

Suggested Readings

Selected research articles from most recently published journals.

BIO 702 PROTEOMICS, METABOLOMICS AND IONOMICS (3L+0P) III

Objective

To impart knowledge in the upcoming areas like Proteomics, Metabolomics and Ionomics and their applications.

Theory

UNIT I
Protein sequencing technologies.

UNIT II
Protein profiling and proteome analysis: Proteome technology, 2D PAGE, MSMS. MALDI-TOF, Protein microarray, comparative and structural proteomics.

UNIT III
Quantitative PCR, SAGE, MPSS, Micro array.

UNIT IV
Metabolomics: Elucidation of metabolic pathways, metabolic pathway engineering. Specific examples of pathway engineering.

UNIT V

Suggested Readings


