**Department of Biochemistry**
**Faculty of Life Sciences**
**AMU, Aligarh**

M.Sc. (Biochemistry) Semester Syllabus
(Effective from 2018-19)
**Passed in BOS held on 07.04.2018**

**M.Sc. (Biochemistry)**
**Semester-I**
**Core Course**

# ADVANCED MOLECULAR BIOLOGY

**(BCM1001)**

**Credits: 04**
**Total Lectures: 48**

**NOTE:** The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: STRUCTURAL ASPECTS OF GENETIC MATERIAL (11 Lectures)

Basic concepts of genomics; conformational variants of DNA and their physiological roles; RNA as catalyst. **(4 lectures)**

C-value paradox. Nucleic acid reassociation kinetics and its significance, cot value; highly repetitive, moderately repetitive and unique sequences; minisatellites. LINES, SINES, Alu sequences and pseudogenes. Transposons and retroposons. **(7 Lectures)**

## UNIT II: REPLICATION AND TRANSCRIPTION OF DNA (12 Lectures)

a) Replication- Unidirectional and bidirectional. Enzymes and proteins involved in replication; primosome and its role; fidelity of replication. Basic differences between prokaryotic and eukaryotic DNA replication. Licensing factor and regulation of eukaryotic DNA replication. Replication of ends of linear DNA, telomeres and telomerase. Mitochondrial DNA replication. **(8 Lectures)**

b) Mechanism of transcription – Sigma cycle; promoters; enhancers and other regulatory elements. Eukaryotic RNA polymerases, carboxyl terminal domain, TBP and its role in eukaryotic transcription. RNA replication. **(4 Lectures)**

## UNIT III: POST-TRANSCRIPTIONAL PROCESSING AND TRANSLATION

**(12 Lectures)**

a) Post-transcriptional processing in prokaryotes and eukaryotes- maturation of rRNA and tRNA. Split genes; mechanism of RNA splicing- spliceosomes, consensus sequence of splice junctions; introns as protein functional domains; alternative splicing. 5'-Capping and poly A tailing; RNA editing; mRNA stability; RNA transport; degradation of abnormal RNAs

**(6 Lectures)**

b) Translation – A comparative study of the mechanism of translation in prokaryotes and eukaryotes. Translational initiation in eukaryotes. Fidelity of translation process. Ribosome skipping/ jumping during translation. **(6 Lectures)**

**UNIT IV: REGULATION OF GENE EXPRESSION AND DNA REPAIR**

**(13 Lectures)**

**(a)** Regulation of gene expression – Transcriptional and translational control in prokaryotic and eukaryotic systems. Regulation of gene expression in lambda phage. Hormonal control of gene expression; role of methylation in regulating gene expression; gene amplification; alternate promoters; NF-κB; Regulatory RNAs, RNA interference, micro-RNA, riboswitches; Epigenetics. **(8 Lectures)**

**(b)** Significance of DNA repair in cells. DNA repair-mechanisms that safeguard DNA in prokaryotic and eukaryotic systems. SOS response and role of RecA and Lex A. Transcription and repair **(5 Lectures)**

**Suggested Reading:**


- Lehninger: Principles of Biochemistry (2017) by Nelson and Cox Seventh edition, WH Freman and Co.
- Biochemistry (2015) by Berg, Tymoczko, Gatto, Stryer. Eighth Edition, WH Freman and Co.
- Molecular Biology of the Gene (2017) by Watson, Hopkin, Roberts, Stertz, Weiner, Freeman Pub., San Francisco.
- Lewin's Genes XII (2017) by Krebs, Goldstein and Kilpatric. Oxford University Press, London.
- Molecular Cell Biology (2016) by Lodish, Berk, Kaiser, Krieger, Bretscher. Eighth edition. W.H. Freeman & Co Ltd
- Molecular Biology of the Cell (2014) by Bruce Alberts. Sixth Edition

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**Core Course**

# METABOLISM AND ITS INTEGRATION

**(BCM1002)**

**Credits: 04**
**Total Lectures: 48**

**NOTE:** The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: CARBOHYDRATE METABOLISM (12 Lectures)

Detailed study of alcoholic fermentation and its regulation. Glycolysis; gluconeogenesis; pentose phosphate pathway. Energetics.. Reciprocal regulation and integration of glycolysis and gluconeogenesis. TCA cycle; glyoxylate pathway involving various sub-cellular organelles e.g. mitochondria, peroxisomes/ glyoxysomes and cytosol. Biosynthesis and degradation of glycogen; reciprocal regulation. Blood glucose homeostasis.

## UNIT II: LIPID METABOLISM (12 Lectures)

A detailed account of beta-oxidation pathway of fatty acid catabolism; role of carnitine; oxidation of odd chain and unsaturated fatty acids; comparison of β-oxidation in mitochondria and peroxisomes. Metabolism of ketone bodies.
Denovo fatty acid biosynthesis; mechanism and regulation of acetyl-CoA carboxylase. Role of fatty acid synthase. Biosynthesis of unsaturated fatty acids including omega-fatty acids (elongation and desaturation) and their role in health and diseases. Relationship between fatty acid synthesis and oxidation. Biosynthesis of cholesterol and its regulation. Transport of cholesterol and triglycerides in body fluids. Classes of lipoproteins: LDL, HDL,VLDL and their role in health and disease.

**UNIT III: AMINO ACID METABOLISM (12 Lectures)**

Specific aspects of amino acid metabolism. Nitrogen fixation, role of nitrogenase complex, nitrogen assimilation into amino acids. Biosynthesis of essential and non-essential amino acids and its regulation - feedback inhibition. Amino acids as precursors of biomolecules. Amino acid degradation, transamination and oxidative deamination. Urea cycle and its regulation. Fate of carbon skeleton of amino acids, glucogenic and ketogenic amino acids. Inborn errors of amino acid metabolism.

**UNIT IV: NUCLEIC ACID METABOLISM (12 Lectures)**

Biosynthesis of purine and pyrimidine ribonucleotides: denovo and salvage pathways, biosynthesis of deoxyribonucleotides and polynucleotides; degradation of purine and pyrimidine nuceotides and its regulation. Genetic defects in nucleotide metabolism; enzymes of nucleotide metabolism as chemotherapeutic targets.

**Suggested Reading:**


- Harper's Biochemistry (2018) by Botham, Bender and Rodwell. Thirty first edition, McGraw Hill.
- Text Book of Medical Physiology (2005) by Guyton and Hall. Eleventh edition, Harcourt Asia
- Lehninger: Principles of Biochemistry (2017) by Nelson and Cox Seventh edition, WH Freeman and Co.
- Biochemistry (2015) by Berg, Tymoczko, Gatto, Stryer. Eighth edition, WH Freeman and Co.

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**Semester-I**
**Elective Discipline Centric**

# BIOTECHNOLOGY-I

**(BCM1003)**

**Credits: 04**
**Total Lectures: 48**

**NOTE:** The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: CONSTRUCTION OF RECOMBINANT DNA (12 Lectures)

Plasmid cloning vectors; properties of ideal plasmid cloning vectors. Formation of chimeric plasmids using restriction enzymes, homopolymeric tailing and synthetic linkers. Isolation of RNA; formation of cDNA from RNA; isolation of genomic DNA, construction of DNA library; genomic vs cDNA library. Subtractive and normalized DNA libraries. Some important vectors like lambda phage, cosmids and yeast vectors.

## UNIT II: SCREENING OF rDNA LIBRARIES (12 Lectures)

**(a)** Selection/ Screening of libraries **(9 Lectures)**

Use of drug resistance in plasmids. Preparation of nucleic acid probes (5' and 3' end labelling, random primer labelling, nick translation, biotinylated probes) and their use in screening gene libraries. Immunological screening. Subcloning of genes; Chromosome walking. Use of reporter genes for analysing gene expression. Transposon tagging for isolation of genes.

**(b)** Electrophoresis and blotting **(3 Lectures)**

Agarose gel electrophoresis of nucleic acids; pulsed field gel electrophoresis. Southern, Northern and Western blotting; gel retardation assay; DNA footprinting by DNase I.

## UNIT III: SEQUENCING, AMPLIFICATION AND MUTAGENESIS IN rDNA TECHNOLOGY (12 Lectures)

**(a)** Synthesis, sequencing and amplification of DNA: Chemical synthesis of DNA; DNA sequencing by Maxam-Gilbert and Sanger's methods, automated DNA sequencers; sequencing of RNA. Amplification of DNA by PCR; types of PCR: end point PCR, real time PCR, qPCR; applications of PCR. **(8 Lectures)**

**(b)** In vitro mutagenesis- Site directed mutagenesis using oligonucleotides of defined sequence, Kunkel's method using uracil substituted DNA; mutagenesis using PCR; linker scanning mutagenesis. **(4 Lectures)**

**UNIT IV: RESTRICTION MAPPING AND APPLICATION OF RDT (12 Lectures)**

**(a)** Restriction and molecular genetics maps **(6 Lectures)**

Construction of restriction maps; RFLP; DNA finger printing; linkage and recombination between genetic markers; Random Amplified Polymorphic DNA (RAPDs) using PCR; Reverse genetics.

**(b)** Applications of recombinant DNA technology **(6 Lectures)**

Biological, medical, agricultural and industrial applications of recombinant DNA technology (pharmaceutical, food, forensic science, diagnosis of disorders, improvement of livestock and plants, vaccine and drug production, gene therapy). Use of antisense RNA technology. Social, moral and ethical implications of genetic engineering.

**Suggested Reading:**


- Molecular Cloning: A Laboratory Manual (volumes I, II & III) (2012) by Green and Sambrook. Fourth edition, Cold Spring Harbor Laboratory Pub.
- General Genetics by Subowen and Edger (Latest edition)
- Principles of Biotechnology (1988) by A. Wiseman. Surrey University Press.

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**Semester-I**
**Elective Discipline Centric**

# MOLECULAR CELL BIOLOGY-I
# (BCM1004)

**Credits: 04**
**Total Lectures: 48**

**NOTE:** The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: CELLS AND SUBCELLULAR ORGANELLES (14 lectures)

Structural organization of eukaryotic and prokaryotic cells. Ultrastructure of nucleus (nuclear envelope, nucleolus, nucleosome and chromatin packaging), mitochondria (ultrastructure organization of the electron transport chain components and oxidative phosphorylation), endoplasmic reticulum (smooth and rough), vectorial discharge, Golgi apparatus (role in secretion, coated vesicles). Role of ER and GA in synthesis of membrane proteins; protein glycosylation, post-translational modifications, sorting, maturation and secretion of proteins. Lysosomes (primary and secondary lysosomes and their functions), peroxisomes, vacuoles and microbodies.

## UNIT II: BIOMEMBRANES AND TRANSPORT (14 lectures)

**a)** Molecular constituents, physico-chemical properties, supramolecular structure, organization and architecture (fluid mosaic model) of biomembranes. Asymmetric organization of lipids and proteins in biological membranes. Specialized regions of the plasma membrane. Detailed structure of human erythrocyte membrane. Liposomes as model membranes and their applications in biology and medicine.

**b)** Transport across biological membranes: Simple diffusion, facilitated diffusion and active transport. Transport ATPases. Detailed mechanism of action of Na- K-ATPase. Transport via vesicle formation. Endocytosis, exocytosis and phagocytosis, receptor- mediated endocytosis of LDL and familial hypercholesterolemia.

**UNIT III: EPITHELIA AND EXTRACELLULAR MATRIX (12 lectures)**

Types of tissues, microvilli, epithelium – types of eptithelial apices and glycocalyx matrix. Specialized regions of biological membranes and types of cell junctions. Structural features and characteristics of basement membrane. Extracellular matrix - collagen, elastin, fibrillin, fibronectin, laminin and proteoglycans.

**UNIT IV: CYTOSKELETON (8 lectures)**

Self assembly and dynamic structure of cytoskeletal filaments, motor proteins associated with microtubules and their role in intra-cellular transport. Labile and semi-permanent structures (cilia and flagella). Structure and organization of actin and myosin in the muscle; mechanism of muscle contraction and relaxation. Role of calcium and calmodulin in muscle contraction

**Suggested Reading:**


- Molecular Biology of the Cell (2014) by Bruce Alberts. Sixth Edition
- Molecular Cell Biology (2016) by Lodish, Berk, Kaiser, Krieger, Bretscher. Eighth Edition, WH Freeman & Co Ltd
- Lewin's Genes XII (2017) by Krebs, Goldstein and Kilpatric. Oxford University Press, London.
- Lehninger: Principles of Biochemistry (2017) by Nelson and Cox. Seventh edition. WH Freeman and Co.
- Biochemistry (2015) by Berg, Tymoczko, Gatto, Stryer. Eighth edition, WH Freeman and Co.

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# MOLECULAR TOXICOLOGY

**(BCM1005)**

**Credits: 04**
**Total Lectures: 48**

**NOTE:** The course will be evaluated out of 100 marks and will have the following components of evaluation: SessionalS for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: INTRODUCTION AND TOXIC RESPONSE (12 Lectures)

Brief history, different areas of modern toxicology, classification of toxic substances, various definitions of toxicological significance; Effect of duration, frequency, route and site of exposure of xenobiotics on their toxicity. Characteristics and types of toxic response. Types of interactions between two and more xenobiotics exposure in humans. Tolerance and addiction.

## UNIT II: EVALUATION AND MECHANISM OF TOXICITY (12 Lectures)

Various types of dose response relationships, assumptions in deriving dose response; LD50, LC50, TD50 and therapeutic index. Delivery of the toxicant, mechanisms involved in formation of ultimate toxicant; detoxification of ultimate toxicant.

## UNIT III: TOXIC AGENTS AND ECO-TOXICOLOGY (12 Lectures)

Human exposure, mechanism of action and resultant toxicities of lead, arsenic, organophosphtes, carbamates. Brief introduction to avian and aquatic toxicology, movement and effect of toxic compounds in food chain (DDT, mercury); bioaccumulation, biomagnification.

**UNIT VI: CLINICAL TOXICOLOGY AND NANOTOXICOLOGY (12 Lectures)**

(a) Management of poisoned patients, clinical methods to decrease absorption and enhance excretion of toxicants from the body, use of antidotes.

(b) Introduction; Biological activities of nanomaterials/nanoparticles. Uptake and cytotoxicity of nanoparticles, role of oxidative stress in nanoparticle induced toxicity. Strategies for reducing and eliminating nanotoxicity.

**Suggested Reading:**


- Cassarett and Doull's Toxicology: Basic Science of The Poisons (2013) by C.D. Klaassen. Eighth edition, McGraw Hill.
- Cassarett and Doull's Essentials of Toxicology (2015) by Klaassen and Watkins, Third edition, McGraw Hill.
- Introduction to Toxicology (2001) by John Timbrell. Third edition, CRC Press.
- Principles of Toxicology (2015) by Stine Karen and Thomas M Brown. Third edition, CRC Press.
- Lu's Basic Toxicology: Fundamentals, Target Organs and Risk Assessment (2012) by Frank C Lu and Sam Kacow. Sixth edition, CRC Press.
- Nanotechnology in Medicine and the Biosciences (1996) by Richard Coombs and Dennis Robinson, Editors. Taylor & Francis.
- Nanotechnology in Biology and Medicine (2004) by Tuan Vo-Dinh. CRC Press

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**M.Sc. (Biochemistry)**
**Semester-I**
**Elective Discipline Centric**
**ENDOCRINOLOGY**
**(BCM1006)**

**Credits: 04**
**Total Lectures: 48**

**NOTE:** The course will be evaluated out of 100 marks and will have the following components of evaluation: SessionalS for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: INTRODUCTION TO ENDOCRINOLOGY (12 Lectures)

Functions of hormones and their regulation. Chemical signaling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Chemical classification of hormones. Transport of hormones in the circulation and their half-lives. Hormone therapy; general introduction to endocrine methodology.

## UNIT II: HORMONE MEDIATED SIGNALING (12 Lectures)

Hormone receptors - extracellular and intracellular; receptor- hormone binding; Scatchard analysis; G proteins and G protein coupled receptors, second messengers - cAMP, cGMP, IP3, DAG, $Ca^{2+}$, NO. Effector systems- adenyl cyclase, guanyl cyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG); Steroid hormone/ thyroid hormone receptor mediated gene regulation. Receptor regulation and cross talk.

## UNIT III: HYPOTHALAMIC AND PITUITARY HORMONES (12 Lectures)

Hypothalamic - pituitary axis; physiological and biochemical actions of hypothalamic hormones. Pituitary hormones - GH, prolactin, TSH, LH, FSH, POMC peptide family, oxytocin and vasopressin, feedback regulation cycle. Endocrine disorders- gigantism, acromegaly, dwarfs, pygmies and diabetes insipidus.

**UNIT IV: THYROID HORMONE, ADRENAL HORMONES, PANCREATIC AND GI TRACT HORMONES (12 Lectures)**

Thyroid gland; thyroid hormone- its regulation, physiological and biochemical action. Aldosterone, renin angiotensin system, cortisol, epinephrine and norepinephrine physiological and biochemical action. Regulation of release of insulin, glucagon, gastrin, secretin, CCK, GIP, adiponectin, leptin and ghrelin. Summary of hormone metabolites control of GI function, physiological and biochemical action.

**Suggested Reading:**


- Lehninger: Principles of Biochemistry (2017) by Nelson and Cox Seventh edition, WH Freeman and Co.
- Vander's Human Physiology (2013) by Widmaier, Raff, Strang. Thirteenth edition, McGraw Hill International Publications.
- Endocrinology (2007) by MC Hadley and JE Levine. Sixth edition, JE Pearson Education.
- The Cell: A Molecular Approach (2009) by Cooper and Hausman. Seventh edition, Oxford University Press.

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**Semester-II**
**Elective Discipline Centric**

# BIOTECHNOLOGY-II

**(BCM2001)**

**Credits: 04**
**Total Lectures: 48**

**NOTE:** The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: FERMENTATION AND *IN VITRO* CULTURE TECHNIQUES (12 Lectures)

Fermentation technology: introduction, fermenting microorganisms; batch and continuous culture techniques. Applications of fermentation biotechnology. Single cell proteins. Primary and transformed cell cultures; growth requirements for animal cells, differentiated cells in culture. Transformation of eukaryotic cells. Plant tissue culture concepts, isolation of explants and its growth requirements. Cell suspension culture, isolation, regeneration of plants from explants and calluses. Production of secondary metabolites in tissue culture.

## UNIT II: GENETIC TRANSFORMATIONS AND TRANSGENIC TECHNOLOGY (12 lectures)

Cloning in plant cells, gene transfer in plants; transgenic plants (herbicide, insect and virus resistant). Value addition through genetic engineering synthetic seeds. Introduction of DNA in mammalian cells, use of viral vectors, generation of transgenic animals. Ethical, social and biosafety aspects of transgenic technology.

## UNIT III: GENOME MAPPING AND APPLIED GENETICS (12 lectures)

Genome mapping: concept and techniques. Determination of function of genes, computer analysis of gene function. Assigning gene function by experimental analysis. Diagnosis of genetic defects and possible approaches to tackling genetic disorders. Genome editing by CRISPER/Cas9 technology - working and its applications; gene therapy. Positive and negative eugenics. Genetic counseling and anti-natal diagnosis.

**UNIT IV: ENZYME TECHNOLOGY (12 lectures)**

Analytical applications of enzymes- enzymatic analysis of useful substances; enzyme electrodes and enzyme based biosensors (potentiometer, amperometric, calorimetric, optical and piezo-electric etc.). Strategies for the improvement of performance of enzymes in industry. Chemical modification, crosslinking with bifunctional reagents and use of additives. Enzyme immobilization strategies– covalent coupling, adsorption, chemical aggregation, entrapment, etc. Behaviour of immobilized enzymes–micro-environmental. Enzyme reactors: types, advantages and limitations.

**Suggested Reading:**


- Molecular Cloning: A Laboratory Manual. Volumes I, II, III (2012) by Green and Sambrook. Fourth edition, Cold Spring Harbor Laboratory Pub.
- General Genetics by Subowen and Edger (Latest edition)
- Principles of Biotechnology (1988) by A. Wiseman. University of Surrey, UK.
- Enzymes in Industry Production and Applications (1990) by W. Gerhartz. VCH Publishers, Weinheim, Germany.
- Enzymes: Biochemistry, Biotechnology, Clinical Chemistry (2007) by T Palmer. Second edition, Woodhead Publishing Ltd, Cambridge, UK.
- Industrial Enzymology (1996) by Godfrey, Reicheld and West. Second edition, Macmillan Press Ltd. London.
- Methods in Non-Aqueous Enzymology (2000) by MN Gupta. Birkhäuser Verlag, Berlin.
- Pharmaceutical Enzymes (1997) by Lauwers and Scharpe, editors. Marcel Dekker, Inc. USA.
- Enzyme and Microbial Biosensors: Techniques and Protocols (1998) by A. Mulchandani and KR Rogers, editors. Humana Press, USA

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**Semester-II**
**Elective Discipline Centric**

# MOLECULAR CELL BIOLOGY-II

**(BCM2002)**

**Credits: 04**
**Total Lectures: 48**

**NOTE:** The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: CELL COMMUNICATION (13 lectures)

General principles of cell communiation- extra-cellular signaling molecules and their receptors. Autocrine, paracrine and endocrine singling. Synthesis and regulation of signaling molecules and receptors. Intra-cellular signaling molecular aspects; Signaling through G-protein linked receptors; Second messengers, cAMP, Inositol-1,4,5-triphosphate, Ca-calmodulin synthesis phospholipid-phospholipase signaling pathway, G-protein -cAMP-PKA pathway.

Signaling through enzyme-linked receptors; activated receptor tyrosine kinase; Resin chicel downstream cascade; MAP kinase, Jak-STAT signaling pathway signaling through regulated proteolysis; Receptor protein notch, Wnt proteins and Frizzled receptors; B-catenin; protein filamentary stimuli and NF-KB- dependent signaling pathway.

## UNIT II: NEUROBIOLOGY AND NEUROCHEMISTRY (12 lectures)

Cellular organization of dendrites, axons, neurotubules, neurofilaments and synapses; structure and function of synapse, transmission across synapse. Membrane potential in the steady state, action potential generation and propagation. Neuro-muscular junctions: presynaptic-and post-synaptic events. Neuronal membrane excitability, ion channels and transport of ions. Sensory transduction and the visual system; role of cGMP and $Ca^2$ signaling pathway.

**UNIT III: CELL CYCLE AND PROGRAMMED CELL DEATH (12 lectures)**

Culture techniques for the study of cell division; Cell division by mitosis and meiosis. Cell cycle in eukaryotes; regulation by protein kinase, role of cyclins and cyclin dependent protein kinases. An overview of the cell cycle control system in eukaryotes, cell cycle progression; components of the cell cycle control system, cell cycle processes and assets, cyclically activated protein kinase, cyclin-dependent kinases; cdks, cell cycle control- proteolysis and trans path and regulation. Intracellular control of cell cycle events, cyclin- Cdk complexes and activation by p53, p21, p27; Programmed cell death (apoptosis), proteolytic cascade, adaptor proteins, Bcl-2 family protein, extracellular control of cell division, cell growth and apoptosis.

**UNIT IV: CELL DIFFERENTIATION AND CANCER (11 lectures)**

Embryonic and adult stem cells. Biochemistry of cancer, characteristics of cancer cells. Identification of carcinogenesis, agents promoting carcinogenesis; cancer as a micro evolutionary process; reproduction of cancer cells; somatic mutations, aberrant cells; Tumor production, cancer as growth, defective cell death or cell differentiation and proliferation.

Causes and prevention of cancer- DNA damage and altered DNA sequence, viruses and other infection; cancer critical genes, oncogenes, suppressor genes, mutated genes. Cancer critical genes- functions and regulation. Cancer treatment- present and future.

**Suggested Reading:**


- Molecular Biology of the Cell (2014) by Bruce Alberts. Sixth Edition
- Lehninger: Principles of Biochemistry (2017) by Nelson and Cox. Seventh edition, WH Freeman and Co.
- Molecular Cell Biology (2016) by Lodish, Berk, Kaiser, Krieger, Bretscher. Eighth Edition. W.H.Freeman & Co Ltd
- Lewin's Genes XII (2017) by Krebs, Goldstein and Kilpatric. Oxford University Press, London.

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**Semester-II**
**Core Course**

# ADVANCED ENZYMOLOGY

**(BCM2003)**

**Credits: 04**
**Total Lectures: 48**

**NOTE:** The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: NATURE AND KINETICS OF ENZYME CATALYZED REACTIONS (12 Lectures)

Review of unisubstrate enzyme kinetics and factors affecting the rates of enzyme catalyzed reactions. Methods of examining enzyme-substrate complexes; flexibility and conformational mobility of enzymes. Methods for measuring kinetic and rate constants of enzymatic reactions and their magnitudes. Mapping of active site; affinity labeling and chemical modification methods of active site determination.

## UNIT II: KINETICS AND MECHANISMS OF MULTISUBSTRATE REACTIONS (8 Lectures)

Classification of multisubstrate reactions with examples of each class; kinetics of multisubstrate reactions. Derivation of the rate of expression for ping-pong, compulsory, random ordered bi-bi reaction mechanism and Theorell-Chance bi-bi reactions; use of initial velocity, inhibition and exchange studies to differentiate between multisubstrate reaction mechanisms.

## UNIT III: MECHANISM OF ENZYME ACTION (12 Lectures)

Detailed mechanism of catalysis of chymotrypsin and triose phosphate isomerase. Concept of convergent and divergent evolution of enzymes. Multienzyme systems- occurrence, isolation and their properties; polygenic nature of multienzyme systems. Mechanism of action and regulation of pyruvate dehydrogenase complex.

**UNIT IV: ENZYME REGULATION (16 lectures)**

General mechanisms of enzyme regulation; control of enzyme activity by products and substrates; control by zymogen formation. Reversible and irrevesible covalent modification of enzymes. Regulation of enzyme activity by proteins. Allosteric enzymes; structure and functions of ATCase; cooperative binding, homotropic and heterotropic interactions, Hill equation and Hill plot, sigmoidicity of the substrate – velocity curve. Concerted and sequential models for action of allosteric enzymes and their significance. Enzyme turnover and methods employed to measure turnover of enzymes; significance of enzyme turnover number. Isoenzymes and their physiological significance.

**Suggested Reading:**


- Fundamentals of Enzymology (1999) by Price & Stevens.
- Structure and Mechanism in Protein Science; Guide to Enzyme Catalysis (1999) by A. Fersht. Freeman Press.
- Enzymes; Biochemistry, Biotechnology, Clinical Chemistry (2001) by T. Palmer. Horwood Ltd.
- Molecular Enzymology (1981) by CW Wharton and R Eisenthal. Wiley
- Biochemical Calculations (1976) by I.H. Segal. John Wiley & Sons.
- Understanding Enzymes (1985) by T. Palmer. Ellis Horwood Ltd.

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**Core Course**

# MOLECULAR IMMUNOLOGY-I

**(BCM2004)**

**Credits: 04**
**Total Lectures: 48**

**NOTE:** The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: INNATE AND ACQUIRED IMMUNITY (10 Lectures)

**(a)** Innate immune responses and Toll like receptors.

**(b)** Acquired immunity, antigens, immunogen, antigenic determinats, B and T cell epitope carrier effect.

## UNIT II: ANTIBODY STRUCTURE AND DIVERSITY (14 Lectures)

**a)** Structure and function of antibody. Isotype, allotype and idiotype classification of immunoglobulins; physicochemical properties of immunoglobulins. Idiotypic regulation of immune response.

**b)** Generation of antibody diversity; light and heavy chain recombination; recombination sequences class switch, genes encoding antigen specific receptors on T and B cells.

## UNIT III: CMI RESPONSES (12 Lectures)

**a)** Activation of T and B cells by antigen, antigen presenting cells, representation and processing of antigen pathways of B cell activation; T cell activation. Interleukins and interferons and their role in various immune reactions. T and B cell interactions leading to antibody synthesis.

**b)** Cell mediated immunity; recognition of antigen by T cells, MHC restriction, T cell receptors involved in T cell activation. Cell mediated cytotoxicity; natural killer cells; antibody dependent cell mediated cytotoxicity; macrophages and activated macrophages.

**UNIT IV: IMMUNOTECHNIQUES AND VACCINES (12 Lectures)**

**(a)** Production of polyclonal and monoclonal antibodies, principles, techniques and applications with special reference to hybridoma technology and its applications. Fluorescence activated cell sorter technique (FACS).

**(b)** Vaccines: types, their advantages and disadvantages; new vaccine strategies

**Suggested Reading**:


- The Elements of Immunology (2012) by Fahim H. Khan. Second Imp, Pearson Education Inc.
- Kuby's Immunology (2013) by Goldsby, Kindt and Obsorne. Seventh edition, WH Freeman Press, New York.
- Microbiology (1980) by Davis, Dulbacco, Ginsberg, Wood, Mclanty. Third edition, Harper & Row Publishers.
- Roitt's Esential Immunology (2017) by Delves, Martin, Burton, Roitt. Thirteenth edition, Wiley-Blackwell.

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**AMU, Aligarh**

M.Sc. (Biochemistry) Semester Syllabus
(Effective from 2018-19)
**Passed in BOS held on 07.04.2018**

**M.Sc. (Biochemistry)**
**Semester-II**
**Elective Discipline Centric**

# NEUROBIOCHEMISTRY

**(BCM2005)**

**Credit: 04**
**Total Lectures: 48**

**NOTE:** The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: NEUROMORPHOLOGY AND NEUROCELLULAR ANATOMY (12 Lectures)

Central nervous system-general features of neurons. Structural aspects of neuron dendrites, axons, neurotubules, neurofilaments, synapse neuralgia, astrocytes, oligodendrocytes, epenchymal cells, schwa cells. Peripheral nervous system- muscle, nerve endings, sensory receptors and effectors endings, peripheral nerves, spinal and cranial nerves, plexuses ganglia, afferent pathways and sense organs. Spinal cord- topographical anatomy, spinal nerves, spinal meninges, joint reflexes, gray and white matter of spinal cord.

## UNIT II: NEUROPHYSIOLOGY (12 Lectures)

Neural membrane, excitability, ion channels and transport of ions. Structure- function correlation at the synapse. Transmission across the synapse: membrane potential in the steady state, action potential generation and propagation; presynaptic events at the neuromuscular junction: cholinergic and non-cholinergic synapses; EEG patterns.

## UNIT III: CHEMICAL COMPOSITION OF BRAIN (12 Lectures)

Formation, structure and biochemistry of myelin. Chemistry of major brain lipids, developmental changes, lipid composition, biosynthesis and catabolism of major lipids, characteristics of brain lipids, regional variations. Energy metabolism-normal oxygen consumption by the brain, energy demanding functions, role of cerebral circulation, local cerebral blood flow and metabolism; effects of glucose deprivation, influence of age and development on cerebral energy metabolism. Chemistry, synthesis, storage and release of nervous neurotransmitters, transmitter action, synaptic modulation and mechanism of neural integration.

**UNIT III: BRAIN DISORDERS (12 Lectures)**

Disorders of metabolism of brain: biochemical aspects of muscle diseases, sphingolipidosis and other lipid disorders; diseases involving myelin classification and biochemistry of demyelinating diseases. Biochemical pathology of vitamin and nutritional deficiencies in brain, neurotoxic agents. Neurodegenerative disorders; Parkinson's and Alzheimer's diseases, senile dementia. Biochemical theories of mental disorders.

**Suggested Reading:**


- Basic Neurochemistry: Principles of Molecular, Cellular, and Medical Neurobiology (2011) by Brady, Siegel, Albers, Price (Editors). Eighth edition, Academic Press.
- Elements of Molecular Neurobiology (2002) by CUM Smith. Third edition, Wiley.
- Neuroanatomy: An Illustrated Color Text (2014) by Crossman and Neary. Fifth edition, Churchill Livingstone.

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**Elective Discipline Centric**

# DIAGNOSTIC BIOCHEMISTRY

**(BCM2006)**

**Credits: 04**
**Total Lectures: 48**

**NOTE:** The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: INTRODUCTION TO BIOCHEMICAL DIAGNOSTICS (12 lectures)

Evaluation of biochemical changes in diseases, Basic hepatic, renal and cardiovascular physiology; Biochemical symptoms associated with disease and their evaluation. Diagnostic biochemical profile. Inborn errors of metabolism.

## UNIT II: DIAGNOSTIC ENZYMES (12 lectures)

Principles of diagnostic enzymology; Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase, aldolase, lactate dehydrogenase, enzyme tests in determination of myocardial infarction, enzymes of pancreatic origin and billiary tract.

## UNIT III: IMMUNODIAGNOSTICS (12 lectures)

Introduction, antigen-antibody binding and assays. Immunoassays- types (RIA, ELISA, Chemiluminescent IA, FIA) and specific applications. Immunohistochemistry- principle and techniques. Immunodiagnostics for detection of infectious agents. Cancer; autoimmune diseases; immunosensors.

## UNIT IV: MOLECULAR DIAGNOSTICS (12 lectures)

Introduction to DNA based diagnostic techniques. Polymerase chain reaction in diagnostics and analysis; isothermal nucleic acid amplification. Analysis of DNA in forensic science and archaeology. Applications of DNA finger printing.

**Suggested Reading:**


- Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests. Volumes I and II (2010) by KL Mukherjee and S Ghosh. McGraw–Hill Publishing Company Limited (New Delhi).
- Medical Biochemistry (2018) by JW Baynes and M Dominiczak. Fifth edition, Elsevier Mosby Ltd. (Philadelphia), ISBN:0-7234-3341-0.
- Recombinant DNA by Watson
- Experimental Biochemistry: A Student Companion (2005) by BS Rao and V Deshpande. IK International Pvt. Ltd. (New Delhi).

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**Semester-III**
**Core Course**

# MICROBIOLOGY

**(BCM3001)**

**Credits: 02**
**Total Lectures: 24**

**NOTE:** The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: MICROBIAL TAXONOMY (6 lectures)

Introduction to microbial classification and taxonomy: Polyphasic taxonomy; phenetic, phylogenetic and genotypic classification. Numerical taxonomy, taxonomic ranks. Important criteria used for determining microbial taxonomy and phylogeny, classical and molecular characteristics; Bergey's manual of bacteriology.

## UNIT II: GROWTH AND DIVISION (6 lectures)

Microbial physiology. Growth of microbes; modes of cell division, growth curve, synchronous growth, measurement of growth. Stressors; stress response and survival of bacteria. Bacterial endospores: structure, formation and germination. Bioremediation and phytoremediation.

## UNIT III: VIROLOGY (6 lectures)

Virology**:** Structure, classification and life cycle of some important viruses. Mutation analysis. Bacterial mutation tests: Ames test, fluctuation test.

## UNIT IV: (6 Lectures)

Organisms important to agriculture and human health. Common bacterial and viral pathogens of humans, domestic animals and crops.

**Suggested Reading:**


- Microbiology: Principles and Explorations (2014) by JG Black and LJ Black. Ninth edition. Wiley & Sons, Inc.
- Alcamo's Fundamentals of Microbiology (2013) by JC Pomerville. Tenth edition, Jones and Bartlett.
- Microbiology (2001) by Chan, Pelczar and Krieg. Fifth edition. McGraw Hill India.
- Microbiology: An Introduction (2014) by Tortora, Funke and Case. Twelfth edition. Pearson Education, Inc.
- General and Applied Toxicology (1999) by Ballantyne, Marrs and Turner. Macmillan Press.

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**Core Course**

# BIOENERGETICS

**(BCM3002)**

**Credits: 02**
**Total Lectures: 24**

**NOTE:** The course will be evaluated out of 100 marks and will have the following components of evaluation: Sessional for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: BIOENERGETICS AND LAWS OF THERMODYNAMICS (6 Lectures)

(a) Metabolism: Role of living organism in the cycling of carbon and oxygen, nitrogen cycle. Catabolic pathways and anabolic pathways. Energy relationships between catabolic and anabolic pathways.

(b) Principle of bioenergetics: Bioenergetics and thermodynamics- biological energy transformation obey laws of thermodynamics, first and second laws of thermodynamics; Gibbs free energy, enthalpy, entropy and their relationships;. Free energy change and direct relatationship to equilibrium constant. Generation of concentration gradients and understanding enzymes. Coupling of energetically unfavourable and favourable reactions.

## UNIT II: ATP AS ENERGY SOURCE (6 lectures)

Energy cycle and specialized role of ATP as universal currency in biological system; free energy change for ATP hydrolysis. High phosphoryl potential of ATP- structural basis. Role of ATP in shifting equilibrium of coupled reactions. High energy thioesters and phosphorylated compounds (other than ATP). Group transfer reactions of ATP. ATP driven cellular processes, trans-phosphorylation. Inorganic phosphate as a potential phosphoryl donor.

**UNIT III: BIOLOGICAL OXIDATION REDUCTIONS (6 Lectures)**

Flow of electrons involved in biological work; oxidation- reductions as half reactions; oxidation-reduction involving dehydrogenation; reduction potential; standard reduction potentials and free energy change. Coenzymes and proteins as universal electron carriers; NADH and NADPH with dehydrogenases as soluble electron carriers. Flavin nucleotides with flavorproteins as electron carriers, coenzyme Q as lipid soluble electron carrier.

**UNIT IV:ELECTRON TRANSPORT CHAIN AND OXIDATIVE PHOSPHORYLATION (6 Lectures)**

Mitchell's chemiosmotic theory and its justifications. Electron transport chain; proton motive force. Oxidative phosphorylation and uncouplers of ATP synthesis.

**Suggested Reading:**


- Lehninger: Principles of Biochemistry (2017) by Nelson and Cox. Seventh edition, WH Freeman and Co.
- Biochemistry (2015) by Berg, Tymoczko, Gatto, Stryer. Eighth Edition, WH Freeman and Co.
- Molecular Cell Biology (2016) by Lodish, Berk, Kaiser, Krieger, Bretscher. Eighth Edition, WH Freeman & Co Ltd.

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**Semester-III**
**Core Course**

# MOLECULAR IMMUNOLOGY-II

**(BCM3003)**

**Credits: 04**
**Total Lectures: 48**

**NOTE:** The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: COMPLEMENT AND IMMUNOLOGICAL TOLERANCE (10 Lectures)

Complement proteins. Three pathways for the activation of complement, their biological consequences. Plaque assay.
Immunological tolerance; tolerance vs. activation of immune response, B and T cell tolerance and their general characteristics; mechanism of tolerance induction.

## UNIT II: MHC, TRANSPLANTATION AND TUMOR IMMUNITY (12 Lectures)

**(a)** Structure, function and expression of MHC antigens, polymorphisms of MHC genes and products; linkage disequilibrium; different functions of MHC.

**(b)** Transplantation and tumor immunity, histocompatibility genes, role of T cells, effect of antibodies, graft vs. host disease and mixed lymphocyte reaction. Immune responses directed to tumors; cell mediated response and B cell response to tumors. Tumor specific antigens, escape mechanisms and potential immunotherapy.

## UNIT III: HYPERSENSITIVITY (10 Lectures)

Hypersensitivity. Type I, II, III and IV hypersensitivity; the allergic response and its causes, immunoglobulin E, mast cells reactions of delayed hypersensitivity. Techniques related to hypersensitivity; leukocyte migration inhibition technique, cytotoxicity assay, cytokine assay, ELISA and ELISPOT. ABO system and other red cell antigens.

**UNIT IV: IMMUNODEFICIENCY AND IMMUNE RESPONSE TO INFECTIOUS AGENTS (16 Lectures)**

**(a)** Pathogenesis of immunodeficiency. Etiology of AIDS and other immuno deficiency disorders

**(b)** Immune response to viruses, bacteria, helminths. Evasion of host defences by these pathogens.

**Suggested Reading**:


- The Elements of Immunology (2012) by Fahim H. Khan. Second Imp, Pearson Education Inc.
- Kuby's Immunology (2013) by Richard Goldsby, Thomas Kindt and Barbera Obsorne. Seventh edition, Freeman Press, New York.
- Microbiology (1980) by Davis, Dulbacco, Eisen, Ginsberg. Third edition, Harper & Row Publishers.
- Roitt's Esential Immunology (2015) by Delves, Martin, Burton, Roitt. Thirteenth edition, Wiley Blackwell.

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**Semester-III**
**Core Course**

# PROTEINS AND PROTEOMICS

**(BCM3004)**

**Credits: 04**
**Total Lectures: 48**

**NOTE:** The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: GENERAL PROPERTIES OF PROTEINS AND AMINO ACIDS

**(12 Lectures)**

General properties of amino acids, peptide bonds, biologically active peptides. Primary structure of proteins and its significance. Strategies of sequence determination – amino acid composition, determination of N- and C- terminal residues; chemical and enzymatic degradation of polypeptides, automated sequenators. Chemical synthesis of peptides (Merrifield method). Peptide mapping, disulphide bonds in proteins and their significance. Chemical cross-linking of proteins. Selenocysteine.

## UNIT II: PROTEIN STRUCTURE (12 Lectures)

Dihydryl angles and Ramachandran plot. Secondary structure of proteins: alpha helix, beta structure, beta turn. Alpha keratin and collagen helix, dinucleotide fold. Tertiary and quaternary structure of proteins; forces stabilizing the structure of proteins. Denaturation and renaturation of proteins. Multimer, oligomer, protomer, molten globules. Prediction of 2° and 3° structure from knowledge of primary structure; Techniques used in determining protein structure - CD, NMR and X-ray. Hydrophobicity plots; Stokes radius, diffusion coefficient and intrinsic viscosity of proteins.

## UNIT III: PROTEIN DOMAINS AND FOLDING (12 Lectures)

Protein domains and motifs; motifs found in DNA binding proteins, Ca++ binding proteins; helix loop helix, hairpin β-motif and β-α-β motifs. Structure and function of the oxygen binding proteins: hemoglobin and myoglobin. Spontaneous and assisted protein folding, role of chaperones and chaperonins in folding; protein disulphide isomerase and protein prolyl isomerase, prions. Diseases caused by protein misfolding.

**UNIT IV: PROTEOMICS** **(12 Lectures)**

Brief introduction to proteome and proteomics; protein identification and analysis. Protein expression mapping. Protein-protein interaction mapping: experimental and computational; yeast two hybrid system. Protein arrays and protein chips.

**Suggested Reading:**


- Lehninger: Principles of Biochemistry (2017) by Nelson and Cox. Seventh edition, WH Freeman and Co.
- Biochemistry (2015) by Berg, Tymoczko, Gatto, Stryer. Eighth Edition, WH Freeman and Co.
- Biochemistry (1998) by GL Zubay. Fourth edition, WC Brown Publishers, USA.
- Proteomics (2002) by Palzkill. Kluwer Academic Publishers.
- Protein sequencing – A practical approach (1989) by Findlay and Geisow, Editors. IRL Press.

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**M.Sc. (Biochemistry)**
**Semester-III**
**Core Course**

# MOLECULAR GENETICS

**(BCM3005)**

**Credits: 04**
**Total Lectures: 48**

**NOTE:** The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: CHROMOSOME MAPPING AND EVOLUTION (12 Lectures)

Chromosome mapping – Somatic cell hybrids and gene mapping. Structural genomics vs functional genomics. Human genome project. **(5 Lectures)**

Molecular biology of evolution with special reference to proteins and nucleic acids. Population genetics and evolution. Extra nuclear inheritance; random mating, Hardy-Weinberg principle and its implications. **(7 Lectures)**

## UNIT II: CLASSICAL, BIOCHEMICAL AND DEVELOPMENTAL GENETICS (12 Lectures)

Developmental genetics- genes that control development in higher eukaryotes with special reference to Drosophila. Models of differentiation; genetic determinants of development. **(6 Lectures)**

Mendelian genetics – Laws of inheritance, deviation from Mendelian inheritance. Laws of probability and binomial expansion. Crossover mapping of genes with special reference to sex linked and autosomal characters in *Drosophila melanogaster*; construction of crossover maps. **(6 Lectures)**

**UNIT III: BACTERIAL GENETICS** **(12 Lectures)**

(a) Bacterial variation and population dynamics – Genotypic and phenotypic variation. Extragenic inheritance; selection pressures and genetic adaptation. Detection, selection and isolation of mutants. Delayed expression of mutation and determination of mutation rates.

**(6 Lectures)**

(b) Mechanism of gene transfer in bacteria – Transformation, transduction and conjugation-their use in gene mapping. Holliday's model of recombination. **(6 Lectures)**

**UNIT IV: VIRAL AND YEAST GENETICS** **(12 Lectures)**

Viral and phage genetics – Mutation and recombination in viruses with special reference to bacteriophages. Fine structure mapping of rII system of T4 phage with special reference to Benzer's experiment. **(6 Lectures)**

Yeast genetics – Basic features of *S. cerevisiae* and *N. crassa* genetics. Mating type switching; sexual and asexual cycles. Regulation of gene expression in yeast (cassette model).

**(6 Lectures)**

**Suggested Reading:**


- Fundamentals of Biochemistry: Life at the Molecular Level (2016) by Voet, Voet and Pratt. Fifth edition, John Wiley & Sons, N.Y.
- Molecular Biology of the Gene (2017) by Watson, Hopkin, Roberts, Stertz, Weiner, Freeman Pub., San Francisco.
- Lewin's Genes XII (2017) by Krebs, Goldstein, Kilpatric. Oxford University Press, London.
- General Genetics by S. Owen and Edger.
- Fundamentals of Genetics by Gardner and Snustad.
- Principles of Genetics (2006) by Gardner, Simmons and Snustad. Eighth edition, John Wiley & Sons, New York, USA.

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**Semester-III**
**Open Elective**

# FUNDAMENTALS OF BIOCHEMISTRY

**(BCM-3091)**

**Credits: 04**
**Total Lectures: 48**

## UNIT I: PROTEINS AND PROTEOMICS (12 Lectures)

General properties of amino acids, peptide bonds, primary, secondary, tertiary and quaternary structure of proteins; classification of proteins and peptides. Forces stabilizing the structure of proteins. Denaturation and renaturation of proteins.

## UNIT II: ENZYMES (12 Lectures)

Introduction to enzymes and biocatalysis, definition of IU, enzyme turnover number and specific activity. Enzyme kinetics and factors affecting the rates of enzyme catalyzed reactions. General mechanisms of enzyme regulation and control of enzymatic activity. Multifunctional enzymes. Use of enzymes in industry.

## UNIT III: GENOMICS (12 Lectures)

Introductions to genomics: Human Genome Project (HGP), genome mapping, nucleic acid sequencing. DNA based diagnostic techniques; polymerase chain reaction (PCR) and its application in diagnostics and analysis, forensic science, wildlife and archaeology.

## UNIT IV: RECOMBINANT DNA TECHNOLOGY (12 Lectures)

Introduction to basics of recombinant DNA (rDNA) technology, techniques used in rDNA technology; enzymes and cloning vectors used in rDNA technology; preparation of gene libraries; nucleic acid probes. Gene therapy: strategies of gene delivery. Transgenic organisms and their applications, regulation of GM organisms.

**Suggested Reading:**


- Lehninger: Principles of Biochemistry (2017) by Nelson and Cox. Seventh edition, WH Freeman and Co.
- Biochemistry (2015) by Berg, Tymoczko, Gatto, Stryer. Eighth Edition, WH Freeman and Co.
- Biochemistry (1998) by GL Zubay. Fourth edition. W.C. Brown Publishers, USA.
- Lewin's Genes XII (2017) by Krebs, Goldstein and Kilpatric. Oxford University Press, London.
- Proteomics (2002) by Palzkill. Kluwer Academic Publishers.
- Molecular cloning: A Laboratory Manual (volumes I, II, III) (2012) by Green and Sambrook. Fourth edition, Cold Spring Harbor Laboratory Pub.
- Fundamentals of Enzymology (1999) by Price and Stevens.
- Structure and Mechanism in Protein Science; Guide to Enzyme Catalysis (1999) by A. Fersht. Freeman Press.
- Enzymes; Biochemistry, Biotechnology, Clinical Chemistry (2007) by T Palmer and PL Bonner. Second edition, Woodhead Publishing.

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**M.Sc. (Biochemistry)**
**Semester-IV**
**Ability Enhancement Discipline Centric**

# BIOINFORMATICS AND BIOTECHNIQUES

**(BCM4001)**

**Credits: 04**
**Total Lectures: 48**

**NOTE:** The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: BIOTECHNIQUES (12 Lectures)

Statistical methods of measures of central tendency (mean, median and mode). Concept of concentration, molarity and unit conversion.
Isolation and purification of genomic DNA, plasmid DNA, RNA and protein. Qualitative and quantitative analysis of purified DNA and RNA. Analysis of DNA, RNA and proteins by one and two dimensional gel electrophoresis.

## UNIT II: BIOMOLECULAR INTERACTION ANALYSIS (12 Lectures)

Principle, instrumentation and applications of colorimetry, UV-visible spectroscopy. Types of interactions. Interaction studies of small molecules with macromolecules including DNA and protein using spectrophotometer, spectrofluorometer (assays including thermal denaturation, KI quenching, effect of denaturing agents, effect of ionic strength, competitive displacement, viscosity measurements and footprinting), CD spectroscopy.

## UNIT III: BASIC TOOLS OF BIOINFORMATICS (12 Lectures)

Different data bases including gene bank. Searching literature on pubmed. Sequence retrieval systems. Sequence related information eg. genomic, EST, sequence formatting. Similarity search by BLAST. Multiple sequence alignment tools (e.g. CLUSTALW). Restriction enzyme mapping. Degenerate and gene specific primer designing for PCR.

**UNIT IV: NUCLEIC ACID AND PROTEIN SEQUENCE ANALYSIS (12 Lectures)**

Detecting functional sites in DNA: promoters, exons, poly A sites. Introducing gene finders. Identification of open reading frames (ORF). Internet tools for DNA sequence translation. Protease digestion mapping. Prediction of signal peptide, MW, isoelecteic point (pI), secondary structure, tertiary structure, transmembrane domains and post-translational modifications (including phosphorylation, glycosylation, myristoylation, acetylation, signal peptide cleavage site).

**Suggested Reading:**


- Molecular Biology of the Gene (2017) by Watson, Hopkin, Roberts, Stertz, Weiner, Freeman Pub., San Francisco.
- Lewin's Genes XII (2017) by Krebs, Goldstein and Kilpatric. Oxford University Press, London.
- Introduction to Bioinformatics (2002) by Krawetz and Womble. Humana Press, New Jersey, USA.
- Instant Notes: Bioinformatics (2003) by Westhead, Parish and Twyman. BIOS Scientific Publishers, Oxford.

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**Semester-IV**
**Ability Enhancement Discipline Centric**

# PLANT BIOCHEMISTRY

**(BCM4002)**

**Credits: 02**
**Total Lectures: 24**

**NOTE**: The course will be evaluated out of 100 marks and will have the following components of evaluation: sessionals for 10 marks, mid-semester examination of one hour duration for 30 marks, end-semester examination of two hours for 60 marks.

## UNIT I: PLANT CELL WALL AND CELL MEMBRANE (5 Lectures)

Structure and function of plant cell including cell wall, plasmodesmata, meristematic cells, vacuoles, secretary systems, chloroplast and mitochondria.

## UNIT II: PHOTOSYNTHESIS (7 Lectures)

Light harvesting complexes, dark reactions of photosynthesis. Regulation of photosynthesis in higher plants, phytorespiration. C3, C4 and CAM metabolism. Origin of chloroplast (endosymbiont hypothesis).

## UNIT III: NITROGEN FIXATION AND SECONDARY PLANT METABOLISM (5 Lectures)

Biological nitrogen fixation and ammonia assimilation. Nitrate and sulphate reduction and their incorporation into amino acids. Translocation of inorganic and organic substances.

## UNIT IV: PLANT HORMONES AND DEVELOPMENT (7 Lectures)

Plant hormones - growth regulating substances and their mode of action. Molecular effects of auxins in regulation of cell extension and of gibberlic, abscisic acids and cytokinins in the regulation of seed dormancy, germination, growth and development and embryogenesis. Response of plants to biotic (pathogens and insects) and abiotic (water, temperature and salt) stress. Transgenic plants.

**Suggested Reading:**


- Introduction to Plant Biochemistry (1990) by TW Goodwin and EI Mercer. Second edition, Pergaman Press.
- Plant Biochemistry (1997) by PM Dey and JB Harborne. First edition, Academic Press.
- Handbook of Photosynthesis (ed) Mohammad Pe Sarakle, Marcel Dekkar.