Course Structure of M.Sc. Biochemistry w.e.f. 2010-11
(Approved by Board of Studies dated 03.02.2011)

Semester I

Papers	Time/Marks	Credits
MBC-11 Organic Chemistry and Biomolecules	(4 periods/wk) MM= 75+25=100	4
MBC-12 Cell Biology	(4 periods/wk) MM= 75+25=100	4
MBC-13 Enzymology	(4 periods/wk) MM= 75+25=100	4
MBC-14 Intermediary Metabolism	(4 periods/wk) MM= 75+25=100	4
MBC-15 Molecular Genetics	(4 periods/wk) MM= 75+25=100	4
MBC-16 Laboratory Course-I	(16 periods/wk) MM= 100+100=200	8

Semester II

Papers	Time/Marks	Credits
MBC-21 Molecular Biology	(4 periods/wk) MM= 75+25=100	4
MBC-22 Nutritional Biochemistry	(4 periods/wk) MM= 75+25=100	4
MBC-23 Immunology	(4 periods/wk) MM= 75+25=100	4
MBC-24 Plant Biochemistry	(4 periods/wk) MM= 75+25=100	4
MBC-25 Microbial Biochemistry	(4 periods/wk) MM= 75+25=100	4
MBC-26 Laboratory Course-II	(16 periods/wk) MM= 100+100=200	8

Educational Tour*	(After Semester I Exams)

Semester III

Papers	Time/Marks	Credits
MBC-31 Biochemical and Environmental Toxicology	(4 periods/wk) MM= 75+25=100	4
MBC-32 Biochemical Techniques	(4 periods/wk) MM= 75+25=100	4
MBC-33 Bioinformatics and Biostatistics	(4 periods/wk) MM= 75+25=100	4
MBC-34 Clinical Biochemistry	(4 periods/wk) MM= 75+25=100	4
MBC-35 Neurobiochemistry	(4 periods/wk) MM= 75+25=100	4
MBC-36 Laboratory Course-III	(16 periods/wk) MM= 100+100=200	8

Semester IV

Papers	Time/Marks	Credits
MBC-41 Technical Writing and Seminar	MM= 50+50=100	4
MBC-42 Project and Dissertation	M= 300	12

Total Credits = 100

MBC 11

ORGANIC CHEMISTRY AND BIOMOLECULES

ORGANIC CHEMISTRY

Unit I

Electronic theory of valency, dipolar moments. Electronic displacements in a molecule: Inductive effect, resonance, the hydrogen bond, hydrophobic interactions. Atomic and molecular orbitals. Shapes of biomolecules, hybridization and tetravalency of carbon.

Isomerism. Structural isomerism, stereoisomerism, geometrical isomerism (E & Z nomenclature)

Types of organic reactions. Substitution, addition, elimination, rearrangement, condensation and polymerization.

Free Radicals in biological systems. Oxygen as a free radical in the auto oxidation of fats. Antioxidants (Free radical inhibitors in the cells such as vitamin A, vitamin C, Se etc.)

Mechanism of substitution in the benzene ring: o-, p- and m-directing groups. The concept of resonance with reference to benzene derivatives. Direct influence of substituents - electronic interpretation.

Unit II

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, mono- and di- substituted cyclohexane, monosachharides, boat and chair forms, eclipsed, gauche and staggered

conformations, axial and equatorial bonds. Anomers and mutarotation, glycoside, epimers, glucopyranose, fructofuranose, periodic acid oxidation of sugars.

Heterocyclic system occurring in living system: Numbering and properties of the ring; properties of pyran, furan, thiozole, indole, pyridine, pyrimidine, quinine, purine and pteridine.

BIOMOLECULES

Unit III

Carbohydrates: Classification, structure and occurrence of common monosaccharides, di-saccharides and polysaccharides. Glycosaminoglycans, Glycoprotiens; peptidoglycan, proteoglycan, N-linked and O-linked glycoproteins.

Unit IV

Proteins: Amino acids (structure and general properties), peptide bond. Primary structure of proteins (end groups analysis, peptide cleavage and sequence determination), secondary structure (peptide group, structural constraints on polypeptide chain, Ramachandran plot, helical structures, beta pleated sheets, other secondary structure), supersecondary structures. Tertiary structure. Quarternary structure.

Unit V

Lipids: Fatty acids, Triacylglycerols, phosphogylcerides, sphingolipids. Lipid aggregates, lipid linked proteins, Lipoproteins. Glycolipids.

MBC 12

CELL BIOLOGY

Unit I

Cell classification: cell variability (size, shape, complexity, functions)

Structural organization 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.

Cell differentiation – organogenesis, morphological, functional and biochemical maturation of tissues.

Unit II

The cytoskeleton – microtubules and microfilaments.

Viruses: structure and classification. Life cycle. Culture techniques to study cell division – cell division by mitosis and meiosis. Cell cycle.

Biochemistry of cancer – Carcinogenesis, characteristics of cancer cell, agents of carcinogenesis.

Unit III

Bioenergetics: Energy Transformation; Open, closed and isolated system: first law of thermodynamics, heat of formation and heat of reaction; second law of thermodynamics. Molecular basis of entropy, Helmhotz and Gibbs free energy; third law of thermodynamics and calculation of entropy; application of the first and second law of thermodynamics in understanding energies of living cells, chemical potential, equilibrium constant.

Unit IV

Biological oxidations, oxygenases, hydoxylases, dehydrogenases and energy transducing membranes. Gibbs energy free energy changes and redox potentials. Type of electrodes, standard electrodes potential and its determination, its relationship with emf, electron transfer measures. Phosphate potential, ion electrochemical proteins, proton electrochemical potential, membrane potentials, photon energy interconversions. Chemotaxis 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. Shuttle systems.

The mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron sulpur proteins, cytochromes and their characterization. The Q cycle and the stoichiometry of proton extrusion and uptake; P/O and H/P ratios. Reserved 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.

Unit V

Biomembranes

Biological membranes and Transport; Physiochemical properties of cell membranes, molecular constituents of membranes, supramolecular architecture of membranes – a symmetrical organization of lipids and proteins.

Solute transport across membrane: Fick's law, Types of transport, simple diffusion, passive and facilitated diffusions; Active transport – Primary and secondary group translocation.

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

MBC 13

ENZYMOLOGY

Unit I

Review of unisubstrate enzyme kinetics and factors affecting the rates of enzyme catalyzed reactions. Michaelis Menten equation & temperature pH functions and their significance. Classification of multisubstrate reactions with examples of each class. Kinetics of multisubstrate reactions. Derivation of rate of expression for Ping Pong and ordered Bi Bi reaction mechanism. Methods for measuring kinetics and rate constants of enzyme reactions.

Unit II

Enzyme turnover and methods employed to measure Turnover of enzyme. Significance of enzyme Turnover. Protein-Ligand binding. Co-operativity phenomenon, Hill and Scatchard plots. Allosteric enzymes, Sigmoidal kinetics and their physiological significance. Symmetric and sequential modes of action of allosteric enzymes.

Unit III

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

Unit IV

Co-enzyme and Cofactors: Water soluble vitamins and their coenzymes. Metallo enzymes. Detailed mechanisms of catalysis of serine proteases. Chymotrypsin and Triose phosphate isomerase.

Unit V

Enzyme regulations: General mechanisms of enzyme regulation: Feedback inhibition and feed forward stimulation; enzyme repression, induction and degradation, control of enzyme activity by products and substrates; Reversible and irreversible covalent modification of enzymes. Proteolytic activation. Concepts of Convergent and Divergent evolution of enzymes.

MBC 14

INTERMEDIARY METABOLISM

Unit I

Intermediary Metabolism: Approaches for studying metabolism

Unit II

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; Gluconeogenesis, interconversions of sugars; Biosynthesis of glycogen, starch and oligosaccharides. Regulation of blood glucose homeostatis. Hormonal regulation of Carbohydrate metabolism.

Unit III

Lipids

Fatty acid biosynthesis: acetyl CoA carboxylase, Fatty acid synthase, desaturase and elongase, Fatty acid oxidation:α, β, and ω- oxidation and lipooxidation. Lipid biosynthesis: Biosynthesis of Triacylglycerol sphingolipids and phosphoglycerides, Biosynthesis of terpenes, steroids and prostaglandins. Ketone bodies: Formation and utilization, metabolism of Circulating lipids: chylomicrons, LDL, HDL and VLDL. Free fatty acids. Lipid levels in pathological conditions.

Unit IV

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.

Unit V

Nucleic Acids

Biosynthesis of purines and pyrimidines; Degradation of purine & pyrimidine. Regulation of purine & pyrimidine biosynthesis. Structure and regulation of ribonucleotide reductase. Biosynthesis of ribonuclotides, deoxyribonucleotides and polynucleotides; Inhibitors of nucleic acid and biosynthesis.

MBC 15

MOLECULAR GENETICS

Unit I Replication of DNA

Replication of DNA: DNA polymerase and other enzymes involved, replication origin, Replication fork, semi-conservative replication of double stranded DNA, mechanism of Replication.

Unit II: Genome in Flux

Recombination in bacteria, Conjugation and transformation, Generalized and Specialized Transduction, General homologous recombination, Site specific recombination, Transposable elements, Mechanism of Transposition.

Unit III: Mutation and DNA Repair

Molecular basis of gene mutation, Consequences of mutation for protein structure, Induction of mutation in prokaryotes. Chemical mutagenesis in higher organisms, Repair of DNA damage: Photo-reactivation, Excision, post replication and SOS repair mechanisms, base excision, nucleotide excision repair, Repair of DNA damage in higher organisms.

Unit IV: Expression of Genetic Information

Transcription of DNA: RNA polymerase, sigma factor, Initiation, chain elongation, termination, post transcriptional modification (capping, polyadenylation, splicing) and mRNA and antibiotics affecting transcription. The Genetic Code: evolution of the code, degenerate triplet code. Protein synthesis: t-RNA as adapter molecule, ribosome structure, ribosomal genes, Initiation, elongation and termination of protein synthesis, Modification of protein synthesis, Inhibitors of protein synthesis.

Unit V: Regulation of Gene Function

Enzyme induction and repression, The lac operon-positive, negative control and catabolic repression, The arabinose operon, The tryptophan operon, The lambda phage: a complex of operons.

MBC 21

MOLECULAR BIOLOGY

Unit I

Recombination DNA technology. Enzymes used in molecular cloning: restriction enzymes, DNA polymerases, ligase, kinase, phosphatase and nuclease; molecular cloning of DNA or RNA: cloning vectors; lambda phage, plasmid, M13 phage, cosmid, shuttle vectors, yeast and viral vectors, construction of genomic and cDNA library. Agarose gel and poly acrylamide gel electrophoresis, detection and extraction of DNA from gels. Blotting techniques. Chromosomal walking. Molecular probes.

Unit II

Sequencing and amplification of DNA by polymerase chain reaction. Types of PCR: Rt-PCR, inverse PCR, asymmetric PCR. Methods of gene transfer: analysis of gene expression, micro arrays, restriction fragment length polymorphism (RFLP), DNA fingerprinting.

Unit III

Hybridoma technology. Monoclonal antibodies, mycelium cell fusion, selection of hybrids, hybridomas, protoplast fusion and HAT-medium, screening assays; purification and application of monoclonal antibodies. Antibody engineering. Brief introduction of antibodies produced by transgenic plants.

Unit IV

Plant and Animal cell culture: Somatic cell hybridization, protoplast fusion, protoplast culture, genetic transformation, various methods of gene transfer (all vector and vector-less methods); production of transgenic plants and animals,

primary and transferred cell culture, differentiated cells in culture applications.

Unit V

Fermentation technology. Primary and secondary metabolites; continuous and batch type culture techniques; fermentation processes: brewing, manufacture of penicillin, production of single cell protein, production strategies for antibiotics and other organic compounds.

MBC 22

NUTRITIONAL BIOCHEMISTRY

Unit I

Basic Concepts: Composition of human body. Energy contents of foods. Measurement of energy expenditure: Direct and Indirect colorimetry. Definition of BMR and SDA and factors affecting these. Thermogenic effects of foods. Energy requirements of men and women and factors affecting energy requirements.

Carbohydrates: Dietary requirements and sources of available and unavailable carbohydrates. Physicochemical properties and physiological actions of unavailable carbohydrates (dietary fiber). Simple and complex carbohydrates. Artificial sweeteners.

Unit II

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.

Protein Energy Malnutrition (PEM): Etiology, clinical features, metabolic disorders and management of Marsmus and Kwashiorkar diseases.

Starvation: Protein metabolism in prolonged fasting. Protein sparing treatments during fasting. Basic concepts of high protein, low caloric weight reduction diets.

Unit III

Lipids: Major classes of dietary lipids. Properties and composition of plasma lipoproteins. Dietary needs of lipids. Essential fatty acids and their physiological functions.

Obesity: Definition and classification. Genetic and environmental factors leading to obesity. Role of leptin in regulation of body mass.

Unit IV

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 growth of infants and children.

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

Unit V

Clinical nutrition: Role of diet and nutrition in the prevention and treatment of disease: Dental caries, fluorosis, renal failure, hyperlipidemia, atherosclerosis, and rheumatic disorders, inherited metabolic disorders: Phenyl ketonuria, Maple syrup disease, homocystinuria, galactosemia, gout, diabetes insipidus and diabetes mellitus.

Anti-nutrients: Naturally occurring food-borne toxicants: Protease inhibitors, Hemagglutinins, Hepatotoxins, Allergens, Oxalates, Toxins from mushrooms, animal food stuffs and sea food.

MBC 23

IMMUNOLOGY

Unit I

Introduction and Overview of the Immune System. Origin of Immunology and its evolution. Infection and immunity. Types of immunity – Innate and acquired, active and passive, humoral and cell mediated. Clonal selection theory.

Organs and cells of the immune system: structure and function. Hematopoesis. Lymphocyte traffic. Antigens and immunogens. Adjuvants. Requirements for immunogenicity.

Unit II

Structure and function of immunoglobulins. Antibody variants- isotypes, allotypes and idiotypes. Monoclonal antibodies. Hybridoma technology.

Organization of immunoglobulin genes. Theories and genetic basis of antibody diversity. Antibody – antigen binding: affinity, avidity, cross reactivity.

Unit III

Antigen-antibody interactions; agglutination, hemagglutination. Precipitation reactions in solution and in gels. Immunoassays: Radioimmunoassay, ELISA, ELISPOT, immunoflourescent assays. Fluorescence activated cell sorting. Western blotting.

Unit IV

Major histocompatibility complex. MHC genes and Histocompatibility antigens. Role of MHC in T cell selection. Cytokines and their role in immune regulation. Complement system. Mechanism of its fixation; complement

activation and its biological activities. Classical, alternative and lectin pathways; Regulation of complement.

Unit V

Immunological tolerance to self and to antigens; its induction and features. Immunosuppression – specific and non-specific. Allergy and hypersensitivity. Effector mechanisms and examples of each type of hypersensitivity. Transplantation immunology. Tumor immunology. Immunodeficiencies; primary and secondary. Autoimmunity: factors contribution to autoimmunity; examples and diagnosis Immunization and Vaccines.

MBC 24

PLANT BIOCHEMISTRY

Unit I

Structure and function of plant cell (including cell wall, plasmodesmata, meristematic cells, vacuoles, secretory system and root quiescent zone), isolation of cell organelles, absorption, adsorption and transport of water, nutrients, ions and macromolecules in plants. Evapotranspiration.

Unit II

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 mitochondrial electron transfer. 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.

The Hill reaction; photophosphorylation and reduction of CO_2° C_3, C_4 and CAM metabolism light and dark reactions. Light activation of enzymes, regulation of photosynthesis.

Unit III

Respiration, respiratory quotient, photorespiration and its significance. ATP generation, Factors influencing the rate of respiration (light, temperature, oxygen availability).

Unit IV

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

amino acids. Translocation of inorganic and organic substances.

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 function.

Vesicular transport and secretory pathways.

Unit V

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.

MBC 25

MICROBIAL BIOCHEMISTRY

Unit I

Introduction to microbial systems. Importance of microbiology in agriculture, human health, industry and environment. Types of microorganisms, general characteristics of main groups of microorganisms. Criteria used in the classification of microorganisms-cytology, genetics, host specialization, serology.

Unit II

Microbial growth: different phases of growth. Measurement of microbial growth. Effects of various environmental factors on microbial growth; Uptake of nutrients by microbial cells and their nutritional requirements. Control of microbial growth: physical control, chemical control and antibiotics. Mechanisms of drug resistance.

Unit III

Isolation, culture, identification and preservation of bacteria. 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. Role of microorganisms in domestic and industrial sewage.

Unit IV

Classification of viruses. Virus structure, virus proteins. Viroids and prions. Virus-host interaction. Replication of RNA viruses – negative strand (VSV), positive strand (polio), retroviruses (to include all events in the infectious cycle). Replication of DNA viruses (Adenovirus or SV40).

Unit V

Microbial diseases: Respiratory diseases caused by viruses and bacteria-tuberculosis and small pox. Sexually transmitted diseases. Food spoilage and food-borne diseases.

Recommended reading for semester I

1. Stereochemistry of organic compounds. (1994) by EL Eliel & SHW Awley. Wiley and sons Inc.
2. Organic Chemistry (2000) RT Morrison & RN Boyd. Prentice Hall of India.
3. Lehninger's Principles of Biochemistry DL Nelson and MM Cox Macmillan Worth Pub. Inc NY.
4. Molecular Biology of the Cells. Alberts et al. Garland Publishers Inc NY and London.
5. Cell and Molecular Biology (2001). EDP de Robertis & EMF de Robertis. Lippincott.
6. Biochemistry. Lubert Stryer. WH Freeman & Co, NY.
7. Harper's Biochemistry. RK Murray et al. Appleton and Lange, Standford.
8. Enzymes. Dixon and Webb. Longmans, London.
9. Fundamentals of Enzymology. Price and Stevens. Oxford Univ Press.
10. Immobilized Enzymes and Cells. Rosevear, Kennedy and Cabral.
11. Biochemistry. Voet and Voet.
12. Molecular Biology of the Gene. Watson, Hopkin, Roberts, Stertz and Weiner. Freeman Pub, San Francisco.

MBC 26

LAB COURSE II

1. Preparation of buffers and determination of pH.
2. Sterilization techniques.
3. Preparation of culture media.
4. Culture of bacteria; establishing a pure culture; identification of bacteria; staining techniques; antibiotic sensitivity of bacteria.
5. Isolation of plasmid DNA.
6. Conjugation.
7. Quantitative estimation of DNA and RNA.
8. Determination of saponification value of fats / oils.
9. Determination of iodine number of fats / oils.
10. Food analysis.
11. Double immunodiffusion.
12. Radial immunodiffusion.
13. Rocket immunoelectrophoresis.
14. ELISA
15. Quantitative precipitin assay.

Recommended reading for semester II

1. Immunology. Kuby
2. Textbook of Immunology (2012) Basir SF. PHI.
3. Nutrition: An Integrated approach. Pike and Brown; Wiley and Sons Inc, NY.
4. Human Nutrition (2005) Geissler and Powers. Elsevier.
5. Plant Biochemistry by PM Dey and JB Harborne; Harcourt Asia PTE Ltd, Singapore.
6. Introduction to Plant Biochemistry. Goodwin and Mercer. Pergaman Press, Oxford, NY, Toronto, Sydney, Paris, Frankfurt.
7. Microbiology (5^{th} Ed; 2000) Michael Pelczar, Chan, Kreig. Tata McGraw Hill.

MBC 31

BIOCHEMICAL & ENVIRONMENTAL TOXICOLOGY

Unit I

Definition and scope of toxicology

Eco-toxicology and its significance. General classification and nature. Dose – Response relationship: Synergism and Antagonism, Determination of ED_{50} and LD_{50}. Acute and Chronic exposures. Factors influencing Toxicity. Pharamacodynamics. Principles and procedures of testing for acute toxicity.

Biochemical basis of toxicity

Mechanisms of Toxicity: Disturbance of Excitable membrane function. Altered calcium Homeostasis. Covalent binding to cellular macromolecules and Genotoxicity. Tissue specificity of Toxicity.

Unit II

Xenobiotic metabolism

Absorption and distribution. Phase I reactions. Oxidation, Reduction, Hydrolysis and Hydration. Phase II reactions/Conjugation: Methylation, Glutathione and amino acid conjugations. Detoxification mechanism in the body.

Toxicity testing

Test protocol, Genetic toxicity testing and Mutagenesis assay: In virto Tests systems – Bacterial Mutation Tests: Reversion Test, Ames Test, Fluctuation Tests and Eukaryotic Mutation Tests. In vivo Mammalian Mutation tests – Host mediated assay and Dominant Lethal Test. Use of Drosophila in toxicity testing. DNA repair assays.

Chromosome damage test. Toxicological evaluation of Recombinant DNA – derived proteins.

Unit III

Pesticides toxicity

Insecticides: Organochlorines, Anti-cholinesterases – Organophosphates and Carbamates. Fungicides. Herbicides. Environmental consequences of pesticide toxicity. Biopesticide.

Food toxicity

Role of diet in cardio-vascular diseases and cancer. Toxicology of food additives.

Unit IV

Diagnosis of toxic changes in liver and kidneys

Metabolism of Haloalkanes, Haloalkenes and Paracetamol with their toxic effect on tissue.

Detoxification Mechanism in the Body: Enzymes of detoxification – polymorphism in drug metabolizing enzymes. Detection of toxic substances by specific procedures.

Occupational toxicology and assessment of occupational hazards

Industrial effluent toxicology and Environmental health.

Unit V

Air Pollution

Common air pollutants and their sources. Air pollution and ozone. Air pollution due to Chlorofluorocarbons (CFCs) and asbestos.

Metal toxicity

Toxicology of Arsenic, mercury, lead and cadmium. Environmental factors affecting metal toxicity – effect of light, temperature of pH.

An overview of regulatory agencies

Responsibilities of regulatory agencies. Management of Toxicological risk. Regulatory approaches. Regulatory systems and organizations.

MBC 32

BIOCHEMICAL TECHNIQUES

Unit I

Water: Physical properties and structure of water, hydrogen bonding, ionization of water, pH scale, acids – bases. Henderson – Hasselbach equation, buffers, ionization behavior of amino acids and proteins, titration curve, buffer solutions and their actions.

Unit II

Radioisotopic techniques: nature of radioactivity, properties of α-, β-, and γ-rays; measurement of radioactivity, use of radioisotopes in research. In vivo and in vitro labeling techniques, double labeling, quenching, internal standard, channel ratio, external standard ratio, emulsion counting, radioactive decay, autoradiography.

Unit III

Viscosity: its measurement, viscosity of macromolecules, molecular weights of biomolecules. Sedimentation of macromolecules, centrifugation, density gradient and ultracentrifugation techniques. Sub cellular fractionation.

Electrophoretic Techniques: Moving boundary and zonal electrophoresis, paper and gel electrophoresis, isoelectric focusing.

Chromatography: Paper, TLC, adsorption, partition, ion-exchange, reverse phase, gel filtration, gas chromatography, HPLC.

Unit IV

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.

Unit V

Microscopy: Light, electron (scanning and transmision), phase contrast, fluorescence microscopy, freeze-fracture technique, specific staining of organelles or marker enzymes.

MBC 33

BIOINFORMATICS & BIOSTATISTICS

BIOINFORMATICS

Unit I:

Introduction to Bioinformatics and Computer Basics.

What is Bioinformatics, Emerging areas in Bioinformatics, Future prospects of Bioinformatics, Introduction to Genomics, Introduction to Proteomics, Human Genome Project, public Database, GenBank, Using Public database.

Computer and its components, Characteristics of Computer, classification of computers, Hardware basics: Processor/CPU, Input/output devices, motherboard, slots/cards, bus, parallel and serial ports, various storage devices/media, Client-Server concepts, Memory, Software basics: Data vs information, Software: types of software's, Firmware, Operating system, Programming Languages, Compilers, Interpreters, Ideas of portability and platform dependence, MS-DOS, Windows, UNIX, Linux.

Unit II:

Bioinformatics Tools, Techniques and Methods

DNA and Protein sequence analysis, tools, BLAST, FASTA, Protein Visualization tools, Ras Mol, VMD, Chimera, ORF finder, Gene Finder, Gene Scan.

Biological Databases: Medline EMBL Genbank, Pub Med, PDB, Entry and retrieval of Data from public databases.

Unit III:

Bioinformatics Programming; Database and Internet requirements for Bioinformatics

C/C++: Basics, Control Structure, Loop, Array

Perl: variable , Loop, Array Hash Regular Expression

Bio Perl: Basics of Bio Perl

Database: Database basics, RDBMS, MS Access, My SQL, ER-Diagram, Relationship.

Internet: Computer networking: LAN and WAN, Internet and its application, Major features, WWW, and its attributes, web browsers and web server, websites/address/pages, Client Server Principles, protocols, and search engines/tools, Downloading/uploading, Internet connection, Bioinformatics resources on internet.

BIOSTATISTICS

Unit I:

Introduction to Biostatistics; Measures of location, Variability and its measures

Application and uses of Biostatistics as science, as figures, scope, common statistical, terms, notation, sources, and presentation of data: qualitative data, quantitative methods of presentation, Sampling: Types of sampling, variability and significance.

Measures of central tendency- average, mean, median, mode, measures of location-percentile, graphic method, Arithmetical method, application and uses of percentiles, Types, biological, real, experimental, measures of variability, range, semi-inter quartile range (Q), mean deviation, standard deviation (SD), and coefficient of variation (CV), Probability: Addition law of probability, multiplication law, binomial probability, distribution, Poisson distribution, probability chance from shape of normal distribution.

Unit II:

Biostatistical tools and Applications

Idea of parametric and non parametric statistics, Hypothesis testing (large and small sample test), types of errors, and level of significance, confidence interval, test of significance (F-test and T-test), chi-square test, Significance of difference in proportions of large samples, Correlation and regression, Design and methodology of an experiment or a study: Step and methodology, format for presentation of any research work.

MBC 34

CLINICAL BIOCHEMISTRY

Unit I

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

Disorders of Carbohydrate Metabolism: Diabetes mellitus; Glycohemoglobins; Hypoglycemias; Ketone bodies; Glycogen storage diseases; Galactosemia; Various types of glucose tolerance tests.

Lipids, Lipoproteins and Apolipoproteins: Physiology of lipids/lipoproteins, lipidosis; Clinical inter-relationships of lipids (sphingolipiodsis, multiplesclerosis); Lipoproteins and apolipoproteins; Diagnostic tests for apolipoproteins, HDL-cholesterol, LDL-cholesterol and triglycerides disorders.

Unit III

Inborn Errors of Metabolism

Disorders of Amino Acid Metabolism: Phenylalaninemia, homocystineuria, tyrosinemia and related disorders, aminoacidurias.

Electrolytes, Blood Gases and Acid Base Balance: Electrolytes, blood gases, respiration, acid-base balance and acid-base disorders, respiratory and renal mechanism of acid balance disorders.

Disorders of Mineral Metabolism: Hypercalcemia, hypocalcemia, normocalcemia, hypophosphatemia, hyperphosphatemia.

Unit IV

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: Clinical significance of: Aspartate aminotransferase; Alanine aminotransferase; Creatine kinase; Aldolase; Lactate dehydrogenase; Enzyme tests in determination of myocardial infarction; Enzymes of pancreatic origin, biliary tract.

Unit V

Hormonal Disorders: Adrenocortical steroids, Reproductive endocrinology, Thyroid function.

Biochemical Aspects of Hematology: Disorders of erythrocyte metabolism, hemoglobinopathies, thalassemias, and anaemias.

MBC 35

NEUROBIOCHEMISTRY

Unit I

Neuromorphology and Neurocellular Anatomy

Central Nervous system – General features of Neurons. Cellular organization of neurons, astrocytes, oligodendrocytes, ependymal cells, schwan cells. Afferent and efferent pathway; sense organs.

Chemical Composition of Brain

Formation, structure and biochemistry of myelin, chemistry of major brain lipids, lipid composition.

Unit II

Energy Metabolism

Role of astrocytes in energy metabolism. Normal oxygen consumption by the brain, energy demanding functions, role of cerebral circulation, local cerebral blood flow and metabolism, cerebral energy metabolism.

Unit III

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.

Unit IV

Synaptic Transmission and Second Messenger Pathways

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. Cyclic nucleotide and synaptic transmission.

Neurotransmitter and Neuropeptides

Chemistry, synthesis, storage and release of nervous neurotransmitters, transmitter action, synaptic modulation and mechanism of neuronal integration.

Classes of neuropeptides, mode of action, role of neuropeptides in obesity and pain. Neuropeptide receptors.

Unit V

Developmental Neurobiology

Organogenesis and neuronal multiplication, axonal and dendritic growth, glial multiplication and myelination, growth in size, regeneration and plasticity.

Learning and Memory

Correlation of behavioral and biochemical events, measurement of learning and memory, enhancing agents, biochemical correlates of excitation, learning and behavior.

Recommended reading for semester III

1. General and Applied Toxicology. (1995). Marrs and Turner. Macmillian Press Ltd.
2. Basic Environmental Toxicology (1994). Lorris G Corkerhem and Barbara S Shane CRP Press Inc.
3. Tietz Fundamentals of Clinical Chemistry. 5th edition CA Burtis, ER Ashwood. Saunders WB Co.
4. Principles of Internal Medicine. TR Harrison. McGraw Hill, NY.
5. Clinical Biochemistry. By Marshall.
6. Basic Neurochemistry By Siegel.
7. Principles and Techniques of Biochemistry and Molecular Biology K Wilson & J Walker. Cambridge Univ. Press.
8. Biostatistics: A foundation for analysis in the health (7th edition 1999) by WW Daniel. John Wiley and sons Inc, NY.