# DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD.

## Curriculum under Choice Based Credit &

## Grading System

## M.Sc. I & II Year

## Bio-Chemistry

## Semester–I to IV

## run at college level from the

## Academic Year 2015-16 & onwards

# DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY

# AURANGABAD

SYLLABUS

M. Sc. [BIO-CHEMISTRY]

SEMESTER PATTERN
CREDIT BASED GRADE SYSTEM

[Effective from July, 2011 onwards]

# Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

**Syllabus**

**M.Sc. Biochemistry Program**

The student joining M. Sc. Biochemistry should have studied the following subjects at B.Sc. level

1. Biochemistry
2. Chemistry
3. Biology
   Botany / Zoology / Microbiology with background in basic genetics

Students with non-biochemistry background at B.Sc. level should have studied Chemistry as one of the subject.

The optional courses to be offered will be decided by the department depending upon the faculty / expertise available.

**M. Sc. Biochemistry Program**

**Program Structure**

| Semester I | | | |
|---|---|---|---|
| | | | |
| **Course Code** | **Course Name** | **Max. marks** | **Credits** |
| 1001C* | Biomolecules | 100 | 4 |
| 1002C | Molecular Biology | 100 | 4 |
| 1003C | Cell Biology & Physiology | 100 | 4 |
| 1004C | Bioenergetics & Metabolism | 100 | 4 |
| 1005C | Laboratory Course I | 100 | 8 |
| | | | |
| **Semester II** | | | |
| | | | |
| 2001C | Bioanalytical Chemistry | 100 | 4 |
| 2002C | Plant Biochemistry | 100 | 4 |
| 2003C | Enzymology | 100 | 4 |
| 2004C | Advanced Molecular Biology | 100 | 4 |
| 2005C | Laboratory Course II | 100 | 8 |
| | | | |
| **Semester III** | | | |
| | | | |
| 3001C | Biostatistics, Computers and Bioinformatics | 100 | 4 |
| 3002C | Methods in Molecular Biology | 100 | 4 |
| 3003C | Immunochemistry | 100 | 4 |
| | *Any **one** of the following* | | |
| 30041S** | Biomembranes and Cytoskeleton | 100 | 4 |
| 30042S | Muscle Biochemistry and Biomembranes | 100 | 4 |
| 30043S | Plant Biotechnology | 100 | 4 |
| 3005C | Laboratory Course III | 100 | 8 |
| | | | |
| **Semester IV** | | | |
| | | | |
| 4001C | Nutritional Biochemistry | 100 | 4 |
| 4002C | Clinical Biochemistry | 100 | 4 |
| | *Any **two** of the following, one from each extended code* | | |
| 40031S | Biochemical & Environmental Toxicology | 100 | 4 |
| 40032S | Medical and Environmental Biochemistry | 100 | 4 |
| 40033S | Neurobiochemistry | 100 | 4 |
| 40041S | Microbial Biochemistry | 100 | 4 |
| 40042S | Genetics for Biologists | 100 | 4 |
| 40043S | Frontier Technologies in Biosciences | 100 | 4 |
| 4005 | Project/thesis And Seminar | 100 | 8 |

**Core Courses* *** Specialization / Supplementary / Service courses*

**Note:**

1. A student is expected to complete four theory courses and a practical course each semester.
2. Specialization will be provided depending upon availability of expert faculty.
3. Project assignment will begin in semester III and will be continued and completed in semester IV.
4. Seminar will begin from II Semester and continued till the IV semester of the program
5. Additional or alternative practicals may be suggested during all laboratory courses.
6. Additional or alternative text books and reading material may be suggested by teachers.

**M. Sc. Biochemistry Program Contents**

**SEMESTER I**

**Course Code: 1001C**
**Course Name: Biomolecules** Total Credits: 4

Unit I Credit: 1

**Carbohydrates and their derivatives**
Monosaccharides and related compounds, glycosidic bond, disaccharides, polysaccharides, heteropolysaccharides.

**Lipids**
Fatty acids, Phospholipids, Cholesterol and related steroids, other biological lipids. Glycerolipids, sphingolipids, the eicosanoids.

Unit II Credit: 1

**Nucleotides and nucleic acids**
Genetic significance of nucleic acids, structural properties of DNA, chemical synthesis of DNA, conformational behavior of RNA, nucleoproteins.

**Analysis of nucleic acids**
Isolation of nucleic acids, radioactive labeling of nucleic acids, restriction endonucleases, plasmids, purification of complementary DNA strands, hybridization by blotting, determining base sequence of DNA, preparation of DNA complementary to RNA.

Unit III Credit: 1

**Amino acids, peptides and polypeptides**
Amino acids, peptides and polypeptides, determination of amino acid composition of proteins, determination of amino acid sequence of proteins, chemical synthesis of peptides and polypeptides.

Unit IV Credit: 1

**3-D structure of proteins**
Information for folding, forces that determine folding, hierarchy of structural organization, functional diversification of proteins.

**Characterization and purification of proteins**
Methods of protein characterization, methods of protein purification.
Centrifugation, Dialysis, Lyophilization, Ultrafilteration, Chromatography, Electrophoresis,

**Course Code: 1002C**
**Course Name: Molecular Biology** Total Credits: 4

Unit I Credit: 1

**Nucleotides and nucleic acids**
Genetic significance of nucleic acids, structural properties of DNA, chemical synthesis of DNA, conformational behavior of RNA, nucleoproteins.
**DNA replication**
Semiconservative replication of DNA, DNA synthesis in prokaryotes, replication of a viral chromosome, replication of the E. coli chromosome, DNA synthesis and chromosomal replication in eukaryotes, control of DNA replication, specific inhibitors of DNA replication, DNA degradation, DNA repair, DNA recombination.

Unit II Credit: 1

**RNA synthesis**
Different classes of RNA, DNA dependent synthesis of RNA, eukaryotic transcription, other RNA synthesis, posttranscriptional modification and processing of RNA, Degradation of RNA by ribonucleases, inhibitors of RNA metabolism.

Unit III Credit: 1

**Protein synthesis**
The cellular machinery of protein synthesis, steps in translation, deciphering the genetic code, code word assignments, inhibitors of protein synthesis, posttranslational modifications of proteins, intracellular protein degradation, lysosomes and protein degradation.

Unit IV Credit: 1

**Regulation of gene expression in prokaryotes**
Regulation of gene expression in *E. coli*, regulation of gene expression in bacterial viruses.
**Regulation of gene expression in eukaryotes**
Gene regulation in unicellular eukaryotes, gene regulation in multicellular eukaryotes, regulatory phenomena associated with development.

**Course Code: 1003C**
**Course Name: Cell Biology, Physiology** Total Credits: 4

**Cell Biology**

Unit I Credit: 1

Cell classification: Cell variability (size, shape, complexity, functions).
Structural Organisation of prokaryotic and eukaryotic cells. The ultra structure of nucleus, mitochondria, endoplasmic reticulum, rough and smooth, Golgi apparatus, lysosomes and peroxisomes and their functions. Plant and animal cells: variation in structure and function.
The cytoskelton - microtubules and microfilaments.
Types of tissues, epithelium - types, epithelial apices - glycocalyx, microvilli. The basement membrane - structural features and characteristics. The extracellular matrix-collagen, elastin, fibrillin, fibronectin, laminin and protroglycans.

Unit II Credit: 1

Culture techniques to study cell division - cell division by mitosis and meiosis. Cell cycle.
Cell differentiation - organogenesis, morphological, functional and biochemical maturation of tissues.
Biochemistry of cancer - carcinogenesis, characteristics of cancer cell, agents promoting carcinogenesis.

**Physiology**

Unit III Credit: 1

Blood:Composition and functions of plasma, erythrocytes including Hb, leukocytes and thrombocytes plasma proteins in health and diseases.
Blood coagulation - mechanism and regulation. Fibrinolysis, transfers of blood gases oxygen and carbon dioxide. Role of 2,3 DPG, Bohr effect and chloride shift.
Hydrogen ion homeostasis- Factors regulating blood pH - buffers, respiratory and renal regulation. Acid-base balance - metabolic and respiratory acidosis and alkalosis.

Unit IV Credit: 1

**Digestive system:** Composition, functions and regulation of saliva, Gastric, pancreatic, intestinal and bile secretions - digestion and absorption of carbohydrates, lipids, proteins, nucleic acids, minerals and vitamins.

**Excretory system:** Structure of nephron, formation of urine, glomerular filtration, tubular re-absorption of glucose, water and electrolytes - tubular secretion.

Regulation of water and electrolyte balance, role of kidneys and hormones in their maintenance.

**The endocrine glands:** secretion and function - reproduction, pregnancy and lactation.

Biochemistry of vision.

**Course Code: 1004C**

**Course Name: Bioenergetics and Metabolism** Total Credits: 4

Unit I Credits: 1.5

**Bioenergetics:**

Energy transformation, Laws of thermodynamics, Biological oxidations, oxygenases, hydroxylases, dehydrogenases and energy transducing membranes. Gibbs energy, free energy changes and redox potentials, phosphate potential, ion electrochemical potentials, proton electrochemical potential, membrane potentials, photons energy interconversions. Chemo-taxis and chemoreceptors chemo-osmotic theory, ion transport across energy transducing membranes. Influx and efflux mechanisms. Proton circuit and electrochemical gradient, the transport and distribution of actions, anions and ionophores. Uniport, antiport and symport mechanisms, shuffle systems.

The mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterization. The Q cycle and the stoichiometry of proton extrusion and uptake; P/0 and H/P ratios. Reversed electron transfer, respiratory controls and oxidative phosphorylation, uncouplers and inhibitors of energy transfer. Fractionation and reconstitution of respiratory chain complexes.

ATP - synthetase complex. Microsomal electron transport, partial reduction of oxygen, superoxides.

Intermediary metabolism: Approaches for studying metabolism.

Unit II Credit: 0.75

**Carbohydrates:**

Glycolysis, citric acid cycle its function in energy generation and biosynthesis of energy rich bonds, pentose phosphate pathway and its regulation. Alternate pathways of carbohydrate metabolism.

Gluconeogensis, interconversions of sugars.

Biosynthesis of glycogen, starch and oligosaccharides. Regulation of blood glucose homeostasis. Hormonal regulation of carbohydrate metabolism.

Unit III Credit: 0.75

**Lipids**

Fatty acid biosynthesis: Acetyl CoA carboxylase, Fatty acid synthase, desaturase and elongase. Fatty acid oxidation: (x, 0, w oxidation and lipoxidation. Lipid Biosynthesis: Biosynthesis of triacyglycerols, phosphoglycerides and sphingolipids, Biosynthetic pathways for terpenes, steroids and Prostaglandins. Ketone bodies: Formation and utilisation. Metabolism of Circulating lipids: chyiomicrons, LDL, HDL and VLDL. Free fatty acids. Lipid levels in pathological conditions.

Unit IV Credit: 1.0

**Amino Acids**
Biosynthesis and degradation of amino acids and their regulation. Specific aspects of amino acid metabolism. Urea cycle and its regulation, In-born errors of amino acid metabolism.

**Nucleic Acids**
Biosynthesis or purines and pyrimidines, Degradation if purines and pyrimidines
Regulation of purine and pyrimidine biosynthesis, Structure and regulation of ribonucleotide reductase.
Biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides
Inhibitors of nucleic acid biosynthesis

**Course Code: 1005C**
**Course Name: Laboratory Course I** Total Credits: 8

Chemical tests for bioconstituents.
Assay of enzymes like salivary amylases and alkaline phosphatases.
Biochemical estimation like cholesterol, sugars, free fatty acids, iodine value and sponification value in oils, Vitamin C in fruit juices,
Preparation of casein from milk and tests for proteins and amino acids.
Microscopic examination and chemical analyses of blood.
Electrophoretic separation of serum proteins.
Disc gel electrophoretic separation of isoenzymes.
Microscopic examination and chemical analyses of urine and stools.
Histobiology of blood, urine and stools.
Radio-immunoassay of hormones.
Bacterial and chemical analysis of domestic and industrial effluents.

**SEMESTER II**

**Course Code: 2001C**
**Course Name: Bioanalytical Chemistry** Total Credits: 4

Unit I Credit: 1

**Isomerism:** Structural isomerism, Stereoisomerism, geometrical isomerism (E & Z nomenclature)
**Free radicals** in **biological systems:** Oxygen as a free radical in the autooxidation of fats. Antioxidants (Free radical inhibitors in the cell such as vitamin A, vitamin E, vitamin C, Se etc.)
**Stereochemistry:** Optical isomerism, optical activity, meso-compounds, specific rotation, chirality, chiral center, enantiomers, diastereoisomers, D L, R S, threo erythro notations, conformation and configuration, dihedral angles, conformational analysis of ethane, n-butane, cyclohexane, monoand di-substituted cyclohexane, monosaccharides, boat and chair forms, eclipsed, gauche and staggered conformations, axial and equatorial bonds. Anomers and mutarotation, glycoside, epimers, glucopyranose, fructopyranose, periodic acid oxidation of sugars.

Unit II Credit: 1

**Water:** Physical properties and structure of water, hydrogen bonding, ionization of water, pH scale, acids-bases, Handerson-Hasselbalch equation, buffers, ionization behaviour of amino acids and proteins, titration curve, buffer solutions and their action.
**Radioisotope techniques:** Nature of radioactivity, properties of ($\alpha$, $\beta$ and $\lambda$-rays, measurement of radioactivity, use of radioisotopes in research. *In vivo and in vitro* labelling techniques, double labelling, quenching, internal standard, channel ratio, external standard ratio, emulsion counting, radioactive decay, autoradiography.

Unit III Credit: 1

**Viscosity:** Its measurement, viscosity of macromolecules, molecular weights of biomolecules. Sedimentation of macromolecules, centrifugation techniques and their applications, differential centrifugation, density gradient 'and ultracentrifugation techniques. Subcellular fractionation.
**Electrophoretic techniques:** Moving boundary and zonal electrophoresis, paper and gel electrophoresis, isoelectric focusing.

Unit IV Credit: 1

**Chromatography:** Paper, TLC, Adsorption, partition, ion-exchange, reverse phase, gel filtration, affinity, gas chromatography, HPLC (High Pressure Liquid Chromatography).
**Spectroscopy:** Basic concepts and applications of X-ray diffraction, NMR, ESR, UV, IR, fluorescence, Raman, mass spectroscopy in structure determination of organic and biomolecules, CD and ORD.
**Microscopy:** Light, electron (scanning and transmission), phase contrast, fluorescence microscopy, freeze-fracture techniques, specific staining of organelles or marker enzymes.

**Course Code: 2002C**
**Course Name: Plant Biochemistry** Total Credits: 4

Unit I Credit: 1

Structure and functions of plant cell (including cell wall, plasmodesmata, meristematic cells, vacuoles, secretary systems and root quiescent zone), Isolation of cell organelles, absorption, adsorption and transport of water and ions in plants. Evapotranspiration.

Unit II Credit: 1

Photosynthesis - structure of organelles involved in photosynthesis in plants and bacteria. Proton gradients and electron transfer in chloroplasts of plants and in purple bacteria - differences from mitochondria. Light receptors - chlorophyll, light harvesting complexes, bacteriorhodopsin, rhodopsin as ion pump.
Photosystems I and II, their location, mechanism of quantum capture and energy transfer between photosystems - ferridoxin, plastocyanin, plastoquinone, carotenoids.

Unit III Credit: 1

The Hill reaction, photophosphorylation and reduction of CO2.
$C_3$ $C^4$ and CAM metabolism, light and dark reactions. Light activation of enzymes, regulation of photosynthesis. Photorespiration.

Biological nitrogen fixation and ammonia assimilation.
Nitrate and sulphate reduction and their incorporation into amino acids.

Translocation of inorganic and organic substances.

Unit IV Credit: 1

Special features of secondary plant metabolism, formation of phenolic acids, tannins, lignins, lignans, pigments, terpenes, terpenoids, plant phenolics, alkaloids and surface waxes - their biosynthesis and functions, cell wall components.

Plant hormones - Growth regulating substances and their mode of action. Molecular effects of auxin in regulation of cell extension and of gibberellic, abscisic acids and cytokinins in the regulation of seed dormancy, germination, growth and development, and embryogenesis.

Biochemistry of seed development and fruit ripening.

Defence system in plants.

Tissue culture and transgeneic plants.

**Course Code: 2003C**
**Course Name: Enzymology** Total Credits: 4

Unit I Credit: 1

Review of unisubstrate enzyme kinetics and factors affecting the rates of enzyme catalyzed reactions. Michaelis pH functions and their significance.
Classification of multisubstrate reactions with examples of each class. Kinetics of multisubstrate reactions. Derivation of the rate of expression for Ping Pong and ordered Bi Bi reaction mechanism. Use of initial velocity, inhibition and exchange studies to differentiate between multisubstrate reaction mechanisms.
Concept of Convergent and Divergent evolution of enzymes.

Unit II Credit: 1

Methods of examining enzyme-substrate complexes.
Flexibility and conformational mobility of enzymes.
Methods for measuring kinetic and rate constants of enzymic reactions and their magnitudes.

Enzymes Turnover and methods employed to measure Turnover of enzymes. Significance of enzymes Turnover.

Unit III Credit: 1

☐ Protein - Ligand binding, including measurement, analysis of binding isotherms. Cooperativity phenomenon. Hill and Scatchard Plots.
☐ Allosteric enzymes, Sigmoidal kinetics and their physiological significance. Symmetric and sequential modes for action of allosteric enzymes and their significance.
☐ Immobilized enzymes and their industrial applications. Effect of partition on kinetics and performance with particular emphasis on changes in pH and hydrophobicity.

Unit IV Credit: 1

Multienzyme system : Occurrence, isolation and their properties. Polygenic nature of multienzyme systems. Mechanism of action and regulation of pyruvate dehydrogenase and fatty acid synthetase complexes. Immobilized Multienzyme Systems and their applications.

**Structure and function of coenzymes**

Thiamine pyrophosphate, Pyridoxal phosphate, Nicotinamide, flavins, phosphopentetheine, alfa-lipoic acid, biotin, folate, vitamin B12, Iron containing coenzymes, coenzymes in methanogenesis.

**Porphyrines**

Porphyrin nucleus and classification, important metalloporphyrins occuring in nature, detection of porphyrins Spectrophotometry, bile pigments, chemical and physiological significance by and fluoroscence.

**Mechanisms of enzyme catalysis**

Enzyme catalyst and other chemical catalyst, unique features of enzyme catalysts, trypsin family of enzymes, chymotrypsin catalytic mechanism, carboxipeptidase A, pancreatic RNAase A, lysozyme, lactate dehydrogenase.

**Course Code: 2004C**
**Course Name: Advanced Molecular Biology** Total Credits: 4

Unit I Credit: 1

**Recombinant DNA Technology**

Methods of creating recombinant DNA molecule, splicing, properties of restriction endonucleases and their mode of action, selection/screening, construction of DNA library, genomic Vs cDNA library, chemical synthesis of gene, cloning vectors (X-phage, plasmid, M-13 phage, cosmid) shuttle vectors, yeast and viral vectors, expression vectors, uses of cloned gene, subcloning, sequencing by Sanger's method, proteins production in bacteria, site directed mutagenesis, RFLP, PCR, DNA finger printing, antisense-RNA technology, chromosomal walking.

Unit II Credit: 1

**Hybridoma Technology**

Monoclonal antibodies, mycelium cell fusion, selection of hybrids, hybridomas, protoplast fusion and HAT-medium, screening assays, purification and application of monoclonal antibodies.

Unit III Credit: 1

**Plant and Animal Cell Culture**

Micropropagation, somatic cell culture, somaclonal variations, somatic cell hybridization, protoplast isolation, protoplast fusion, protoplast culture, genetic transformation, various methods of gene transfer (all vector and vectorless methods), production of transgenic plants and animals, production of secondary metabolites, primary and transferred cell culture, differentiated cells in culture, applications.

Unit IV Credit: 1

**Fermentation Technology**

Primary and secondary metabolites in biotechnology, continuous and batch type culture techniques, principle types of fermentors, general design of fermentor, fermentation processes-brewing, manufacture of penicillin, production of single cell proteins, production strategies for other antibiotics and other organic compounds.

**Course Code: 2005C**
**Course Name: Laboratory Course II** Total Credits: 8

Subcellular fractionation of organelles from liver cells and identification by the use of marker enzymes.
Purification of an enzyme using ion-exchange columns, gel filtration, affinity chromatography.
Molecular weight determination and kinetic studies on purified enzymes.
Writing a BASIC computer program to plot graphs of enzyme kinetic data by a variety of linear transforms and the Michaelis-Menten hyperbolic plot.
Protein synthesis in a cell free protein synthesizing system from rat liver or wheat germ.
Extraction of lipids from tissues, separation and estimation using thin layer chromatography.
Separation of phospholipid species in HPLC and estimation of their fatty acid composition by GLC.

**SEMESTER III**

**Course Code: 3001C**
**Course Name: Biostatistics, Computers and Bioinformatics** Total Credits: 4

Unit I Credit: 1

Population, Sample, variable, parameter, primary and secondary data, screening and representation of data. Frequency distribution, tabulation, bar diagram, histograms, pie diagram, cumulative frequency curves. Mean median, mode, quartiles and percentiles, measures of dispersion: range, variance, standard deviation, coefficient of variation, symmetry: measures of skewness and kurtosis
Sample space, events, equally likely events. Definition of probability (frequency approach), independent events. Addition and multiplication rules, conditional probability, Examples Bernoulli, Binomial, Poisson and Normal distributions. Mean and variance of these distributions (without proof). Sketching of p.m.f. and p.d.f, Use of these distributions to describe in biological models. Model sampling and Simulation study.

Unit II Credit: 1

Scatter plot, correlation coefficient (r), properties (without proof), Interpretation of r, linear regression. Fitting of lines of regression, regression coefficient, coefficient of determination. Use of random numbers to generate simple random samples with replacement and without replacement. Sampling distribution and standard deviation of sample mean. Stratified sampling and its advantages.
Hypothesis, critical region, and error probabilities. Tests for proportion, equality of proportions, equality of means of normal populations when variance known and when variances are unknown. Chi-square test for independence. P-value of the statistic. Confidence limits, Introduction to one way and two-way analysis of variance.

Unit III Credit: 1

History of development of computers, Basic components of computers, Hardware; CPU,input, output, storage devices. Software; operating systems, Programming languages (Machine, Assembly and Higher level)
Introduction to MSEXCEL-Use of worksheet to enter data, edit data, copy data, move data. Use of in-built statistical functions for computations of Mean, S.D., Correlation, regression coefficients etc. Use of bar diagram, histogram, scatter plots, etc. graphical tools in EXCEL for presentation of data. Introduction to MSWORD word processor editing, copying, moving, formatting, Table insertion, drawing flow charts etc.

Unit IV Credit: 1

Introduction to Internet and use of the same for communication, searching of database, literature, references etc. Introduction to Bioinformatics, Databank search- Data mining, Data management and interpretation, BLAST, Multiple sequence alignment, Protein Modeling, Protein structure Analysis, Docking, Ligplot interactions, Genes, Primer designing, Phylogenetic Analysis, Genomics and Proteomics.

**Course Code: 3002C**
**Course Name: Methods In Molecular Biology** Total Credits: 4

Unit I Credit: 1

**Physical properties of RNA:** Classes of RNA, rRNA, tRNA, mRNA, HnRNA etc. Structure and methods of isolation and fractionation, gel electrophoresis and DNases, RNases, Phosphodiesterases.
**Satellite DNA:** C-value paradox, possible functions o satellite DNA, Mechanical strength, gene library, supppressor mutation, centromeric DNA, split genes.
**Chromatin:** Histone and non-histone proteins, general properties of histones, packing density. Nucleosomes, size variable linker, role of H 1. Selenoid structure. Transcriptionally active chromatin.

Unit II Credit: 1

**Classes of DNA sequences:** Zero-order bending, highly repetitive, unique. Methods of distinguishing double and single stranded DNA.
**Re-association kinetics:** Cot values, experimental procedure, qualitative significance, use of Ag* cesium sulphate.
**Rapid DNA sequencing techniques** and strategies details of a range of methodologies, e.g. plus and minus, dideoxynecleotide, partial ribosubstitution, Maxam and Gilbert. Use of thin gels, resolution etc. Interpretation of DNA sequences.
Role of counterions, deep and narrow grooves, single stranded DNA, A, B and Z DNA etc. Chirality of the helix, syn/antiparallel complementary stands.
**Rapid RNA sequencing techniques:** plus and minus, dideoxy-nucleotide, Zimmern and Kaesberg, Peattie, Simoncsits et al., method etc. Interpretation of RNA sequence.

Unit III Credit: 1

**Movable genes:** transposons and associated inverted repeats. The cassette model. Transforming DNA and plant genes. Retrovirus life cycle.
Strategies for cloning in plasmid vectors, features of commonly used vectors, their purification and characterization. Identification of bacterial colonies that contain recombinant plasmids. Bacteriophage λ vectors, growth, purification. Cloning in Bacteriophage λ vectors.
Cloning in cosmid vectors. Construction of Genomic DNA libraries in cosmid vectors. Enzymes used in molecular cloning, restriction enzymes, DNA-Polymerases, ligases, kinases, phosphatases, and nucleases. DNA binding proteins.

Unit IV Credit: 1

Agarose gel and polyacrylamide gel electrophoresis, detection and extraction of DNA from gels. Construction and analysis of c-DNA; protocols and strategies for C-DNA cloning. Analysis of Genomic DNA by Southern Hybridization. Amplification of DNA by the polymerase chain reaction. Preparation of radiolabelled DNA and RNA probes. Synthetic oligonucleotides probes. Expression of cloned Genes in cultured cells. Screening expression with antibodies and oligonucleotides. Microarray chips and their applications.

**Course Code: 3003C**
**Course Name: Immunochemistry** **100**

Unit I

Natural and acquired immunity, nature of immune response, cells and tissues of immune system. Components of natural immunity - complement system - classical and alternative pathway, opsonization and phagocytosis by macrophages.

Antigens, haptens and antibodies. Fine structure and subclasses of antibodies. Clonal selection theory and genetic basis of antibody diversity, immunoglobulin class switching. Antigen-antibody interactions.

Unit II

T and B lymphocyte classes. Major histocompatibility complex I and II. Processing and presentation of antigen by MHC, molecular basis of recognition, activation and maturation of T lymphocytes. Activation of B lymphocytes. Humoral immune response and its regulation. Cell mediated immunity - cytolytic and natural killer T lymphocytes.

Unit III

Cytokines, biogenic amines, interleukins and other effector components.
Cytokine signaling – JAK-STAT pathway
Programmed cell death – Apoptosis, Casapases and their role in cell death, Fas ligand signaling, TNF signaling
Immunodiffusion, immunoelectrophoresis, RIA, EIA, ELISA, fluroscent labelling and fluroscent cell sorter. Monospecific and bispecific antibodies. Hybridoma technology and monoclonal antibodies, catalytic antibodies. Western blotting.

Unit IV

Allergy and hypersensitivity, immunodeficiency - inherent and aquired, HIV, autoimmune disorders, mechanism of immunosuppression, graft rejection, organ transplantation and tumor immunology.
Interaction of microbes with immune system. Strategies adopted by viruses, bacteria and parasites to escape immune surveillance. PAMPS and Toll like receptors in microbe interaction

*Any one of the following extended code*

**Course Code: 30041S**
**Course Name: Biomembranes and Cytoskeleton** Total Credits: 4

Unit I Credit: 1

Historical perspectives, organisation of lipids in micelles, liposomes.
Components, properties and characterization of lipid bilayer. Assymetry, fluidity, lipidlipid and lipid-protein interactions. Merits and demerits of various membrane models.
Singer and Nicolson - fluid mosaic model.

Biosynthesis and transport of phospholipids to plasma membrane and other organelle membranes. Role of transport proteins and flippase. Biosynthesis of membrane proteins. Topology of membrane proteins, Role of endoplasmic reticulum – post translational modifications, core glycosylation and targeting of proteins. Temporal problems in membrane flow and cycling. Targetting of proteins to plasma membrane, cell organelle and exoplasmic location, targetting signals and adaptor proteins. Role of Golgi bodies in protein glycosylation and targetting. Diseases associated with defect in protein targeting.

Unit II Credit: 1

Active , passive and facultative transport and ion channels. Symport and antiport system.
Organisation, mechanism and significance of Na+ - K+ ATPase, Na+ - H+ ATPase, and Ca++-ATPase pumps. Inhibitory studies.
Special bacterial transport systems.
Permeases, Phosphotransferase system, transport through binding proteins.
Transport of macromolecules.
Endocytosis, pinocytosis and phagocytosis, receptor mediated endocytosis, transcyctosis.
role of calcium, clathyrin and other associated proteins in receptor mediated endocytosis.
Fates of receptors and ligands.
Specialized transport systems
Transport antibiotics, gap junctions and nuclear pores.
Transport of water – Aquaporins
Transepithelial transport of glucose / amino acids

Unit III Credit: 1

Signaling molecules and cell surface receptors – hormones, growth factors, G Protein – coupled receptors, Activation & inhibition of adenyl cyclase, Activation of phospholipase C
Activation of gene transcription – CREB proteins
Cell adhesion – Cadherins, Selectins and Integrins
Extracellular matrix of cells – Proteoglycans, collagens, elastin, fibronectin and laminin

Unit IV Credit: 1

Elements of cytoskeleton - microtubules, microfilaments and intermediary filaments.
Role of cytoskeleton in maintenance of cell shape, providing structural rigidity, cell movement , phagocytosis, cell viscosity, transport and other functions.
Factors influencing polymerisation of cytoskeltal elements. Inhibitors of association and dissociation of cytoskeletal elements. Mechanism of treadmilling.
Erythrocyte and non-erythrocyte cytoskeletons. Microvillar cytoskeleton
Cell –cell interactions - tight junctions, gap junctions, desmosomes and spot desmosomes.

**Course Code: 30042S**
**Course Name: Muscle Biochemistry and Biomembranes** Total Credits: 4

**Muscle Biochemistry**

Unit I Credit: 1

Skeletal muscle structure
Biochemical characterization of the extracellular matrix, plasmalemma, transverse tubular system, Sarcoplasmic reticulum and myofibrils.

Actin, myosin, tropomyosin, troponin, Z disc and H line components. The sliding filament mechanism and subcellular ion movements during the contraction cycle in skeletal muscle, length tensions relationship.
Metabolic and functional classification of skeletal muscle fibers (types 1, 2A, 2B). Twitch speeds and myosin ATPase activities. Oxidative and anaerobic metabolism.
Enzyme, histochemical and immunofluorescence characterization of muscle fibers
The motor unit and redifferentiation following cross insertion

Unit II Credit: 1

Effect of aging and thyroid states. Skeletal muscles diseases
Specialized metabolism in cardiac and smooth muscle
All or none versus graded responses. Thick filament regulation.
Cyclic AMP and hormonal sensitivity.

Role of calmodulin, phospholamban, cardiac troponin 1, slow $Ca^{++}$ channel phosphorylation.
Depolarization induced and calcium induced release from S.R.I. calcium export from muscle cells.
Role of sodium, effects of ouabain, stimulation frequency and Verapanil.
Structure of eukaryotic and prokaryotic cell covering including cell membrane and walls of bacteria, fungi and plant cell.

**Bio-membranes**

Unit III Credit: 1

Biological membranes and transport.
Physicochemical properties of cell membranes, molecular constituents of membranes supra molecular architecture of membranes - asymmetrical Organisation of lipids and proteins.
Solute transport across membranes : Fick's law, Types of transport - simple diffusion, passive - facilitated diffusion.
Active transport - primary & secondary group translocation.

Unit IV Credit: 1

Transport ATPases
Molecular models of transport mechanism:
Mobile carrier and pores mechanisms.
Transport by vesicle formation:
Endocytosis, exocytosis
Intracellular communication through junctions gap junction, tight junction, desmosomes.
Membrane biogenesis and regulation of cell membrane components; cell-cell interaction Artificial membranes - transport studies.

**Course Code: 30043S**
**Course Name: Plant Biotechnology** Total Credits: 4

**Plant defence:**

Unit I Credit: 1

Plant pathogens and integrated defense response to infection
Gene silencing as an adaptive defense
Natural products and plant disease resistance

Unit II Credit: 1

Programmed cell death
Hypersensitive response of plants and mitochondrial function
Biochemistry of airborne signals during plant defense
Co-evolution and plant resistance to natural enemies

**Engineering pest and disease resistant plants**

Unit III Credit: 1

Production of transgenic organisms: microbes
Producing proteins in bacteria and fungi
Methods to produce transgenic plants
Herbicides, manipulating herbicide tolerance in plants
benefits and problems of herbicide tolerance in plants

Unit IV Credit: 1

Plants with increased resistance to insects
Biotechnology and tomato, genetic modifications of foods, oils and starches
Improving plant tolerance to environmental stress
Production of transgenic animals
Release of transgenic organisms in the environment
Safety and regulation of genetically engineered food

**Course Code: 3005C**
**Course Name: Laboratory Course III** Total Credits: 8

End groups analysis of proteins
Peptide mapping
Preparation of plasmid DNA, digestion by endonucleases and separation of DNA restriction fragment on agarose gel electrophoresis.
Restriction mapping of DNA
DNA and RNA techniques using nitrocellulose - Southern & Northern Blotting.
Electroblotting of DNA restriction fragments.
Sequencing of DNA and RNA on polyacrylamide gels.
Production of antisera - immunodiffusion and immuno-electrophoresis, complement fixation.

**SEMESTER IV**

**Course Code: 4001C**
**Course Name: Nutritional Biochemistry**

Total Credits 4

Unit I

Credit: 1

**Basic Concepts:** Composition of human body. Energy content of foods. Measurement of energy expenditure: Direct & indirect calorimetry. Definition of BMR and SDA and factors affecting these. Thermogenic effects of foods. Energy requirements of man and woman and factors affecting energy requirements.
**Carbohydrates:** Dietary requirements and sources of available and unavailable carbohydrates. Physico-chemical properties and physiological actions of unavailable carbohydrates (dietary fibre).
**Proteins:** Protein reserves of human body. Nitrogen balance studies and factors influencing nitrogen balance. Essential amino acids for man and concept of protein quality Cereal proteins and their limiting amino acids. Protein requirement at different stages of development.
**Lipids:** Major classes of dietary lipids. Properties and composition of plasma lipo- proteins. Dietary needs of lipids. Essential fatty acids and their physiological functions.

Unit II

Credit: 1

**Electrolytes and water balance:** Electrolyte concentrations of body fluids. Acid base regulation by the human body. Concept of metabolic and respiratory acidosis and alkalosis.
**Minerals:** Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper.
**Vitamins:** Dietary sources, biochemical functions and specific deficiency diseases associated with fat and water-soluble vitamins. Hypervitaminosis symptoms of fat- soluble vitamins. Nutritional requirements during pregnancy, lactation and of infants and children.

Unit III

Credit: 1

**Processed Food:** Food processing and loss of nutrients during processing and cooking
Anti-nutrients: Naturally occurring food born toxicants: Protease inhibitors, Hemagglutins, Hepatotoxins, Allergens, Oxalates, Toxins from Mushrooms, Animal food stuffs and sea foods.
**Protein energy malnutrition (PEM):** Aetiology, clinical features, metabolic disorders and management of Marsmus and Kwashiorkar diseases.
**Starvation:** Techniques for the study of starvation. Protein metabolism in prolonged fasting. Protein sparing treatments during fasting. Basic concept of High protein, low caloric weight reduction diets.

Unit IV

Credit: 1

**Obesity:** Definition and classification. Genetic and environmental factors leading to obesity Obesity related diseases and management of obesity. Role of leptin in regulation of body mass.
**Clinical nutrition:** Role of diet & nutrition in the prevention and treatment of diseases: Dental caries, Fluorosis, Renal failure, Hyperlipidemia, Atherosclerosis & Rheumatic disorders, Inherited metabolic disorders: Phenyl ketonuria, Maple syrup disease. Hemocystinuria, Galactosemia, Gout, Diabetes Insipidus and Diabetes Mellitus.
**Food allergy:** Definition, Role of antigen, host and environment. Types of Hypersensitivities. Diagnosis and management of allergy.

**Course Code: 4002C**
**Course Name: Clinical Biochemistry** Total Credits: 4

Unit I Credit: 1

Introduction to laboratory principles and instrumentation in Clinical Biochemistry.
**Automation in the Clinical Biochemistry**
Instrumental concepts
Chemical reaction phase
Measurement approaches
Selection of instruments.
**Quality Assurance**
Control of Pre-analytical variables
Control of analytical variables
External and internal quality control measurements.

Unit II Credit: 1

**Disorders of Carbohydrate Metabolism**
Diabetes mellitus
Glycohemoglobins.
Hypoglycemia's.
Ketone bodies
Various types of glucose tolerance tests. Glycogen storage diseases
Galactosemia
**Lipids, Lipoproteins and Apolipoproteins**
Physiology of lipids/lipoproteins, lipidosis
Clinical inter-relationships of lipids (sphingolipidosis, multipisclerosis), Lipoproteins and apolipoproteins.
Diagnostic tests for apolipoproteins, HDL-cholesterol, LDL-cholesterol and triglycerides disorders.

Unit III Credit: 1

**Disorders of Amino Acid Metabolism**
Phenylalaninemia, homocystineuria, tyrosinemia and related disorders, aminoacidurias.
**Evaluation of Organ Function Tests**
Assessment and clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions, bilirubin metabolism.
Clinical presentation and diagnosis of various organ diseases.
**Diagnostic Enzymes:** Aspartate aminotransferase, Alanine aminotransferase, Creatine kinase Aidolase, Lactate dehydrogenase
Enzyme tests in determination of myocardial infarction, pancreatitis, biliary diseases

Unit IV Credit: 1

**Hormonal Disturbances**
Protein hormones, anterior pituitary hormones, posterior pituitary hormones, steroid hormones, adrenocortical steroids, reproductive endocrinology, thyroid function.
**Disorders of Mineral Metabolism**
Hypercalcemia, hypocalcemia, normocalcemia, hypophosphatemia, hyperphosphatemia.
**Detoxification Mechanism in the Body**
Enzymes of detoxification - polymorphism in drug metabolizing enzymes.
Detection of toxic substances by specific procedures.

*Any 2 of the following courses, one from each extended code*

**Course Code: 40031S**
**Course Name: Biochemical & Environmental Toxicology** Total Credits: 4

Unit I

Credit: 1

**Definition and scope of toxicology:** Eco-toxicology and its environmental significance. Toxic effects: Basis for general classification & nature. Dose - Response relationship: Synergism and Antagonism, Determination of ED 50 & LD 50' Acute and Chronic exposures. Factors influencing Toxicity. Pharmacodynamics & Chemodynamics.
**Principles & procedures of testing for acute toxic effects:** Regulatory guidelines, Mammalian systems affected & the clinical signs of Systemic Toxicity. Factors affecting acute Toxicity studies.

Unit II

Credit: 1

**Xenobiotic metabolism:** Absorption & distribution. Phase I reactions. Oxidation, Reduction, Hydrolysis and Hydration. Phase 11 reactions/Conjugation: Methylation, Glutathione and amino acid conjugations. Detoxification.
**Biochemical basis of toxicity:** Mechanisms of Toxicity : Disturbance of Excitable membrane function. Altered calcium Homeostasis. Covalent binding to cellular macromolecules & Genotoxicity. Tissue specificity of Toxicity.
**Toxicity testing:** Test Protocol, Genetic toxicity testing & Mutagenesis assays: In vitro Test systems - Bacterial Mutation Tests: Reversion Test, Ames Test, Fluctuation Tests and Eukaryotic Mutation Tests. In vivo Mammalian Mutation tests - Host mediated assay & Dominant Lethal Test. Use of Drosophila in Toxicity testing. DNA repair assays. Chromosome damage test. Toxicological evaluation of Recombinant DNA - derived proteins.

Unit III

Credit: 1

**Pesticide toxicity:** Insecticides: Organochlorines, Anti-cholinesterases - Organophosphates and Carbamates. Fungicides. Herbicides. Environmental consequences of pesticide toxicity. Biopesticides.
**Food toxicology:** Role of diet in cardiovascular diseases and cancer. Toxi(iology of food additives.
**Metal toxicity:** Toxicology of Arsenic, mercury, lead and cadmium. Environmental factors affecting metal toxicity - effect of light, temperature & pH.

Unit IV

Credit: 1

**Diagnosis of toxic changes in liver and kidneys:** Metabolism of Haloaklkanes, Haloalkenes & Paracetamol with their toxic effects on tissues.
**Air pollution:** Common air Pollutants & their sources. Air pollution & ozone. Air pollution due to chloroflurocarbons (CFCS) and asbestos.
Occupational toxicology & assessment of occupational hazards: Industrial effluent toxicology & Environmental health.
**An overview of regulatory agencies:** Responsibilities of regulatory agencies. Management of Toxicological risk. Regulatory approaches. Regulatory systems & organizations.

**Course Code: 40032S**
**Course Name: Medical and Environmental Biochemistry** Total Credits: 4

Unit I Credit: 1

BLOOD:Composition, Blood group, Types of Anaemias and Hemoglobinopathies
METABOLIC DISORDERS: Molecular Basis of diabetes, types of diabetes, Atherosclerosis; Types of Jaundice and its assessment, Hypertension, Myocardial infarction biochemical assessment and monitoring.

Unit II Credit: 1

INBORN ERRORS OF METABOLISM: Inborn errors of Carbohydrate, Lipid, Nucleic acids and Amino acid metabolism

Unit III Credit: 1

Teratogenesis, carcinogenesis, silicosis, toxicity of Hg++, Cd++, Pb++, F-
ENVIRONMENTAL POLLUTION: Air, Water, and Soil pollution, Control of pollution

Unit IV Credit: 1

BIODIVERSITY:Characterization, generation, maintenance and loss, magnitude and distribution of Biodiversity. Economic value, wild life biology, conservation strategies and cryopreservation

**Course Code: 40033S**
**Optional Paper 5: Neurobiochemistry** Total Credits: 4

Unit I Credit: 1

**Neuromorphology and Neurocellular Anatomy.** Central Nervous system - General features of Neurons. Cellular Organisation of neurons, Dendrites and Axons, neurotubules, neurofilaments, synapse neuralgia, astrocytes, oligodendrocyte, ependymal cells, schwa cells.
**Peripheral Nervous System (PNS):** Muscle, nerve endings, sensory receptors and effector 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.
**Role of the Nervous System in Homeostasis:** Cellular organization of specific regions such as cerebellum, cerebral cortex, hippocampus, retina, evolution of the nervous system - a comparative aspect.

Unit II Credit: 1

**Neurophysiology.,** Neuronal membrane, excitability, ion channels and transport of ions.
**Nerve and Synapse Structures:** 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.
**Postsynaptic Events at the Neuromuscular Junction. Electrophysiology of Channels: EEG patterns.**
**Chemical Composition of Brain:** 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.

Unit III

Credit: 1

**Neurotransmitter:** Chemistry, synthesis, storage and release of nervous neurotransmitters, transmitter action, synaptic modulation and mechanism of neuronal integration.
**Blood Brain CSF Barriers:** Special transport systems, characteristics of BBB - morphology, diffusion, mediated transport, enzymatic barriers in capillary endothelium. Characteristics of blood CSF barrier, composition of CSF, formation of CSF, active transport from CSF to brain. CSF brain interface, similarities of BBB to blood CSF barrier.
**Synaptic Transmission:** Structure of the synapse, correlation of structure and function at the synapse, transmission across the synapse, pre and post synaptic events, membrane potential in the steady state action, action potential and propagation of nerve impulse. CAMP in hormone action. Cyclic nucleotide and synaptic transmission - CAMP and neuronal function, neurotransmitter sensitive adenylate cyclases and their role in neuronal function, mechanism of action of CAMP in synaptic transmission, CAMP and cell growth with differentiation, CAMP and microtubule function.

Unit IV

Credit: 1

**Endocrine Effects on the Brain and their Relationship to Behaviour.** Behavioral control of hormone secretion, biochemical aspects of activational hormones effects, steroid receptor sites in brain, integration of behavioral and neuroendocrine effects, organizational effects of hormones on developing brain, thyroid hormone and brain development.
**Sphingolipidosis and other Lipid Disorders:** Diseases involving myelin classification, and biochemistry of demyelinating diseases.
Biochemical Pathology of Vitamin and Nutritional Deficiencies: Neurotoxic agents and diseases related to them.
**Psychopharmacologyand Biochemical theories of** Mental Disorders: Chemistry of neuroleptics and anxiolytics, antidepressants, hallucinogenic agents, biochemical theories of mental disorders.
**Neurodegenerative Disorders:** Parkinson's, Alzheimer's disease, amyotrophic lateral sclerosis, senile dementia.

**Course Code: 40041S**
**Course Name: Microbial Biochemistry**

Total Credits: 4

**Microbiology**

Unit I

Credit: 1

Types of microorganisms: Mycoplasma, Protozoa, archea and yeast, fungi, general characteristics of main groups of microorganisms. Criteria used in the classification of microorganisms - cytology, genetics, host specialization, serology, different phases of growth.

Nutrition, physiology and growth of microbial cells. Microbial growth: The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yield, synchronous growth, continuous culture

Unit II Credit: 1

Gram positive and gram-negative organisms. Structure and functions of peptidoglycan in gram-positive and gram-negative organisms. Functions of polymeric components in outer membrane and acidic polymers in gram-negative organisms.

Special features of bacterial metabolism. Food spoilage, fermentation, food-borne infection. Role of microorganisms in domestic and industrial sewage. Microbiological standards

**Virology**

Unit III Credit: 1

Virus structure, virus proteins, virus classification schemes
methods of assay: culture methods, serological detection, complement fixation, plaque reduction assay, neutralization tests

Replication of RNA viruses - negative strand (VSV), positive strand (polio), retroviruses (to include all events in the infectious cycle).

Unit IV Credit: 1

Replication of DNA viruses (Adenovirus or SV40). Herpes simplex virus, cytomegalovirus
Virus-host interaction
Vaccines and prevention – smallpox, polio, AIDS, rotavirus vaccine, influenza

**Course Code: 40042S**
**Course Name: Genetics for Biologists** Total Credits: 4

Unit I Credit: 1

**Genetic Counseling**
Possible approaches for tackling genetic disorders; Diagnosis of genetic defects; Positive eugenics; Negative eugenics; genetic counseling (antenatal diagnosis, fetus sexing).
**Restriction Maps and Molecular Genetic Maps**
Restriction Mapping. Restriction fragment length polymorphisms (RFLPs); Linkage and recombination between molecular and phenotypic markers; Random amplified polymorphic DNA (RAPDS) using PCR. Chromosome walking; reverse genetics and chromosome jumping

Unit II Credit: 1

**Applied Genetics : Scope and Importance**
What is applied genetics; Achievements of applied genetics; Need for future development.
**Cloning and Amplification of DNA**
Restriction enzymes in cloning; Techniques used in recombinant DNA technology (Polyacrylamide gel electrophoresis, Southern, Northern and Western blotting); Cloning vectors for recombinant DNA; cloning in bacteria, Molecular probes, Construction and screening of genomic and CDNA libraries; PCR and its applications.

Unit III

Credit: 1

**Isolation, Sequencing and Synthesis of Genes**
Isolation of genes (genes with Tissue specific expression; mutant complementation, transpose tagging); Sequencing of genes ( Maxam-Gitbert's method); Synthesis of genes (organochemical synthesis of TRNA gene and interferon gene).

Unit IV

Credit: 1

**Gene Transfer Methods and Transgenic Organisms**
Gene transfers methods for animals and plants; Agro-bacterium mediated gene transfer, electroporation and particle gun. Transgenic animals (mouse and rabbit); Transgenic plants (Herbicide insect and virus resistance).

**Course Code: 40043S**
**Course Name: Frontier Technologies in Biosciences**

Total Credits: 4

Unit I

Credit: 1

**Stem cell technology**
Stem cell, definition, types of stem cells, scientific terms
Manipulations of stem cells
factors governing manipulations of stem cells
The future of stem cell technology using pluripotent stem cells
Culture of stem cells
Study of microenvironmental factors governing stem cell propogation
Tissue engineering using stem cell technology
Reprogramming of genome function through epigenic inheritance
Ethical, social considerations of stem cell technology.

Unit II

Credit: 1

**Functional Proteomics**
What is proteome
Mass spectroscopy of various protein complexes
Organization of proteome in an organism and its systematic study
Protein chips
Computation

**Nanobiotechnology**
Definitions and terms
Molecular Motors
DNA hybridization control using metal ion crystal antenae

Unit III

Credit: 1

**Microarray chips,**
Microarray probes / chips, array fabrication, targets, assays, read out, image analysis, uses and examples.

**SNPs**
Identification and uses, DNA variations, SNP detection, data bases, study design, uses, genotyping.
Unit IV

Credit: 1

**Bioremediation and Phytoremediation**
The interaction of soils and groundwater with organic and synthetic contaminants
The role of soils in pollution control
The physical, chemical, and microbiological properties of soil and water
Conventional remediation and bioremediation techniques
Regional pollution problems
Agricultural runoff, landfill leachates, leaking underground storage tanks.

**Course Code: 4005**
**Course Name: Thesis / Project work and Seminar** Total Credits: 8

Note: Project work and seminars begin in semester III and are continued and completed in semester IV.

## Reference Books and literature for M. Sc. BIOCHEMISTRY Program

### Bioanalytical Chemistry

Stereo chemistry of organic compounds (1994) by E L Eliel & SHW Awley., Inter Science Pub. 30, Wiley and Sons. Inc.
Organic Chemistry (6th Ed. 2000) by R T Morrison & R N Boyd, Prentice Hall of India, New Delhi.
Organic Chemistry Vol.1 Fundamental Principles (6th Ed. 1985) by IL Finar, ELBS.
Vol.2 Stereo Chemistry and the Chemistry of Natural Products. (5th Ed. 1985) by I L Finar, ELBS.
Lehninger's Principles of Biochemistry (2nd Ed 2000) D L Nelson and M M Cox, Macmillan Worth Pub. Inc NY.
Physical Biochemistry by Kansal Edward Van Holde (1971) Prentice Hall Inc. New Jersey.
Physical Biochemistry 2nd Ed (1 982) by David Friefelder, W H Freeman and Co. NY.
Principles and Techniques of Practical Biochemistry (4th Ed 1999) by K Wilson and J Walker (eds.) Cambridge Univ. Press.

### CELL BIOLOGY AND PHYSIOLOGY

Molecular Biology of the Cells (3rd Ed 1994) by Alberts et al., Garland Publications Inc NY and London.
Cell Biology (1993) by E S Sedava, Jones and Barlett Publishers Boston, London.
Cell and Molecular Biology (8th Ed. 2001) by E D P de Robertis & E M F de Robertis (Jr) Lippincott Williams & Wilkins, Philadelphia.
Principles of Cell Biology (1988) by Klein Smith and M. Kish, Harper-Cellins Pub. Inc. New Delhi.
Text book of Medical Physiology (10th Ed. 2001) by A C Guyton & J E Hall, Harcourt Asia.

### BIOENERGETICS AND METABOLISM

Lehninger's Principles of Biochemistry (2nd edn. 2000) by D L Nelson and M M Cox, Macmillan, Worth Pub Inc., NY.
Biochemistry (4th Ed. 1992) by Lubert Stryer W H Freeman & Co., NY
Harper's Biochemistry (25th Ed.) by R K Murray and others. Appleton and Lange, Stanford.

### PLANT BIOCHEMISTRY

Handbook of photosynthesis (Ed.) Mohammad Pe sarakle, Marcel Dekkar, Inc. NY. Basel. Hong Kong 1997.
Introduction to plant biochemistry (1983) T W Goodwin and E I Mercer. Pergaman Press, Oxford, NY, Toronto, Sydney, Paris, Frankfurt.
Seed: physiology of development and germination (2nd Ed. 1994) J D Bewley and M Black Plenum Press NY.
Biochemistry of energy utilization in plants D T dennis Blackie, Glasgow and London 1987.
Plant Biochemistry by P M Dey and J B Harborne. Harcourt Asia PTE Ltd., Singapore.

### ENZYMOLOGY

The chemical kinetics of enzyme action by K J Laidler and P S Bunting, Oxford University Press, London.
Enzymes by M Dixon, E C Webb, CJR Thorne and K F Tipton, Longmans, London.
Enzyme structure and mechanism (1977) by Alan Fersht, Reading, USA.
Enzymatic reaction mechanism (1979) by Christopher Walsh, Freeman Pub., San Francisco.
Immobilized enzymes (1978) by Ichiro Chibata, Halsted Press Book.
Enzyme structure and function by S Blackburn (1976) Marcel Dekker, Inc., NY.

### ADVANCED MOLECULAR BIOLOGY

Biochemistry (2nd Ed 1995) by Donald Voet and Judith Voet.
Molecular Biology of the gene (IV Ed 1987) J Watson NH Hopkin J W Roberts J P Stertz A M Weiner, Freeman Pub., San Francisco.
Genes Vil Benjamin Lewin (2000) Oxford Univ Press. London.

**Immunochemistry**

Immunology (4th Ed. 1998) by Ivan Roitt, J Brostoff and David Mole (4th edn) Mosby Times Mirror Int. Pub. Ltd.
Essential Immunlogy (9th Ed. 1997) by Ivan Roift Blackwell Science Ltd.
Immunology (1992) by Janis Kuby W H Freeman and Co. Ltd. USA.
Immunology (2nd Ed. 991) by Edwards S Golub, Sinauer Associate, Sunderland.

**METHODS IN MOLECULAR BIOLOGY**

Molecular cloning: a laboratory manual (Vol.1, 2 & 3) (1989) by T.Maniatis, E.F.Fritsch, J.Sambrook. Cold Spring Harbor Laboratory Publications
RNA Isolation and Analysis by P Jones, J. Qiu, D.Rickwood (1st Ed. 1994) Bios Scientific Publishers.
Gene and Probes: A Practical Approach Series (1995) by B D Hames and S J Higgins. Oxford University Press.
Gel Electrophoresis of Nuclei Acids: A Practical Approach (1990) by D.Rickwood and B.D.Hames. Oxford University Press.

**NUTRITION BIOCHEMISTRY**

Nutrition- An integrated approach (3rd Ed. 1984) R L Pike and M L Brown, Wiley & Sons Inc., NY.
Text Book of Biochemistry and Human Biology G P Talwar, Prentice Hall.
Mechanism and Theory in Food Chemistry (1996) DWS Wong, CBS, New Delhi.
Text Book of Human Nutrition (1996) M S Bamji N Pralhad Rao and V Reddy, Oxford & IBH Publishers.
Nutritional Biochemistry and Metabolism Linten.
Principles of Food Science -1 (Food Chemistry) Fennemona D R.
Human Nutrition and Dietetics (8th Ed. 1982) by Davidson and Passmore ELBS.
Modern Nutrition in Health and Diseases (7th Ed. 1988) by Maurice E Skills and V R Young K M Varghese Co. Bombay.

**BIOSTATISTICS**

Biostatistics: A foundation for analysis in the health. (7th Ed. 1999) by W W Daniel John Wiley and Sons Inc., New York.

**BIOCHEMICAL AND ENVIRONMENTAL TOXICOLOGY**

General and Applied Toxicology 1995 by Marrs and Turner, Macmillan Press Ltd.
Basic Environmental Toxicology (1994) by Lorris G.Corkerhem and Barbara S S Shane CRP Press Inc.
Introduction to Food Technology by Takayurki Shibamato & Leonard F. Bzeldanes.
Molecular Biotechnology 2nd Ed 1994 by Barnard R Glick & J J Pasternak.

**BIOMEMBRANES AND CYTOSKELETON**

Molecular Cell Biology by H. Lodish, David Baltimore, et al W. H. Freeman Publication, 1996
Biological Membranes Findlay and Evans
Biochemistry of Tissues by Banks
Cell by Cooper

**MUSCLE BIOCHEMISTRY**

Biochemistry by Lubert Stryer, Freeman & Co., NY.
Principles of Biochemistry -Smith, Lehman, Lefkowtz, Handler and Smith.
Lehninger's Principles of Biochemistry - D L Nelson and M M Cox, Macmi.lian/Worth Pub Inc., NY.

Biochemistry of Lipids, Lipoproteins and Membranes (1991) - D E Vance and J E Vance, Elsevier Sci.

**MICROBIAL BIOCHEMISTRY**

Microbial World (5th Ed. 1987) R Y Stanier, Hampshire-Macmillan Press.
Medical Microbiology (12th Ed. 1973) Cruckishank R and others, ELBS Press, London.
Microbiology (1967) B D Davis, R Delbecco, H M Eisent H S Ginsberg, Hoeber Med Divn NY.
Microbiology (5th Ed. 2000) Michael J Peiczar (Jr) ESC Chan, N R Kreig, Tata McGraw Hill.

**CLINICAL BIOCHEMISTRY**

Tietz Fundamentals of Clinical Chemistry - (5th Ed.) C A Burtis, E R Ashwood (eds.) Saunders WB Co.
Notes on Clinical Chemistry - Whitby L G, A F Smith, G J Beckett, S M Walker, Blackwell Sci Inc.
Principles of Internal Medicine (1983) Harrison T R, McGraw Hill, NY.

**MEDICAL AND ENVIRONMENTAL BIOCHEMISTRY**

Clinical Chemistry by Kaplan L.A. and Pesce A. J. C. V. Mosby, 1989
Clinical Biochemistry by W. J. Marshall and S. K. Bangert, Churchill Livinston N.Y. 1995
Practical Clinical Biochemistry (Varley) by Gowenlock
Biochemical Aspects of Human Diseases by Elkeles and Tavill
Biodiversity by Hawksworth

**NEURO BIOCHEMISTRY**

Basic Neurochemistry by Siegel.
Elements of Molecular Neurotoxicology by CUM Smith.
Neuroanatomy by Grossman & Neavy.

**GENETICS FOR BIOLOGISTS**

General Genetics Sub Owen and Edger.
Genes VII (2000) Benjamin Lewin, Oxford Univ Press.
Molecular Biology of Gene (4th Ed. 1987) Watson *et al* Freeman Pub. San Francisco.