Department of Biochemistry

Syllabus
for
M. Sc. Biochemistry
Effective from academic session 2016-2017

Central University of Rajasthan
NH-8, Bandarsindri,
Kishangarh-305817
Dist. Ajmer

M.Sc. Biochemistry (Course Structure implemented from academic session 2016- 17 onwards)

Semester I

Code	Title of the course	Type of Course	Credits
MSBC 101	Fundamentals of Biochemistry	Core	3
MSBC 102	Molecular Genetics	Core	3
MSBC 103	Cell Biology	Core	3
MSBC 104	Microbiology	Core	3
MSBC 105	Metabolism and Bioenergetics	Core	3
MSBC 106	Elective I A. Infection Biology B. Environmental Biochemistry C. Human Physiology (Offered by Dept. of Biotechnology)	Elective	3
MSBC 107	Lab-1	Core	3
MSBC 108	Lab-2	Core	3

Total credits: 24

Semester – II

Code	Title of the course	Type of Course	Credits
MSBC 201	Immunology	Core	3
MSBC 202	Developmental Biology	Core	3
MSBC 203	Plant Biochemistry	Core	3
MSBC 204	Analytical techniques	Core	3
MSBC 205	Enzymology	Core	3
MSBC 206	Elective II A. Cancer biology B. Neurobiochemistry C. Bioengineering (Offered by Dept. of Microbiology)		
MSBC 207	Lab-3	Core	3
MSBC 208	Lab-4	Core	3

Total credits: 24

Semester – III

Code	Title of the course	Type of Course	Credits
MSBC 301	Clinical Biochemistry	Core	3
MSBC 302	Genetic Engineering and Applications	Core	3
MSBC 303	Pharmaceutical Biochemistry	Core	3
MSBC304	Biophysics and Bioinformatics	Core	3
MSBC 305	Biosafety, Laboratory safety and IPR	Core	3
MSBC 306	Elective III A. Glycotechnology B. Genomics and Proteomics C. Nanobiotechnology (Offered by Dept. of Biotechnology)	Elective	3
MSBC 307	Lab-5	Core	3
MSBC 308	Lab-6	Core	3

Total credits: 24

Semester – IV

Code	Title of the course	Type of Course	Credits
MSBC 401	Journal Club Presentation	Tutorial/Presentation	3
MSBC 402	Review of Literature for Major project	Tutorial	3
MSBC 403	Major Project (Research Dissertation)	Tutorial/Laboratory	15
MSBC 404	Research Dissertation Presentation	Tutorial/Presentation	3

MSBC-101 Fundamentals of Biochemistry Credit 3

Unit I

Composition of living matter; properties of water; properties of biomolecules in aqueous environment; molecular assemblies; pH, pKa and buffer, Henderson-Hasselbatch equation, super acid, buffers and its mechanism, biological buffers, molarity and normality.

Conformation and configuration, bonding, types of boding, stabilizing interactions hydrogen bonding, van der Waals interaction, electrostatic interaction, hydrophobic interaction, role of non-covalent interaction in the stability of biomolecules.

Unit II

Nomenclature, classification and structure of amino acids, ionization of the amino acids, isoelectric point, determination of isoelectric point of amino acid, classification and structure characterization of proteins, primary, secondary, tertiary and quaternary structure, geometry, symmetry and intermolecular interfaces of quaternary structure, detection of proteins.

Nomenclature, classification and structure of monosaccharides, oligosaccharides and polysaccharides, mutarotation, annomerisation, epimerization, stability of polysaccharides, glycoproteins, glycolipids and proteoglycans, detection of carbohydrates.

Unit III

Nomenclature, classification and structure of nucleic acids, structure of nitrogenous bases, nucleosides and nucleotide, ionization of the bases, detection of nucleic acids.

Nomenclature, classification and structure of lipids, phospholipids, cholesterol, effect of composition of fatty acid and alcohol in the stability of lipids, Lipoproteins structure, and detection of lipids.

Books recommended

- Voet D., Voet J.G, Biochemistry 4th Edition., John Wiley and Sons, 2011.
- Nelson, D. C. andCox, M.M., Lehninger Principles of Biochemistry, 5thEdition,W. H. Freeman, 2010.
- Berg J.M., Tymoczko J.L. and Stryer L., Biochemistry. 7th edition, W.H. Freeman and Co. New York, 2011.

MSBC-102 Molecular Genetics Credit 3

Unit-I

Replication, Transcription and Translation: Replication in prokaryotes and inhibitors of replication, bidirectional replication, replication in RNA virus, eukaryotic replication. Transcription, promoter, foot-printing experiment, posttranscriptional processing in prokaryotes, biosynthesis of rRNA and tRNA, eukaryotic transcription, post-transcriptional modifications of eukaryotic RNAs -RNA editing, RNA splicing. Gene expression and regulations, operon models, genetic code, structure of tRNA, ribosomes, reading frame-shift, prokaryotic and eukaryotic protein biosynthesis

Unit-II

Mutation, DNA repair mechanism: Mutagenesis-numerical mutations involving full chromosome set – polyploidy, aneuploidy, euploidy, transient and spontaneous chemical changes in DNA, transposable elements, DNA repair - direct reversal repair, direct repair of nicks, excision repair, nucleotide excision repair, mismatch repair, long and short patch mismatch repair, recombination error, SOS response and mutagenic repair. Nijmegw breakage syndrome, ataxia-telangiectasia like disorder, xeroderma pigmentosum,

Unit-II

Genetic code and translation: Bacterial genetics- transformation, conjugation and transduction. Non-Mendelian inheritance, Drosophila mapping using recombination analysis. Maternal effect, maternal influence, cytoplasmic inheritance, molecular basis of human genetic disorders- color blindness, Cri du chat syndrome, Down syndrome, Duchenne muscular dystrophy, Tay-Sachs disease, Progeria, Cystic fibrosis, Turner syndrome. Role of telomeres in aging and cancer. Triplex DNA, Quadraplex DNA, R loop, D loop, transcription replication collision.

Books recommended

- Molecular biology by Robert F. Weaver McGraw-Hill 4 edition (2007)
- Advanced molecular biology by R. M. Twyman, (1998)
- Genes VII by B. Lewin Oxford University Press, Cell Press, London (2000)
- Cell and molecular biology by G. Karp, John Wiley & Sons Inc (2002)
- Biochemistry by D.Voet and J. Voet. John Wiley and Sons Ltd

MSBC-103 Cell Biology Credit 3

Unit-I

Cellular organization: Membrane models, chemical composition of membrane, membrane proteins, movement of small and large molecules across the cell membrane, osmosis, diffusion, endocytosis, phagocytosis, artificial liposomes and its application.

Sub-cellular organelles: Structure and functions of intracellular organelles such as nucleus, mitochondria, endoplasmic reticulum, golgi apparatus, lysosomes, plastids, peroxisomes.

Cytoskeleton: Structure, organization and function of microtubules and microfilaments, role of myosin, kinesin and dynein, cell movements.

Unit-II

Extracellular matrix and cell adhesion molecules: Function and composition of extracellular matrix molecules, types of cell adhesion molecules, integrin, cadherin and immunoglobin superfamily proteins.

Protein targeting: Protein synthesis on free and bound ribosomes, modification and quality control of protein in ER, secretion and transport of protein to various cell compartments, post translational modification.

Signal Transduction: Receptors and ligands, cellular communication, signalling through membrane receptors like GPCR, receptor tyrosine kinase, receptor serine/threonine kinase, PI3K/Akt, MAPkinase, cytokine signalling like JAK-STAT, TCR mediated signalling.

Unit-III

Cell cycle and cell death: cell cycle, role of cyclins, cylcin dependent kinase in cell cycle progression. Apoptosis; pro-apoptotic and anti-apoptotic regulators, mechanism of necrosis and autophagy.

Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, interaction of cancer cells with normal cells, therapeutic interventions of uncontrolled cell growth, embryonic signature in cancer cells.

Books recommended

- G.M. Cooper. 2013. The Cell - A Molecular Approach, Sunderland (MA), Sinauer Associates, Inc. USA.
- Gerald K., Cell and Molecular Biology, Concept and Experiment, 5th Edition, Wiley, 2007.
- Lodish, H., Berk A., Kaiser C. A., Krieger M., Bretscher A., Ploegh H., and Scott M.P. Molecular Cell Biology, 7th Edition, Freeman, W. H. and Co., 2013.
- Alberts B., Walter P., Johnson A., Lewis J., Morgan D., and Raff. M., RobertsK., Walter P. Molecular Biology of the Cell, 6th Edition, Garland Publishing Inc., 2014.

MSBC-104 Microbiology Credit 3

Unit-I

Introduction of Microbiology: Origin and evolution of microbial world; Pathway of discovery in Microbiology; Haeckel's three kingdom concept, Whittaker's five kingdom concept, three domain concept of Carl Woese. Classification and bacterial and archaea systematics: conventional and modern methods of bacterial taxonomy. Classification of bacteria according to Bergey's manual, polyphasic approach of bacterial identification, 16S rRNA, genomic similarity - content of guanine (G)+ cytosine (C) (%GC), DNA-DNA homology, fatty acid analysis; general characteristics of archaea, eubacteria, acellular life forms, metagenomics, metatranscriptomics, metaproteomics and microbiome.

Microbes Growth: Definition of growth, mathematical expression of growth, growth curve, diauxic & synchronous growth, continuous culture. Effect of environmental on bacterial growth

Unit-II

Prokaryotic and Eukaryotic Microbiology: General characteristics of various groups of prokaryotes: bacteria including, Rickettsiae, Chlamydiae, Spirochaetes and Actinobacteria, Cyanobacteria and Mycoplasmas.

Eubacteria: cell structure, nutrition, isolation and cultivation. Diversity, nutrition, ecology, significance of gram-positive (Firmicutes, Actinobacteria) and gram-negative [Proteobacteria (cyanobacteria, Rhizobia), Deinococcus-Thermus, Spirochaetes, Bacteroidetes].

Mycology and phycology: General characters of fungi and algae, cultivation, cultural characteristics, microscopic morphology, importance of fungi and algae in industry and food production.

Yeasts: General characteristic, structure, classification, life cycles (important forms), sexual and asexual reproduction of yeast (*Saccharomyces cerevisiae)*

Unit-III

Virology- Structure of animal viruses and plant viruses; satellite viruses; viroids; prions; diseases caused by animal viruses and plant viruses, genome organization of animal viruses; genome organization of DNA and RNA plant viruses, bacteriophages, lytic and lysogenic cycles, cultivation of viruses, diagnosis viruses

Protozoa: Classification, morphology, reproduction, modes of nutrition, modes of transmission, life cycle, cultivation of protozoa. Structure and significance: *Leishmania*, *Entamoeba*, *Plasmodium*.

Books recommended

- Michael J Pelczar, Microbiology, Tata McGraw, India.
- Microbiology by Stuart Walker, W B Saunders

- Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses. S. J. Flint, V. R. Racaniello, L. W. Enquist, V. R. Rancaniello, A. M. Skalka.

MSBC-105 Metabolism and Bioenergetics Credit 3

Unit-I

Bioenergetics-basic principles; enthalpy, entropy, Equilibrium constant and concept of free energy; coupled reaction; principles of metabolic regulation; redox potentials regulatory steps; signals and second messengers, high-energy compounds, ATP as energy currency.

Energy transducing membrane, electron transport system in mitochondria, structure of different electron carrier, oxidative phosphorylation, P/O ratio, uncouplers, thermodynamics of electron transport system in mitochondria.

Unit-II

Glycolytic pathway; regulation of the hexokinase, phosphofructokinases, Kreb'scycle; amphibolic nature of TCA cycle, glyoxylate cycle, glycogen breakdown, glycogen synthesis, regulation of glycogen metabolism, gluconeogenesis and its regulation, pentose phosphate pathways.

Synthesis of various lipids, elongation of fatty acids, desaturation of fatty acids in microsomes, regulation of fatty acid synthesis, cholesterol metabolism, regulation of cholesterol metabolism, composition and synthesis of lipoproteins and their transport in the body

Unit-II

Synthesis of purine and pyrimidine nucleotides *De Novo* and its regulation. Synthesis of nucleoside di- and triphosphates, deoxynucleotides and TMP and degradation of purine and pyrimidine nucleotides, salvage pathways of nucleotides synthesis.

Role of vitamins in the metabolism, essential and non-essential amino acids, general reactions of amino acid metabolism, urea cycle, synthesis of various molecules via amino acid metabolism intermediates

Books recommended

- *Voet D., Voet J.G, Biochemistry*4th Edition., John Wiley and Sons, 2011.
- Nelson, D. C. andCox, M.M., Lehninger Principles of Biochemistry, 5th Edition,W. H. Freeman, 2010.
- *Berg J.M., Tymoczko J.L.* and *Stryer L.,* Biochemistry. 7th edition, W.H. Freeman and Co. New York, 2011.

MSBC-106 Elective I Credit 3

A. Infection Biology

Unit-I

Viral infection: Development of HIV virus, HIV infection to humans, Structure of HIV virus, mechanism of HIV infection, role of T cells in infection development, development of therapy against HIV, anti-retroviral therapy, HAART, economic loss by HIV at national & international level. Hepatitis virus, types of hepatitis infection, viral outbreaks such as Ebolla, H1N1, and Zika virus.

Unit-II

Bacterial infection: Development of tuberculosis infection, diagnosis of tuberculosis, epidemiology and geography of tuberculosis, treatment of tuberculosis, identification of drug targets, vaccine development for tuberculosis, mechanism of antituberculosis drug action, development of resistant, multidrug resistant, economic loss by tuberculosis at national and international level, HIV-tuberculosis co-infection.

Unit-III

Parasite infection: Parasitic infectious diseases, leishmaniasis, epidemiology and geography of leishmaniasis, vector and transmission of leishmaniasis, host-pathogen interaction, diagnosis and treatment for leishmaniasis, genetics of leishmaniasis, mechanism of drug resistance and drug susceptibility for promastigotes and amastigotes, history of malaria, life cycle of *plasmodium*, factors affecting transmission of parasite, vectors and epidemics, parasite

metabolisms, secondary endosymbiosis, drug resistant parasites, identification of drug targets, amoebiasis.

Books recommended

- Irwin W. Sherman, Malaria Parasite Biology, Pathogenesis, andProtection, American Society for Microbiology. 1998.
- WHO technical series-949; Control of the leishmaniasis (ISBN 978 92 4 120949 6).
- Virology: Principles and Applications John Carter, Venetia Saunders.

B. Environmental Biochemistry

Unit-I

Environmental components: Atmosphere, structure and chemical composition of atmosphere, Internal structure of the Earth, rocks and their classification, minerals and their classification. Weathering and soil formation, soil profile, soil classification, soils of India.
Global Water Balance. Origin and composition of sea water. Hydrological cycle. Classification of trace elements, mobility of trace elements, biogeochemical cycles.

Unit-II

Fundamentals of Ecology: Definition, subdivisions. Ecosystems: concept of ecosystems, aquatic ecosystem, terrestrial ecosystem, energy flow in ecosystems, nutritional flux. Food-chains, Food web, ecotone, edge effects, ecological habitat & niche, ecological pyramids and ecosystem stability, concept of habitat and niche.
Biomes and Habitat Diversity: Classification of biomes, major biotic elements of each biome and their characteristics. Population and community ecology, population growth curves, life history strategies (r &k selection); concept of metapopulation. Ecological succession, primary and secondary, mechanism of succession.

Unit-III

Global environmental issues and International laws: Global warming, Green house effect, ozone depletion, acid rains, hazardous waste, CITES etc. Earth's carbon cycle, carbon sequestration, sustainable development.
Bioremediation: Introduction and types of bioremediation, bioremediation of surface soil and sludge, bioremediation of subsurface material, *In situ* and *Ex-situ* technologies, Phytoremediation.
Chemical toxicology: Biochemical effects of heavy metals (Pb, As, Hg, Cd), pesticides, insecticides, herbicides, weedicides, larvicides.

Books recommended

- Fundamentals of Ecology 5th Edition by Eugene Odum (Author), Gary W. Barrett (Author)
- Environmental Chemistry Paperback –by V. K. Ahluwalia (Author), Lalita S. Kumar (Author), ANE Books
- Environment and Ecology: Biodiversity, Climate Change and Disaster Management, by Majid Husain (Author), Access Publishing
- Environmental Biology (Principles of Ecology), 4/e DR. P.S. VERMA & DR. V.K. AGARWAL, S. Chand Publishing
- Ecology Environmental Science and Conservation, 1/e, J.S. SINGH, S. R. GUPTA& S P Singh, S. Chand Publishing.
- Textbook of Environmental Chemistry, by Ayodhya Singh, Publisher: Neha Publishers & Distributors.

MSBC-107 Biochemistry Laboratory I Credit 3

- To prepare an Acetic-Na Acetate Buffer system and validate the Henderson-Hasselbach equation.
- To determine concentration of an unknown protein by plotting a standard graph of BSA using UV-Vis Spectrophotometer. Determination of Molar extinction coefficient.
- Qualitative and Quantitative Analysis of Carbohydrates, Amino acids and proteins, Vitamin C.
- Separation of amino acids and sugars by TLC
- Protein purification and separation by gel filtration, ion-exchange chromatography and SDS-PAGE
- Determine pKa and pI of amino acids
- Introduction to animal cell culture techniques
- Extraction of proteins, RNA and DNA from cultured cells.

MSBC-108 Biochemistry Laboratory II Credit 3

- Sterilization, disinfection, safety in microbiological laboratory
- Preparation of media (plates, broth and slants) for growth of various microorganisms.
- Identification and culturing of various microorganisms. Spreading and streaking plating techniques.
- Staining of bacteria – Simple staining, differential staining, staining of spores and capsules
- Enumeration of microorganisms from water by viable plate counting

- Determination of growth curve of bacteria and calculation of bacterial population by turbidometry
- Effect of pH, temperature and UV irradiation in bacterial growth
- Determination of Minimal Inhibitory concentrations (MIC) for kanamycin and ampicillin against Bacteria.

MSBC-201 Immunology Credit 3

Unit-I

Introduction to Immune system: Basic concept of immune system, cells and organs of immune system, lymphoid cells (B- lymphocytes, T- lymphocytes and Null cells), mononuclear cells (phagocytic cells and their killing mechanisms), granulocytic cells (neutrophils, eosinophils and basophils), mast cells and dendritic cell. Structure and functions of primary and secondary lymphoid organs.
Innate Immunity: TLR receptors and sensing of PAMPs. Opsonization, Fc Receptors, prostaglandins and leukotrienes. Antigen, super antigens, immunogens, adjuvents, antigen processing, antibody structure and function, classification of immunoglobulins, concept of variability, cross reactivity, isotypes, allotypes and idiotypic markers, class switching, receptor and soluble form of immunoglobulins.

Unit-II

B and T cell Immunology- B and T cell development, differentiation, maturation, clonal anergy, humoral immune response, B cell differentiation, antibody engineering, BCR and pre-BCR, Receptor editing, complement system, classical and alternative pathways, concept of histocompatibility, structure and function of class I and class II MHC molecules, structure of HLA complexes. T cell receptors

Antigen presentation cells, APC-T cell interaction, T cell differentiation in thymus, Th1, Th2, Th17, Treg cells and cytokines, chemokines, cytotoxic T cells, natural killer cells, dendritic cells.

Unit-III

Antigen dependent cell cytotoxicity, cytotoxicity reactions, CD8+ T cell cytotoxicity, autoimmunity, acquired immunodeficiency, hypersensitivity reactions, grafting and transplantation immunology, host-pathogen interaction, immunotherapy, T cell immunotherapy & B cell immunotherapy.

Vaccines, different types of vaccines and its significance, monoclonal and polyclonal antibody production, hybridoma technology.

Books recommended

- Kindt, T. J.,Osborne, B. A. and Goldsby, R. A. Kuby Immunology, 6th Edition, W. H. Freeman, 2006.
- Abbas, A. K., Lichtman, A. H. and Pillai, S., Cellular and Molecular Immunology, 6th Edition, Saunders, 2007.
- Roitt's, Essential Immunology. Ivan M Roitt& Peter J. Delves. 10th edition. Blackwell Publishing**.**

MSBC-202 Developmental Biology Credit 3

Unit-I

Basic concept of development: Basic features of development in animals, gametogenesis, types of eggs, fertilization, cleavage, and blastula, modification of development in evolution, generation of multicellular embryo, formation of germ layers, patterning of vertebrate body plan, Hormonal regulation of gametogenesis in male and female of mammals.

Morphogenesis and organogenesis in animals and plants: *C. elegans*: Study of cell lineage, mosaic development and organogenesis. **Drosophila**: Pattern formation, polarity determination of embryo, formation of body segments, Homeotic genes. **Mouse**: Vertebrate development, determining function of genes during development by generation of knockout and knock-in models. **Arabidopsis:** Organization of shoot and root apical meristem; shoot and root development.

Unit-II

Stem cells in development: Properties of stem cells, embryonic stem cells, mesenchymal stem cells, hematopoietic stem cells, inducible pluripotent stem cells, epithelial to mesenchymal transition, cancer stem cells, embryonic signature in cancer stem cells, stem cell markers and factors.

Differential gene expression in development: Differential gene transcription, differential RNA processing, DNA methylation and control of gene transcription, control of gene expression at the level of translation.

Unit-III

Cell culture: Primary cells, cell lines, immortalization of cells, basic steps of cell culture, isolation of primary cells and stem cells, cryopreservation of cell lines, Cell culture assays (cell

viability and cytotoxicity tests, migration and invasion assays), applications of animal cell culture in testing of drugs and production of pharmaceutical proteins.

Medical implications of developmental biology: Medical embryology and teratology, Genetic errors of human development, in-vitro fertilization, environmental assaults on human development, design of future medicines like gene therapy, therapeutic cloning and regeneration therapy.

Books recommended

- Developmental Biology by Scott F. Gilbert, Sinauer Associates, Inc, MA, USA, 10th Edition, 2013.
- CaenorhabditisElegans: Molecular Genetics and Development, second edition, By Joel H. Rothman Academic Press, 2011
- A. Nagy, M. Gertsenstein, K Vintersten, R. Behringer. 2003. Manipulating the mouse embryo: a laboratory manual, Cold spring Harbor Press, New York, USA.
- Stem cell biology edited by Daniel R. Marshak, Richard L. Gardner, David Gottlieb,2001 Cold Spring Harbor Laboratory Press.
- Essentials of Stem Cell Biology, 3rd Edition, edited by Lonza and Atla, Academic Press, 2013

MSBC-203 Plant Biochemistry Credit 3

Unit-I

Plant cell: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins, stomatal movement, transpiration, photoperiodism and biological clocks, plant movement.

Photosynthesis: Photosynthetic apparatus, pigments of photosynthesis, Calvin cycle (C3 plants), Hatch slack (C4 plants) & CAM pathways of carbon reduction and its regulation, Structure, function and regulation of RUBISCO, Crassulacean acid metabolism in plants.

Photorespiration: photorespiration pathway and significance, cyanide resistance, relationship between photosynthesis, photorespiration.

Unit-II

Phytohormones: Biosynthesis, transport, physiological effects, mode of action and signal transduction of auxins, gibberlic acid, abscisic acid, ethylene and cytokinins in germination, embryogenesis, growth and development of plant.

Nitrogen metabolism: Nitrogen fixation, nitrogenise complex, biochemistry and genetics of nitrogen fixation and ammonium assimilation, structure of 'NIF' genes and its regulation,

structural features of nitrate reductase and nitrite reductase, regulation of nitrate and sulphate assimilation.

Secondary plant metabolites: Nature, distribution, biosynthesis and function of plant metabolites, biosynthesis of nicotine. Biochemistry of plant toxins, phytohemagglutinins, lathyrogens, nitriles, protease inhibitors, protein toxins, role of secondary metabolites in chemical defence.

Unit-III

Plant stress physiology: Plant stress, plant responses to abiotic and biotic stresses, salinity, water, heat, chilling, anaerobiosis, heavy metals, radiations and their impact on plant growth and metabolism, mechanisms of resistance to biotic stress and abiotic stress, antioxidative defence mechanism.

Plant defence: Genetic basis of plant-pathogen interactions, antio R-Avr gene interactions and isolation of R genes, hypersensitive response (HR), systemic acquired resistance (SAR) and induced systemic resistance (ISR).

Books recommended

- Introduction of Plant Biochemistry, by Goodwin T. W. and E.I. Mercer, Pergamon Press, Oxford, 1983.
- Plant Physiology, 5th Edition, by Lincoln Taiz and Eduardo Zeiger, Amazon press, 2012
- Introduction of Plant Biochemistry, by Goodwin T. W. and E.I. Mercer, Pergamon Press, Oxford.
- Buchanan BB, Gruissem W & Jones RL. 2000. *Biochemistry and Molecular Biology of Plants.* 2nd Ed. John Wiley.
- Dey PM &Harborne JB. 1997. *Plant Biochemistry*. Academic Press.
- Heldt HS. 1997. *Plant Biochemistry and Molecular Biology*. Oxford Univ.Press.

MSBC-204 Analytical techniques Credit 3

Unit-I

Gel filtration chromatography, Ion exchange chromatography, affinity chromatography, HPLC, Electrophoresis, SDS-PAGE, AGE, PFGE, Capillary electrophoresis, Centrifugation and Ultracentrifugation, RCF/RPM, Sedimentation (s).

Different hybridization methods, Southern blotting, Northern blotting, Western blotting, South-western blotting, EMSA, Foot printing, Yeast Two hybrid system, Chromatin immuno-precipitation

Polymerase chain reaction, Thermostable polymerases and other component of PCR, Asymmetric PCR, methylation-specific PCR, Nested PCR, Inverse PCR, Anchored PCR, reverse transcriptase PCR, Real-time-PCR, efficiency of PCR,

Unit-II

Proteomics, Protein sequencing methods, Genomics, DNA sequencing methods, Next Generation Sequencing, Metagenomics. Species identification via r-RNA analysis, FAME analysis.

Light microscope, Fluorescent microscopy, AFM, Phase Contrast microscopy, Confocal Microscopy, Electron microscopy, Radioisotopes and its half-life, specific activity, scintillator counter, proposal counter, Geiger Muller counter, Cerenkov counter and autoradiography, Application of PET, MRI and CT scan.

Molecular Marker Analysis -RFLP maps, RAPD markers, AFLP markers, VNTR, SNP analysis, SCAR (sequence characterized amplified regions), SSCP (single strand conformational polymorphism).

Unit-III

Principle and significance of UV-Vis spectroscopy, Fluorescence spectroscopy, FRET, Luminescence, Circular Dichroism, Infra-Red spectroscopy, Raman spectroscopy, Nuclear Magnetic Resonance, X-ray diffraction, Mass spectrometry, Differential scanning calorimetry, Isothermal titration calorimetry, Surface Plasmon Resonance
Immuno-electrophoresis, immune-precipitation, agglutination, RIA, ELISA, FACS, immune-fluorescence microscopy, Immuno-electron microscopy, Fluorescence In-situ hybridization (FISH).

Measures of central tendency, Regression and Correlation, ANOVA; Errors; Levels of significance; probability distributions; Analysis of variance Hypothesis; Probabilities; t-test, p-value; χ^2test.

Books recommended

- Christian, G. D., Analytical Chemistry, John Wiley & Sons (Asia) Pvt. Ltd., 2004.

- Wilson, K. and Walker, J., Principles and Techniques of Practical Biochemistry and Molecular Biology, 7th Edition, Cambridge Univ. Press, 2010.
- David Freifelder, Physical Biochemistry, 2nd edition, John Wiley and Sons 2005.

MSBC-205 Enzymology Credit 3

Unit-I

Enzyme definition and characteristics, mechanism of enzyme action, activation energy, collision & transition state theories, nomenclature and classification of enzyme, pH optimum curve and determination of p*K* Values.

Type of enzymatic catalysis; acid-base, nucleophilic-electrophilic covalent catalysis, mechanisms of action of chymotrypsin, ribonuclease and lysozyme; ribozymes, synthetic enzymes (e.g., β-benzyme)

Kinetics of single substrate reaction, rapid equilibrium and steady-state approach, enzyme kinetics parameters (Km, Vmax, Kcat, Kcat/Km), determination of kinetics parameters using Lineweaver-Burk, Eddie-Hofstee plot, Scatchard plot.

Unit-II

Enzyme Inhibition, irreversible inhibition, mechanism and kinetics of competitive non-competitive and un-competitive inhibition, model of enzyme inhibitions, kinetics of bi-substrate reaction, ping-pong reaction, multi-substrate reaction, therorell chance displacement,

Allosteric enzymes, symmetrical and sequential model, Hill's coefficients, cooperativity, positive and negative, hemoglobin as a model for cooperativity.

Enzyme regulation and feedback control, phosphorylation, enzyme regulation of aspartic transcarbamylase and metalloenzymes, carboxypeptidase A, isozymes and their significances.

Unit-III

Enzyme stability, stability estimates from denaturation curves, engineering physical and biological properties of enzyme, engineering disulphide bonds and modifying enzyme activity & specificity, engineering thermostable and cryostable enzymes.

Engineered chimeric antibody, protein engineering of antibody, combining sites, replacement of FC domains, catalytic antibodies (abzymes).

Enzyme immobilization techniques, use of isolated enzymes in industrial processes, engineering industrial important enzyme.

Books recommended

- Enzymes: Biochemistry, Biotechnology and Clinical Chemistry by Trevor Palmer, Publisher; Horwood Publishing Limited (2004)
- Enzymes: A Practical Introduction To Structure, Mechanism And Data Analysis by Robert A. Copeland, publisher: Wiley (2012)
- Introduction to Enzyme and Coenzyme Chemistry, 3rd Edition by T.D.H. Bugg, publisher Wiley-Blackwell
- Lehninger Principles of Biochemistry, Fourth Edition, David L. Nelson and Michael M. Cox. W. H. Freeman; 4th edition (2004)

MSBC-206 Elective II Credit 3

A. Cancer Biology

Unit-I

Introduction to Cancer Biology: Definition and classification; cancer statistics; evolution of cancer cells; cellular oncogenes; oncogene, viral-oncogene, tumorigenicity, classes of tumor suppressor genes; p53, Rb and PTEN, micro RNAs and regulation of cancer growth; tumor suppressor microRNAs and oncomiRs. Characteristics of tumors; metastasis; migration & invasion, metastasis steps, epithelial to mesenchymal transition, angiogenesis; hypoxia and VEGF, crosstalk between autophagy and apoptosis in mammalian cells.

Unit-II

Microenvironment of Tumor cells: Stroma interaction,adipose stromal cells, mesenchymal stem cells, impact of tumor-stroma interaction on tumor development, tumor immunology; interferons, T cells, cancer stem cells; origin, isolation and culture of cancer stem cells, animal models of cancer study; xenograft and metastasis models.

Unit-III

Signalling mechanisms: Cancer growth and metastasis: PI3Kinase/Akt, MAPkinase, EGF & PDGF signalling; TGF beta, BMP and Smad signalling; involvement of Zeb1, Twist factors in cancer metastasis, *in vitro* testing of stemness property of cancer stem cells; detection and monitoring of metastasis process in animal models; osteoblastic & osteolytic metastasis, Success and failure of chemotherapy, targeted specific therapy, monoclonal antibody for cancer treatment, micro-RNA mediated cancer treatment and targeted drug delivery, drug resistance, molecular diagnosis and stem cell therapy.

Books recommended

- The Biology of Cancer, 2nd Edition, Robert A Weingberg, ISBN-10: 0815342209, ISBN-13: 978-0815342205
- Cancer Biology, 4th Edition, Raymond W Ruddon, ISBN-10: 0195175441 | ISBN-13: 978-0195175448

B. Neurobiochemistry

Unit-I

Developmental Neurobiology: Organogenesis and neuronal multiplication, axonal and dendritic growth, glial multiplication and myelination, growth in size, regeneration and repair mechanisms, plasticity.

Neuromorphology and neurocellular anatomy: Central nervous system (CNS) and peripheral nervous system (PNS), autonomous nervous system, somatic nervous system, dendritis and axons, neurofilaments. Sensory receptor and effector endings; peripheral nerves, spinal and cranial nerves: Plexuses ganglia, afferent pathways and sense organs. Spinal cord: Topographical anatomy, spinal nerves, grey and white matter of spinal cord.

Unit-II

Neurotransmitters: Acetylcholine, dopamine, norepinephrine, etc., - chemistry, synthesis, storage and release of neurotransmitters, transmission, synaptic modulation, receptors involved and mechanism of neuronal integration. Electrical and chemical synapses, temporal and spatial summation, voltage dependent calcium channel and their blockers, EPSP and IPSP, receptor agonists and antagonists.

Secondary Messengers: Importance of cyclic nucleotides and protein phosphorylation in nervous system. Involvement of protein kinases and calcium in neuronal metabolism. Neuropeptides: classes of neuropeptides, mode of action, role of neuropeptides in obesity and pain neuropeptide receptors.

Unit-III

Learning and Memory: Correlation of behavioral and biochemical events, measurement of learning and memory, agents affecting learning and memory, biochemical correlates of excitation, learning and behavior.

Neurodegenerative diseases: Parkinson's, alzheimar's disease, amyotrophic lateral sclerosis, senile dementia. Biochemical theories of mental disorder: chemistry of neuroleptics and anxiolytics and Schizophrenia.

Books recommended

- Siegel et al., Basic Neurochemistry, 6th Edition, Lippincott -Williams-Wilkins, 1999
- Kandel et al., Principles of Neural science, 4 Edition, McGraw-Hill Medical, 2000.
- Zegmond, Fundamentals of Neuroscience, 1st Edition, Academic Press, 1999
- Bear: Neuroscience: Exploring the Brain, 2nd edition, Lippincott Williams & Wilkins, 2001

MSBC-207 Biochemistry Laboratory III Credit 3

- Serum separation, Storage.
- Antibody titer by ELISA method.
- Precipitin reaction by double immunodiffusion and radial immunodiffusion (Ouchterlony and Mancini's methods)
- Separation of mononuclear cells by Ficoll-Hypaque
- Immunodiagnostics using commercial kits
- Blood smear identification of leucocytes by Giemsa stain
- Detection of antigens by immunoblotting techniques, western bloting
- Identification of various stages in the embryonic development of frog and mice using permanent slides.

MSBC-208 Biochemistry Laboratory IV Credit 3

- Estimation of total chlorophyll, chlorophyll a and chlorophyll b pigments firm the leaves.
- Estimation of starch content.
- Spectrophotometric estimation of Indole acetic acid in plant tissues.
- Estimation of carotene, ascorbic acid, phenols and tannins in fruits and vegetables.
- Enzymatic Assays
- Determination of optimum pH and temperature for enzymatic activity
- Effect of substrate concentration on enzyme kinetics
- Determination of kinetic parameters

MSBC-301 Clinical Biochemistry Credit 3

Unit-I

Quality control, accuracy, precision, specificity, sensitivity and limitation of errors allowable in the laboratory; Chemistry, composition & functions of lymph, CSF, and synovial fluid;

Urine formation, excretion and urine analysis; collection of bloods, anti-coagulants, preservatives of blood; Composition, chemistry & functions of specialized tissues like i.e. bone, brain, adipose tissue, etc.

Clinical investigation of sugar levels in blood and urine; factors influencing blood glucose level; carbohydrate tolerance tests, glycogen storage diseases;

Biosynthesis of bile acids, bile pigments and steroid hormones, plasma lipoproteins, Disorders associated with lipid metabolism and its therapeutic intervention, ketone bodies and ketosis;

Unit-II

Hemoglobin, Met-Hb, embryonic-Hb, heme metabolism associated diseases, sickle cell anemia, thalasemia, malnutrition, measurement of fuel values of foods, measurement and calculation of BMR,

Metabolic disorders of amino acid metabolism and urea cycle, phenylketonuria, alkaptonuria, albinism, Lesch-Nyhan syndrome, disorders of nucleic acids metabolism

Biochemical mechanism of blood clotting and hemorrhagic disorders, disseminated intravascular coagulation, acquired prothrombin complex disorders.

Biochemistry of vitamins and micronutrients, biochemical basis of diseases with their deficiency;

Unit-III

Electrolytes, reabsorption of electrolytes, acid-base balance, regulation of electrolyte content of body fluids and maintenance of pH, regulation of sodium and water balance, renin-angiotensin system, clinical investigation of sodium, potassium, chloride;

Pathophysiology of different diseases like diabetes, Jaundice, Fatty liver, atherosclerosis, and osteoporosis;

Functional test of liver, kidney, thyroid, gastrointestinal and pancreas, biochemical diagnosis of diseases by enzymatic assays;

Clinical tissue analysis, biopsy, liquid biopsy, circulating RNA and DNA as molecular diagnosis of different diseases.

Books recommended:

- Harpers Illustrated Biochemistry 30th Edition, McGraw-Hill Education, 2015
- Clinical Biochemistry and Metabolic Medicine Eighth Edition by Martin Andrew Crook, CRC Press, 2012
- Textbook of Biochemistry for Medical Students, 7th edition, by D M Vasudevan, Sreekumari S, KannanVaidyanathan, 2010, Jaypee.
- Clinical chemistry: Techniques, Principles, Correlations , 6th Edition, by Bishop, Fody and Schoeff, 2012, Lippincott Williams & Wilkins

MSBC-302 Genetic Engineering and Applications Credit 3

Unit-I

rDNA Technology: Restriction enzymes, restriction modification system, DNA ligase, *E. coli* DNA polymerase I and Klenow enzyme, T4 DNA polymerase, reverse transcriptase, polynucleotide kinase, alkaline phosphatase.

Cloning Methodologies: Plasmids and plasmid vectors, new generation of plasmid cloning vectors, Lambda vectors - insertion and replacement vectors, cosmids. High capacity cloning vectors – YACs, BACs and PACs. Shuttle vectors. Expression vectors - pMAL, GST, pET-based vectors. Eukaryotic expression vectors. Protein purification: His-tag, GST-tag, MBP-tag etc. Vectors used for cloning in animal cells: SV-40, vaccinia/bacculo and retroviral vectors. Plant based vectors, Ti vectors.

Unit-II

Genomic and cDNA library preparation: Methods for construction of genomic and cDNA libraries – vectors used, generation of cDNAs, preparation of genomic DNA for library construction. Lambda *in vitro* packaging. Methods used in the identification and analyses of recombinant DNA clones. Protein-protein interaction and yeast two hybrid system. Phage display. Principles of maximizing protein expression

RNA interference &rDNA therapy: Introduction to siRNA, siRNA technology, microRNA, construction of siRNA vectors, principle and application of gene silencing. Production of insulin, drug, vaccines, diagnostic probe of genetic diseases. Gene therapy

Unit-III

Transgenic Technology: Gene knockout and knock-in, Generation of transgenic animals and its application, Cre-loxP recombination technology, Homologus and Non-homologus recombination, Gene isolation, gene transfer systems, Ti plasmid, plant virus vectors,

electroporation, microinjection, microprojectile technology, particle bombardment, Generation of transgenic plants and its application, Plant tissue culture, anther and pollen culture, protoplast culture, protoplast fusion, cybrid, somatic hybrid, somatic embryogenesis, embryo rescue, application of recombinant DNA technology in photosynthetic efficacy, nitrogen fixation efficiency and resistance to environmental stresses.

Books recommended

- T.A. Brown, Gene Cloning and DNA Analysis: An Introduction. Fifth Edition, Wiley-Blackwell, 2006.
- S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2011.
- J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.

MSBC-303 Pharmaceutical Biochemistry Credit 3

Unit-I

Bioinformatics approached for drug development: Identification of potential molecules, chemical compound library preparation, Identification of target in pathogen, Ligand & protein preparation, Molecular docking, Binding free energy estimation, High throughput virtual screening, Docking protocol validation and enrichment analysis, Single point energy calculation, Pharmacokinetics and Pharmacodynamics, ADME & toxicity prediction, Molecular dynamic simulation, Rule of three and five, Lipinsky rule, Pharmacophore development, Quantitative structure activity relationship, 3D-QSAR, Techniques of developing a pharmacophore map covering both ligand based and receptor based approaches.

Unit-II

Drug metabolism & interactions: Drug-receptor interactions, receptor theories and drug action, Xenobiotics, xenobiotics phases (Phase-I, Phase-II and Phase-III), role of cytochrome P450 oxidases and glutathione S-transferases in drug metabolism, factors affecting drug metabolism, Enzymes as a drug target, Kinase inhibitors, ATPase inhibitors, drug protein interaction, Drug-DNA interaction.

Basic ligand concepts – agonist, antagonist, partial agonist, inverse agonist, efficiency and potency. Forces involved in drug-receptor complexes. Receptor classification – the four superfamilies. Receptor binding assays- measurement of K_d, B_{max} and IC_{50}.

Unit-III

Drug delivery & trials:General principles of screening, correlations between various animal models and human situations, Correlation between in-vitro and in-vivo screens; Special emphasis on cell-based assay, biochemical assay, radiological binding assay, Pharmacological assay, In vitro, In vivo & Ex-vivo experiments, Preclinical and clinical trials (Phase-I, Phase-II, Phase-III and Phase-IV clinical trial).

Main features of clinical trials, including methodological and organizational considerations and the principles of trial conduct and reporting. Key designs surrounding design, sample size, delivery and assessment of clinical trials.

Books recommended

- Practical Application of Computer-Aided Drug Design, Ed. Charifson P., Marcel Dekker Inc.
- 3D QSAR in Drug Design: Theory, Methods and Applications, Ed. Kubinyi H., Ledien ESCOM.
- Pharmaceutical Profiling in Drug Discovery for Lead Selection, Borchardt RT, Kerns EH, Lipinski CA, Thakker DR and Wang B, AAPS Press, 2004

MSBC-304 Biophysics and Bioinformatics Credit 3

Unit-I

Conformations of peptide and proteins; different level of protein structure, Ramachandran plot, non-repetitive structures, protein folds, protein motifs, domains and domain swapping, protein symmetry and rules of association of subunits, prokaryotes and mammalian molecular chaperons, rotamases, intrinsically disorder proteins and their significance. Structure of globular proteins and fibrous proteins, unnatural amino acids, peptides and peptidomimetics.

Two state models of protein stability, protein denaturation, effect of osmolytes on biomolecules stability, protein folding- rules, pathways, thermodynamics and kinetics, folding of RNaseA, Levinthal Paradox, Chevron plot, Φ-value analysis, m-value analysis, protein-protein interactions, Receptor binding assays; Determination of affinity and binding capacity of receptor; Scatchard plot, Receptor agonists and antagonists.

Unit-II

Torsion angles of nucleotide, sugar conformation, DNA motifs, DNA repeats and their significance chemical structure and properties of purine, pyrimidine, nucleoside, nucleotide and their derivative, structure and properties of different type of DNA and RNA, triple-helix DNA, quadraplex DNA, higher orders of DNA structure. Effect of pH, humidity, metal & salt on the conformation of DNA, protein-nucleic acid interactions

Physical properties of membrane, membrane melting and effect of membrane composition on the Tm of membrane, trans-membrane helices, hydropathy plot and prediction of membrane spanning domains, membrane asymmetry, membrane fluidity, detergents and membrane solubilization, functional reconstitution of artificial membranes Membrane potentials, nernst equation, trans-membrane potential, zeta, stern, membrane transport, Donnan's equilibrium, membrane transport

Unit-III

Databases (protein, nucleic acid, Domain), multiple sequence alignment, phylogenetic clustering and analysis, *ab initio* structure prediction methods, fold recognition methods, methods for modelling, homology modelling, threading and protein structure prediction, structure-structure comparison of macromolecules with reference to proteins, force fields, molecular energy minimization,

Docking- using energy minimization, superimposition, molecular dynamics, metropolis montecarlo, genetic algorithms and build-up approach, molecular dynamics simulation, rational drug design, proteins as targets for rational structure based drug design, different types of scoring function, Pharmacokinetics and its utility in drug design, use of bioinformatics in proteomics, genomics and meta-genomics.

Books recommended

- Thomas E. Creighton, Proteins: Structure and Molecular Properties, W H Freeman & Co, 2011.
- Alexei V. Finkelstein, Oleg BorisovichPtitsyn, Protein physics: A course of lectures, Academic Press, 2002.
- Carl-IvarBrändén, John Tooze, Introduction to Protein Structure , Garland Pub., 1999.
- Jack Kyte , Structure in Protein Chemistry , Garland Science, 2007.
- David Whitford, Proteins-Structure and function , Wiley, 2005.
- Moganty R. Rajeswari, An introduction to Biophysics, Rastogi Publications, 2012.
- A. Kessel and Nir Ben-Tal, Introduction to Proteins-Structure, function and motion, CRC press, Taylor and Francis, 2011.
- Georg E. Schulz, R. HeinerSchirmer, Principles of protein structure, Springer, 1998.

MSBC-305 Biosafety, Laboratory safety and IPR Credit 3

Unit-I

Biosafety: Historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; recommended biosafety levels for infectious agents and infected animals; biosafety guidelines - government of India, roles of IBSC, RCGM, GEAC etc. for GMO applications in food and agriculture; environmental release of GMOs; risk assessment; risk management and communication; national regulations and international agreements.

Bioethics: Introduction to bioethics, human genome project and its ethical issues, genetic manipulations and their ethical issues, ethical issues in GMOs, foods and crops in developed and developing countries, environmental release of GMOs, ethical issues involved in stem cell research and use, use of animals in research experiments, animal cloning, human cloning and their ethical aspects, testing of drugs on human volunteers.

Unit-II

Intellectual Property Rights (IPR): Introduction to patents, types of patents, process involved in patenting in India, trademarks, copyright, industrial design, trade secrets, traditional knowledge, geographical indications, history of national and international treaties and conventions on patents, WTO, GATT, WIPO, Budapest Treaty, Patent Cooperation Treaty (PCT) and TRIPS.

Patent databases: Searching international databases; analysis and report formation. Indian Patent Act 1970; recent amendments; filing of a patent application; precautions before patenting-disclosure/non-disclosure; procedure for filing a PCT application.

Unit-III

Patent filing and infringement: Patent application- forms and guidelines, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and convention patent applications, International patenting-requirement, financial assistance for patenting-introduction to existing schemes; Publication of patents-gazette of India, status in Europe and US.

Research Patenting: Patenting by researchers and scientists-University/organizational rules in India and abroad. Detailed information on patenting biological products, Case studies on patents (basmati rice, turmeric, neem etc.), and patent infringement.

Books recommended

- P Ganguly, Intellectual Property Rights, Tata McGraw Hill, 2007.

- Thomas J.A., Fush R.L., (2002), Biotechnology & safety Assessment (3rdEd.), Academic press.
- Fleming D.A., Hunt D.L., (2002), Biological safety Principles &practices(3rd Ed.) ASM Press, Washington.
- Biotechnology- A Comprehensive treatise (Vol 12), Legal economic & ethical Dimensions VCH.
- Sasson A, Biotechnologies & Development, UNESCO Publications.
- Singh K, Intellectual Property Rights on Biotechnology, BCIL, New Delhi.
- Singh BD. 2007. *Biotechnology: Expanding Horizon*. Kalyani.
- Biotechnologies and Development, Sasson A, UNESCO Publications, 1988
- Biotechnologies in developing countries present and future, Sasson A, UNESCO Publications, 1993
- Intellectual property rights on Biotechnology, Singh K, BCIL, New Delhi

MSBC-306 Elective III **Credit 3**

A. Glycotechnology

Unit-I

Glycobiology: Fundamentals of glycan structure and diversity, the importance of sugars in biology, classes of glycans, N- and O-glycans – structure and function, fundamentals of interactions of glycans with proteins, glycoproteins versus proteoglycans, functions of N- and O-glycans, sites of biosynthesis of glycoproteins and the secretion pathway, structure and biosynthesis of N-glycans, an overview of cellular membrane trafficking and trafficking of N-glycoproteins.

Unit-II

Lectinomics: Endogenous and exogenous lectins, biochemistry functions and applications. Lectin biorecognition technology, carbohydrate/glycan microarrays and lectin microarrays for decoding the glycome, lectins as potential in cancer treatment. Carbohydrate-active enzymes (CAZymes), introduction to the CAZy database, glycosyl transferases (GTs), glycoside hydrolases and transglycosidases (GHs), carbohydrate binding modules (CBMs).

Unit-III

Glycotechnology: Carbohydrate-based drugs, chemical glycobiology, examples of carbohydrate-based biotech applications. Lectins as microbial toxins and bacterial adhesion

molecules. Influenza - hemagglutinins and neuraminidases, Fabry and Schindler diseases, blood groups and blood group interconversion.

Books Recommended:

- Essentials of Glycobiology, 2nd Edition – a freely available, online resource (ISBN: 978-0879697709)
- The Sugar Code: Fundamentals of Glycosciences– partly available online! (ISBN: 978-3527320899)
- Introduction to Glycobiology, 3rd Edition – partly available online! (ISBN: 978-0199569113)
- Carbohydrates-Comprehensive studies on glycobiology and Glycotechnology. byChuan-Fa Chang, InTech publisher.
- Carbohydrates: Integrated Research on Glycobiology and Glycotechnology (Volume I): by Sydney Marsh (Editor)
- Lectins, Second edition, Nathan Sharon, H. Lis, Springer Science & Business Media
- Structural Glycobiology, Elizabeth Yuriev, Paul A. Ramsland, CRC Press
- Animal Lectins Form, Function and Clinical Applications, by Author : Gupta, G. S., Springer

B. Genomics and Proteomics

Unit-I

Proteomics-Tools of proteomics and their strengths and weaknesses; fundamentals of mass spectrometry- basic theory, ionization techniques and mass analyzers; nano-LC, UPLC; different type of proteomics, protein identification and analysis tools, protein database search tools, proteomic analysis of post-translational modifications, protein sequencing methods, N-terminal sequencing and other omics methods

Unit-II

Genomics-Different step of genome analysis, DNA sequencing methods- Maxam Gilbert, dideoxy, standard chain terminator, automated, shotgun sequencing, Pyro-sequencing, High throughput sequencing, next generation sequencing, De-novo sequencing, RNA sequencing, microarray and its application, antibody array, type of genomics-functional, structural, epi-genomics and meta-genomics.

Unit-III

Meta-genomics-Type of metagenomics- shotgun, comparative and meta-transcriptomics; different steps of meta-genomics analysis; species identification using FAME analysis and MALDI methods.

Books recommended

- Genomics, Proteomics and Metabolomics in Nutraceuticals and Functional Foods, 2nd Edition By DebasisBagchi, AnandSwaroop, ManashiBagchi. Wiley Publication 2015.
- Biocode: The New Age of Genomics. by Dawn Field and Neil Davies, Oxford University Press 2015.
- The Proteomics Protocols Handbook, by John M. Walker (Editor), Humana Press, 2005.
- Introduction to Genomics, 2 edition. by Arthur M. Lesk, Oxford University Press,
- Clinical Proteomics: Methods and Protocols (Methods in Molecular Biology) 2nd edition. by Antonia Vlahou, ManousosMakridakis,Humana Press, 2015.
- Proteomics: A Cold Spring Harbor Laboratory Course Manual, 1st Edition by Andrew J Link, Cold Spring Harbor Laboratory Press, 2008

MSBC-307 Biochemistry Laboratory V Credit 3

- Extraction of plasmid DNA from bacterial cell and electrophoresis in agarose gel.
- Restriction enzyme digestion and electrophoresis.
- Ligation and cloning in a plasmid vector
- Preparation of competent cells followed by transformation and calculation of transformation efficiency.
- PCR and analysis by agarose gel electrophoresis
- Blue white screening, restriction map Analysis.
- Expression and purification of the recombinant protein
- Multiple sequence alignment and Primer designing

MSBC-308 Biochemistry Laboratory VI Credit 3

- Blood cell counts
- Determination of blood sugar, urea.
- Determination of blood cholesterol, triglycerides
- Determination of blood uric acid, albumin, creatinine.
- Determination of blood SGPT, SGOT.
- Determination of blood SOD, Catalase, Glutathione peroxidase activity
- Determination of blood alkaline phosphatase, myeloperoxidase activity
- Determination of blood Ca^{2+}, $Na^{+}$and K^{+}.