M. Sc. Biochemistry Part I [Semester I]

Course Code: **MSBCCC101T**	Course Title: **Biomolecules**	
Course Credit: **4**	Total contact hours: 60 Hrs	

Sr. No.	Course Contents (Topics & subtopics)	Reqd. hours
Unit I	**The molecular logic of life** The chemical unity of diverse living organisms, composition of living matter. Macromolecules and their monomeric subunits. Properties of Water: With interactions in aqueous systems. Ionization of water, weak acids and weak base. The pH scale, measurement of pH, pH metry, acid base titration curves. Buffers, biological buffer systems	**15 Hrs**
UNIT II	**Carbobhydrates** Classification, characteristics and functions of monosaccharides, disaccharides - polysaccharides. Epimers, Isomers, Anomers, Chiral carbon atom, Chair and boat conformation, Glucopyranose and Fructopyranose Complex Carbohydrates: Classification and general functions of amino sugars, sialic acid and mucopolysaccharides. Structure and functions of glycoproteins and proteoglycans. Blood group sugar compounds, sugar nucleotides, bacterial cell wall components. Lectins - specificity, characteristics and uses, pectin, xylans.	**15 Hrs**
UNIT III	**Lipids** Definition, classification, characteristics and functions of lipids Fatty acids - general formula, nomenclature and chemical properties. Structure, function and properties of simple, complex, acylglycerols, phosphoglycerides, sphingolipids, waxes, terpenes, steroids and prostaglandins	**15 Hrs**
UNIT IV	**Nucleic acids** Structure of nucleoside, nucleotide. De novo and salvage pathways of nucleotide synthesis. Experimental evidence for nucleic acids as genetic material. Secondary structure of DNA, Watson and Crick model of DNA. A, B and Z forms of DNA, Tm and its relation to GC content Chemical and enzymatic degradation of nucleic acids	**15 Hrs**
	Suggested readings	
	1. Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox. 2. Biochemistry by Lubert Stryer. 3. Biochemistry by Zubay. 4. Biochemistry by Garrett and Grisham. 5. Biochemistry by Voet and Voet.	

Course Code: **MSBCCC102T**	Course Title: **Cell biology and Microbiology**	
Course Credit: **4**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**	**Reqd. hours**
UNIT I	**CELL BIOLOGY**	**15 Hrs**
	Cell as a basic unit of life. Cell organization of prokaryotic and eukaryotic cells. Structure and functions of cell and cell organelles –mitochondria, chloroplast, lysosomes, golgi bodies, cytoskeleton, cell wall, nucleus. Plasma Membrane: 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. Cell cycle, cell division - mitosis and meiosis.	
UNIT II	**Membrane transport**	**15 Hrs**
	Transport across biomembranes: Active, passive and facultative transport and ion channels. Symport and antiport system. Transport of water, glucose and amino acids. Organisation, mechanism and significance of Na^+ - K^+ ATPase, Na^+ - H^+ ATPase, and Ca^{++} - ATPase pumps. Special bacterial transport systems. Permeases, Phosphotransferase system, transport through binding proteins. Transport of macromolecules. Endocytosis, pinocytosis and phagocytosis, receptor mediated endocytosis, transcyctosis. Fates of receptors and ligands.	
UNIT III	**Cell signaling and cytoskeleton**	**15 Hrs**
	Signaling molecules and cell surface receptors – hormones, growth factors Receptor Families : 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 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. Cell-cell interactions - tight junctions, gap junctions, desmosomes and spot desmosomes.	
UNIT IV	**Microbiology**	**15 Hrs**
	Structure, classification and general characteristics of Bacteria, Mycoplasma, Protozoa, archea, yeast and fungi.	

	Methods in microbiology: Pure culture techniques, principles of microbial nutrition, Sterilization methods, Microbial contamination control and Sterility testing. Microbial growth: Definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yield, synchronous growth, continuous culture. Virology: Classification, General properties and structure of plant, animal and bacterial viruses, Bacteriophages - lytic cycle & lysogeny, Oncogenic viruses. Cultivation of viruses: cell culture, chick embryo and animal inoculation. Persistent, chronic and acute viral infections. Host- Virus Interactions, Mechanism of interferon and antiviral therapy.	
	Suggested readings	
	1. Textbook of Medical Physiology by A.C. Guyton and J. E. Hall, W.B. 2. Saunders Publication, 9th Edition, 1996. 3. Physiology Illustrated by Lipfold and Cogdell. 4. Cells by David Prescott. 5. Cell Structure and Function by Loewy and Gallant. 6. Essential Cell Biology by Albert Bray et al, Garland Publication New York 1997 7. Introduction to Modern Virology by Dimmock and Primrose. 8. Molecular Virology by Alan Cann. 9. Madigam M.T., Martinko J.M and Parker J. (2001) Biology of Microorganisms 9th ed. Prentice Hall Int. (U.K.) Ltd, London. 10. General Microbiology by Stanier.	

Course Code: **MSBCCC103T**	Course Title: **Amino acids & Protein Biochemistry**	
Course Credit: **4**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**	**Reqd. hours**
UNIT I	AMINO ACIDS: Chemical structure and general properties, pI of amino acids, General metabolism scheme of amino acids and Urea cycle. PROTEINS: Classification- size, shape, degree of association, complexity. Classification of proteins according to biological functions (Enzymes, transport, storage, contractile, structural, defense and regulatory) Structure of peptide bond - restricted rotation, cis - trans bending, Ramchandran plot. Peptides.	**15 Hrs**
UNIT II	Secondary structure - alpha helix and beta pleated structure, triple helix (collagen) and supersecondary structures. Tertiary structure - forces stabilising tertiary structure,	**15 Hrs**

	unfolding/refolding experiment, prediction of secondary and tertiary structure. Dynamics of protein folding, role of molecular chaperones in protein folding, Lysosomal and membrane proteins. Quaternary structure - forces stabilising quaternary structure. Structure function relationship - myoglobin and hemoglobin. Techniques for studying primary sequence of proteins, experimental methods, end group analysis, finger printing and sequenators.	
UNIT III	Chemical synthesis of peptides/ solid phase automated synthesis, prediction of conformation from amino acid sequence, zymogens and their conversion into active proteins Protein evolution - phylogenic tree, convergent and divergent trees, sequence analysis, comparison matrix, Dot matrix and substitution matrix. Protein turnover: Ubiquitination, proteasome and protein degradation.	**15 Hrs**
UNIT IV	Concept of prosthetic group, apoenzyme, holoenzyme, enzyme. Coenzyme: Vitamins as coenzymes: sources, requirements, functions and deficiency symptoms of water soluble vitamins. structure and biochemical role. Assay of vitamins. Cofactors: Role of trace elements, their bound forms in biological systems and in enzyme structure and function.	**15 Hrs**
	Suggested readings	
	1. Lehninger's Principles of Biochemistry by D. L. Nelson and M. M. Cox, CBS Publications, 2000 2. Biochemistry by Lubert Stryer, 4th Edition 3. Biochemistry by David Rawn 4. Principles of protein structure by Shulz and Schirmer 5. Fundamentals of Enzymology by Royer 6. Fundamentals of enzymology by Price and Steavens	

Course Code:**MSBCIE101T**	Course Title: **Bioorganic Chemistry and Nanobiotechnology**	
Course Credit: **4**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**	**Reqd. hours**
UNIT I	**Biochemical Basis of Evolution**	**15 Hrs**

	Theories of Evolution – Time scale and spontaneous origin of life Genesis of oxygen generating photosynthesis & aerobic respiration. Methanogens – evolution of prokaryotes, protists & eukaryotes Oparin's Hypothesis, Miller Experiment, Smith's Model, RNA first model. Theories regarding origin of mitochondria and chloroplast Evolution of proteins and nucleic acid – elastic analysis. Evolution of introns Evolutionary view of exon domain relationships Process or Origin of life of Eukaryotes, Molecular Evolution of Proteins	
UNIT II	**Bioenergetics**	**15 Hrs**
	Chemistry of Water. Laws of thermodynamics as applied to biological systems, enthalpy, entropy, free energy, standard free energy Role of High Energy phosphates in Bio-energetics and energy capture, Theories of ATP Biosynthesis Electron Transport Chain in Plants, Eukaryotes and Prokaryotes, Significance or Redox potentials, Mechanism of Oxidative Phosphorylation. Uncouplers and Inhibitors of energy transfer. Numerical problems based on the above	
UNIT III	**Biosensors, Bioluminescence, Biotransformation &Biomimetics**	**15 Hrs**
	Biosensors: Basic principles and operation of biosensors, types of biosensors and applications of biosensors. Biosensors in diagnostics. Immobilization of enzymes for the fabrication of biosensors. Bioluminescence: History, Source of Bioluminescence material, examples of bioluminescence organism Mechanism of Bio-luminescence in specific organisms, Evolution and Bioluminescence. Use and applications of bioluminescence Biotransformation: Xenobiotic metabolism: phase I and phase II reactions, Biotransformation enzymes Microbial biotransformation: Biodegradation of pollutants: enzymes involved in microbial biotransformation. Bioaccumulation and biomagnifications, Bioaugmentation, Types of biotransformation, methods of biotransformation- in situ and exsitu. Biomimetics: Introduction, Artificial life, Artificial intelligence, Nature as a model for structures and tools, Biologically inspired mechanisms and structures, Defense and attck mechanisms in biology, artificial organs	

UNIT IV	Nanobiotechnology	15 Hrs
	Nanomaterials: Types and synthesis methods. Top-down and bottom up approach. Physical chemical and biological methods of synthesis of nanomaterials. Advantages and disadvantages of various synthesis methods. Use of bacteria, funfi, Plants, and products derived from them for nanomaterial synthesis. Mechanism of synthesis of nanomaterials by biological systems. Bioinspired nanomaterials: DNA and peptide based. Interaction between biomolecules and nanoparticle surfaces. Nanomaterials in food industry, Packaging, Environment, agriculture and medical fields	

Suggested readings

1. Bioenergetics (Fourth Edition), David G. Nicholls and Stuart Ferguson, Academic Press, 2013.
2. Biochemical calculations, 2nd Edition by Irwin H. Segel. John Wiley & Sons,
3. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox Publisher: W. H. Freeman
4. Biochemistry. Jeremy M. Berg, John L. Tymoczco, and LubertStryer: W.H. Freeman
5. Biochemistry. (4th Ed.). Donald Voet, Judith G. Voet – Publisher John Wiley & Sons.
6. Membranes and their cellular functions- IB Filnean, R. Coleman and R.H. Mitchell, 1984, Blackwell Scientific Publishers, Oxford, 3rd ed.
7.The Cell, 2nd edition A Molecular Approach Geoffrey M Cooper.Boston University Sunderland (MA): Sinauer Associates 2000.ISBN-10: 0-87893-106-6
8. Cell and Molecular Biology. D. P. De Robertis. Lippincott Williams & Wilkins ISBN: 9788184734508, 8184734506 Edition: 8th Edition, 2010.
9. Biotechnology by R. C. Dubey
10. Biomimetics: biologically inspired technologies Edited by Yoseph Bar-Cohen, Taylor and Francis publishers

Course Code:**MSBCGE101T**	Course Title: **Pharmaceutical Biochemistry, Human Nutrition and dietetics**	
Course Credit: **4**	Total contact hours: 30Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**	**Reqd. hours**
UNIT I	**Pharmacokinetics and drug metabolism**	**15 Hrs**
	Fundamental concepts in drug absorption, distribution, metabolism & elimination (ADME) Kinetics of drug following different modes of drug administration. Introduction to important Pharmacokinetics parameters, PK of oral	

	administration & bioavailability, objectives of Pharmacokinetics Mechanism of Drug Action and structure-Function Relationship: Molecular basis of drug action & pharmacological selectivity Drug receptor theory, stimulus response , classification of receptors & strategy in receptor binding studies, receptor preparation & receptor binding kinetics Clinical research- Importance, significance & rationale, Models used in clinical research Clinical Trials- Stages/ Phases I to IV, Ethical issues in clinical trials	
UNIT II	**Nutrition and dietetics**	**15 Hrs**
	Role of Carbohydrates, lipids, proteins, vitamins and minerals in human nutrition. Nutrition during pregnancy, lactation, infancy, childhood, adolescence, adulthood, ageing. Nutrition for health, weight management, Exercise, Sports performance and bone health. Nutrigenomics: Nutrient gene interaction, Drug Nutrient Interaction Food quality: Chemical and Biochemical Indices. Obesity and Eating disorders (Anorexia nervosa, Bulimia nervosa) Recommended Dietary allowances (RDA), factors affecting RDA, Methods used to calculate RDA, Practical application of RDA, Reference man and woman Mid day programme Food safety: Laws and regulations, regulatory agencies	
	Suggested readings	
	1. Anderson I et al. Nutrition in Health and Disease 2. Anita F.P., Clinical Dietetics and Nutrition's, 3. Bennion H., Clinical Nutrition, 4. Carolyn E., et al, Nutrition and Diet Therapy, 7th Ed.,2000, Delmer Publishers 5. Gopalan C et al, Dietary Allowances for Indians, NIH, Hyderbad. 26 6. Gopalan C et al, Nutritive Value of Indian Foods, 1988, NIH, Hyderabad. 7. Kinney J.M. et.al, Nutrition and Metabolism in Patient Care, 19th ed., 1999, W.B. Saunders and Co. 8. Robinson C.et al, Normal and Therapeutic Nutrition, 16th Ed., 1982, Macmillan Publishing Co. 9. Shils M.E.et al, Modern Nutrition in Health and Disease, 1998, Lea and Febiger, Philadelphia. 10. Swaminathan M., Essentials of food and Nutrition, 2nd Ed., 1985, Ganesh and Co. 11. Pharmaceutical chemistry, G Melentyeva L LAntonova Mir Publishers, Moscow 12. Chemical Pharmacology, R B Barlow, 2nd Ed, Methven and CO.	

	New Fetters Lane 13. Medicinal Chemistry, Vol I, 3rd Ed, Alfred Burga, Wiley Inter sciences 14. Pharmacology, B Suresh, 1st Ed. Shanti, Publication.	

Course Code: **MSBCAE101T**	Course Title: **Biostatistics**	
Course Credit: **2**	Total contact hours: 30 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**	
UNIT I	Statistical population, sample from population, Random sample. Central Tendency: Mean, Median and Mode, Standard Deviation, Variance.	**15**
UNIT II	Tests of Significance. Hypothesis testing:- Theory of errors- Type I and Type II errors, Null hypothesis, P values-one v/s two tail P values. t-test (paired & unpaired), Z-test, Chi square test.	**15**
	Suggested Reading	
	1. Lemeshow S, Homer DW, Klar J and Lwanga SK, (1996) Adequacy o sample size in health studies. John Wiley and Sons, Chichester. 2. Machin, D., Campbell MJ, Fayers P, Pinol A., (1998) Statistical Tables for the design of Clinical Studies, Second Edition, Blackwell Oxford. 3. Quinn &Keough, Experimental Design and Data Analysis for Biologists, Cambridge University Press. http://www.lacbiosafety.org/wp- 4. Statistical methods for research workers – RA Fisher, 14th edition, Oliver Boyd publication 5. Statistical methods in research and production – Davelr OL & Goldsmith PL, Longman 6. Methods in biostatistics for medical students and research workers – BK Mahajan, Jaypee Brothers, New Delhi 7. Genetics and Biostatistics – MeyyanPillai, Saras Publication, Kanyakumari 8. Statistical methods in biological array – Davids J Finney, 3rd edition charles Griffin & co, London 9. Statistics for Biology – Bishop ON, 1983, Longman 10 A Textbook of Biostatistics by A Annadurai, New Age Publication	

Semester- I Practicals

MSBCLB101P:

1. Estimation of:
    1. Proteins by Bradford
    2. Proteins by Folin-Lowry methods
    3. Amino acids by Ninhydrin method
    4. Total sugar content by Anthrone method
    5. Glucose by Folin-Wu methods.
    6. Phosphorus (P) by Fiske-Subbaraow Method.

MSBCLB102P:

1. Estimation of: (from blood/plasma/serum/urine)
2. Cholesterol by Zak and Zaltsky Method.
3. Copper (Cu) by Dithiocarbonate Method.
4. Microbiology techniques:
    i. Gram Staining
    ii. Spores Staining
    iii. Capsule Staining
    iv. Acid Fast Staining

MSBCLB103P:

1. Buffers and Microscopy:

    pka values of Ala or Gly by Titration Curve

2. Proteins: Extraction, isolation, partial purification (of any), calculation of percentage yield and performing a confirmatory test for the following -
    a. Casein from milk.
    b. Albumins and globulins from egg white.
    c. Proteins from germinating seeds.
3. Estimation of Sodium Benzoate from Jam/ Jelly

MSBCLB104P:

1. Percentage Purity of Starh from Starch Hydrolystate by Willstatter's method.
2. Estimation of Calcium (Ca) by Clark and Collip Method/ Trinder Method.
3. Estimation of Iron (Fe) by Dipyridyl Method.
4. Estimation of Triglycerides.
5. One numerical problem each on

a. Measurement of Central Tendency (Mean, Median, Mode)
b. Measurement of Dispersion/variability (Mean Deviation, Standard Deviation, Coefficient of variation).

Suggested Readings for Practical syllabus

1. J Jayaraman-Laboratory Manual in Biochemistry, New age international publishers.

2. Holme David J – Problem solving in analytical biochemistry, H & Longman Sc. And Tech, Essex

3. Ninfa Alexander J and Ballou David P – Fundamental Laboratory Approaches for Biochemistry and Biotechnology, Fitzgerald Science Press, Bethesda

4. Upadhyaya et al – Biophysical Chemistry, Himalaya Publishing Home, New Delhi

5. Rodney Boyer Experimental Biochemistry Pearson Publ. Sawheny and Singh

6. Practical Biochemistry by David Plummer

7. Henry Richard et al – Clinical Chemistry, Principles and Techniques, 2nd edition, Harper and Row, New York

8. Kamal SH – Clinical Biochemistry for Medical Technologies, Churchill Livingston, London

9. Rodrigues Fred K Carbohydrate chemistry with clinical correlations, New Age International, New Delhi

10. John Bernard Henry, Clinical Diagnosis and Management by Laboratory Methods, Saunders publications, 20th edition

11. Total synthesis of natural products, Vol I-John Apsinon

12. Chemical Process Industries – Norris Shreeve& Joseph Brink

13. Roger's Industrial Chemistry Vol I & II – Edited by CC Furnas

14. Animal Biotechnology – Edited by AK Srivastava, oxford & IBH publishing Co, New Delhi, 2005

15. Proteins, Biochemistry & Biotechnology – Gary Walsh, John Wiley & Sons, 2002

16. Biotechnology, An Introduction – Susan R Barnum, Vikas Publishing House, International Student Edition

17. Enzymes, Biochemistry, Biotechnology, Clinical Biochemistry – Trevor Palmer, First East-West Press Ed. 2004.

18. Lemeshow S, Homer DW, Klar J and Lwanga SK, (1996) Adequacy o sample size in health studies. John Wiley and Sons, Chichester.

19. Machin, D., Campbell MJ, Fayers P, Pinol A., (1998) Statistical Tables for the design of Clinical Studies, Second Edition, Blackwell Oxford.

20. Quinn & Keough, Experimental Design and Data Analysis for Biologists, Cambridge University Press. http://www.lacbiosafety.org/wp-

21. Statistical methods for research workers – RA Fisher, 14th edition, Oliver Boyd publication

22. Statistical methods in research and production – Davelr OL & Goldsmith PL, Longman

23. Methods in biostatistics for medical students and research workers – BK Mahajan, Jaypee Brothers, New Delhi

24. Genetics and Biostatistics – MeyyanPillai, Saras Publication, Kanyakumari

25. Experimental Biochemistry, Theory and exercises in fundamental methods – Robert Switzer and Liam Garrity, 3rd edition, WH Freeman & Co. NY

26. Statistical methods in biological array – Davids J Finney, 3rd edition charles Griffin & co, London

27. Statistics for Biology – Bishop ON, 1983, Longman

28. A Textbook of Biostatistics by A Annadurai, New Age Publication

* Teachers may suggest alternative/additional practical/references.

M. Sc. Biochemistry Part I [Semester II]

Course Code: **MSBCCC201T**	Course Title: **Enzymology**	
Course Credit: **4**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**	**Reqd. hours**
Unit I	**ENZYMES and ENZYME CATALYSIS**	**15 Hrs**
	Classification- IUB system, rationale, overview and specific examples. Characteristics of enzymes, enzyme substrate complex. Concept of active site, binding sites, stereospecificity and ES complex formation. Effect of temperature, pH and substrate concentration on reaction rate. Activation energy. Transition state theory. Acid-base, Covalent and Nucleophilic catalysis. Factors affecting catalytic efficiency- proximity and orientation effects, distortion or strain. Chemical modification of enzymes. Isoenzymes and multiple forms of enzymes.	
UNIT II	**ENZYME KINETICS**	**15 Hrs**
	Michaelis-Menten Equation - form and derivation, steady state enzyme kinetics. Significance of Vmax and Km. Bisubstrate reactions. Enzyme inhibition- types of inhibitors - competitive, non-competitive and uncompetitive. Enzyme activity, international units, specific activity, turnover number. Methods for studying fast reactions.	
UNIT III	**STRUCTURE FUNCTION RELATIONSHIPS, ALLOSTERIC INTERACTIONS and ENZYME REGULATION**	**15 Hrs**
	Lysozyme, phosphorylase, glutamine synthetase and phosphofructo kinase. Multi enzyme complexes-pyruvate dehydrogenase and fatty acid synthetase; Na-K ATPase. Protein ligand binding including measurements, analysis of binding isotherms, co-operativity, Hill and Scatchard plots and kinetics of allosteric enzymes. Product inhibition, feedback control, enzyme induction and repression and covalent modification. Allosteric regulation.	
UNIT IV	**Immobilized Enzymes**	**15 Hrs**

	Relative practical and economic advantage for industrial use, effect of partition on kinetics and performance with particular emphasis on charge and hydrophobicity (pH, temperature and Km). Various methods of immobilization - ionic bonding, adsorption, covalent bonding (based on R groups of amino acids), microencapsulation and gel entrapment. Immobilized multienzyme systems Biosensors - glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors.	
	Suggested readings	
	1. Biochemistry, by L. Stryer, WH Freeman and Co. 2. Lehningers Principles of Biochemistry by Nelson and Cox 3. Biochemistry by Voet and Voet. 4. Biochemistry the chemical reactions of living cell by David E Metzler 5. Enzyme a practical introduction to structure mechanism and data analysis by Robert Copeland 6. Fundamentals of Enzymology – The Cell & Molecular Biology of Catalytic protein by Nicholas Price & Lewis Stevens. Third Edition. 7. Joel L. Sussman & Paola Spadon. From Molecules to Medicine. Springer. 8. Protein-Ligand interactions – Methods & Applications by Mark A. Williams & Tina Daviter. Second Edition. Humana Press. 9. The Molecules of Life – Physical & Chemical Principles by John Kuriyan. 10. Fundamentals of Enzyme Kinetics by Athel Cornish-Bowden. 2012. Wiley-Blackwell. Fourth Edition. 11. Enzyme Technology. by Martin Chaplin and Christopher Bucke. 1990. Cambridge University Press. 12. Enzymes: principles and biotechnological applications. Essays in Biochemistry. 59, 1-41: doi: 10.1042/BSE0590001 byPeter K. Robinson. 2015. . 13. Enzyme Assays - High-throughput-screening, Genetic selection and Fingerpriting by Jean-Luis Reymond. 14. Enzymes-Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer, Philip L. Bonner. 2007. -Woodhead Publishing. 15. Methods in Enzymology by Colowick P & Kaplan.	

Course Code: **MSBCCC202T**	Course Title: **Molecular Biology**	
Course Credit: **4**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**	**Reqd. hours**
UNIT I	**Chromosome Structure, Mendelian Principles, Mutation and Replication**	**15 Hrs**
	Chromatin – Heterochromatin, euchromatin. Histones and non-histone proteins, general properties of histone, packing density,	

	nucleosomes, size, variable linkers, solenoid structure, packaging of DNA, satellite DNA. Mendelian laws of inheritance: Law of dominance, Law of segregation and Law of independent assortment. Mutation – Types of mutations, mechanism of mutation, mutagenic agents, Ames test, DNA repair and transposable elements. DNA Replication – Concepts of replication initiation, elongation and termination in prokaryotes and eukaryotes, enzymes and accessory proteins involved in DNA replication, Fidelity in replication, synthesis of leading and lagging strand, difference between prokaryotic and eukaryotic replication, Okazaki fragments, replication fork, lagging strand, leading strand.	
UNIT II	**Transcription and post transcriptional modifications**	**15 Hrs**
	Mechanisms of Transcription – Prokaryotic transcription; promoters, properties of bacterial RNA polymerase, steps: initiation, elongation and termination. Eukaryotic transcription, promoters, enhancers factors and properties of RNA polymerase I, II and III , post transcriptional modifications, 5' capping, 3' poly A tailing, splicing and editing, Reverse transcription, Inhibitors of transcription.	
UNIT III	**Translation and post translation modifications**	**15 Hrs**
	Genetic code: Genetic and biochemical basis of Genetic code, Salient features, Translation in Pro- and Eukaryotes – Translation apparatus, Ribosomes, structure and subunit assembly, adaptor role of tRNA, formation of initiation complex, initiator-tRNAs, aminoacyl-tRNAs, initiating factors, chain elongation, translocation & termination and the role of respective factors involved therein, structure of tRNA, P site, A site, activation of amino acid, Inhibitors of protein biosynthesis, Post translational processing: Proteolytic cleavage, covalent modifications.	
UNIT IV	**Regulation of gene expression**	**15 Hrs**
	Regulation of Transcription and Translation – Positive and negative control, Repressor & Inducer, concept of operon, lac-, ara-, trp operons, attenuation, catabolite repression. Eukaryotic gene regulation: Role of upstream, downstream and enhancer elements, cis-trans acting elements in gene expression, examples and experimental evidences	
	Suggested readings	
	1. Biochemistry, by L. Stryer, WH Freeman and Co. 2. Molecular biology of the gene, by J D Watson, Benjamin/Cummings publ. Co Inc. 3. Molecular cell biology, by J Darnell and D. Baltimore, W,H Freeman and Co.	

	4. Genetics-Analysis of genes and genomes, by Daniel L. Hartl, Elizabeth W. Jones 5. Molecular Biology, by David Freifelder. 6. iGenetics, by Peter J. Russell 7. Biochemistry, by Geoffrey L. Zubay	

Course Code: **MSBCCC203T**	Course Title: **Plant- Biochemistry and Tissue culture**	
Course Credit: **4**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**	**Reqd. hours**
UNIT I	**Photosynthesis and photorespiration**	**15**
	Chlorophylls and accessory pigments Photosynthesis-Light and Dark reactions, Schemes-I, II & Z, Cyclic and Non-Cyclic Photophosphorylation, C-3 & C-4 pathways, CAM pathway. Biosynthesis of Starch and Cellulose from Glucose. Photosynthesis in Bacteria, Fungi, Algae and Yeast. Photoperiodism Photorespiration: Enzymes involved in photorespiration, Factors affecting rate of photorespiration, Interaction of photorespiration with other processes	
UNIT II	**Plant nutrition and hormones**	**15**
	Plant nutrition: Micro and macronutrients, Transport systems: xylem and phloem Biological Nitrogen fixation and sulphur assimilation in plants Tropism and nastic movements in plants Plant growth hormones: Biosynthesis and functions of Auxins, Gibberellins, Cytokines, Abscisic Acid and Ethylene, Brassinosteroids, Polyamines, Jasmonic acid and salicylic acid.	
UNIT III	**UNIT III: Introduction to plant tissue culture**	**15**
	History of Plant Tissue culture Infrastructure and Organization of Plant Tissue Culture Laboratory-equipments and instruments, **Aseptic Techniques-** Washing and preparation of glasswares, packing and sterilization, media sterilization, surface sterilization, aseptic workstation, precautions to maintain aseptic conditions. **Culture Medium-** Nutritional requirements of explant, PGR and their invitro roles, composition of basal M.S. medium and media preparation. **Callus Culture Techniques**- principle, protocol, morphology and internal structure, genetic variations, applications. **Suspension Culture Technique-** Introduction, principle, protocol, types, growth measurement, viability test, synchronization,	

	applications. **Organ Culture Technique-** principle, protocol, applications, with respect to root tip culture, leaf culture, ovary and ovule culture. **Anther and Pollen Culture Technique-** principle, protocol, factors affecting, applications.	
UNIT IV	**UNIT IV: Techniques in Plant tissue culture**	**15**
	Micropropagation- Introduction, stages of Micropropagation, factors affecting, advantages and applications. Different Pathways of Micropropagation, Axillary bud proliferation, **Somatic Embryogenesis:** principle, protocol, applications. **Organogenesis-** principle, protocol, applications. meristem culture. **Somaclonal Variation-** Introduction, terminology, origin, selection at plant level, selection at cell level, mechanism, assessment, applications and limitations. **Plant Protoplast Culture:-** Principle, protocol for isolation, Mechanical and Enzymatic, protoplast culture methods, viability test applications. **Production of Secondary Metabolites-** Introduction, types of secondary metabolites, principle, systems of culture, optimization of yield, commercial aspects, applications, limitations. Applications of Plant Tissue culture	
	Suggested readings	
	1.Biochemistry by Lubert Stryer 4th Edition 2. Biochemistry by Mathew VanHolde 3. Lehningers Principles of Biochemistry by Nelson and Cox 4. Plant Physiology by Buchanan 5. Biochemistry and Physiology of Plant Hormones, Thomas Moore 6. Plant Tissue culture by S. S. Chawla 7. Plant Tissue culture by Kalyan Kumar De	

Course Code: **MSBCIE201T**	Course Title: **Instrumentation and analytical techniques**	
Course Credit: **4**	Total contact hours: 60 Hrs	
Sr. No.	**Course Contents (Topics & subtopics)**	**Reqd. hours**
UNIT I	**Acid, Bases, Buffers and Colligative properties**	**15**

	Ionization, Dissociation, Acidity, Basicity theories of Acid and Bases, Strength of Acids and Bases. pH, pH-dependent functions and structures of bio-molecules. Henderson –Hasselbach Equation, different methods for measurement of pH. Definitions, Factors affecting , measurement of and physiological applications of Osmosis, Osmotic Pressure, Osmoregulation, Adsorption, Colloids, Surface Tension and Viscosity Numerical Problems based on above topics	
UNIT II	**Spectroscopic techniques**	**15**
	Beer-Lamberts Law, its verifications and deviations, concept of Absorptions, Transmission, Scattering, Phosphorescence, Fluorescence, Luminescence. Principle Instrumentation, working and application of – U V, Visible and IR Spectroscopy, Turbidometry and Nephlometry. Spectrofluorometric, Flame Spectrophotometry, Atomic Absorption Spectrometry, Luminometry. Principle, instrumentation, working and application of- Nuclear Magnetic Resonance(NMR), Electron Spin Resonance (ESR), Mass Spectrometry, Mossbauer Spectroscopy, Matrix Assisted LASER Desorption, Ionization, Time of Flight-Mass Spectroscopy (MALDI-TOF-MS), Inductively Coupled Plasma Mass Spectrometer (ICP-MS) X-Ray Diffraction Spectra, Optical Rotatory Dispersion, (ORD), Circular Dichroism (CD)	
UNIT III	**Radioisotopic and Microscopic techniques**	**15**
	Basic principles, instrumentation and application of Compound, Phase contrast, Fluoroscence Microscope, SEM, TEM, Confocal and atomic force microscopy. Nature of radioactivity & its detection and measurements of Radioactivity, Radioactive decay, Interaction of radioactivity with matter GM Counter, Scintillation Counter, Counting Pulse Height Analyser. Isotope Dilution, Analysis, Autoradiography, Application of Radioisotopes in Biological Science Safety Measures in Handling Isotopes	
UNIT IV	**Centrifugation, Chromatography and electrophoreses**	**15**

	General scheme for purification of Biomolecules Basic principles of sedimentation, relation between g, rpm and Svedberg constant. Principles, Instrumentation, Working and Applications of Preparative and Analytical Ultracentrifugation, Isopycnic Centrifugation, Rate Zonal Centrifugation Basic Principles, Instrumentation, working and applications of partition chromatography (Paper), Absorption Chromatography (TLC, HPTLC, Column), Affinity Chromatography, Ion Exchange Chromatography, Gel filtration chromatography Basic Principles, Instrumentation, working and applications of Permeation Chromatography, Gas-Liquid Chromatography (GLC), High Pressure Liquid Chromatography (HPLC), High Resolution Liquid Chromatography Mass Spectrometry (HR LC-MS) Basic principles, factors affecting electrophoresis. General principles, instrumentation, working and applications of electrophoretic techniques-zone, Disc, Capillary, 2-D, Pulsed Field Gel, Diagonal, Isoelectric Focussing, immune-electrophoresis	
	Suggested readings	

1. Van Holde KE – Principles of Physical Biochemistry, Prentice Hall, 1998
2. Wilson K & Walker J – Principles and Techniques of Practical Biochemistry. Cambridge Low Price Edition
3. Frelfelder D- Physical Biochemistry
4. Skoog Douglas A – Principles of Instrumental Analysis Harcourt Brace publishers, London
5. Harvey David – Modern Analytical Chemistry, International edition, McGraw, Hill, Boston
6. Srivastava VK and Kishore K – Introduction to chromatography: Theory & Practice, S Chand & Co, New Delhi
7. Holme David J – Problem solving in analytical biochemistry, H & Longman Sc. And Tech, Essex
8. Brave Robert D – Introduction to Instrumental Analysis, McGraw Hill Book Co, New York
9. Ninfa Alexander J and Ballou David P – Fundamental Laboratory Approaches for Biochemistry and Biotechnology, Fitzgerald Science Press, Bethesda
10. Upadhyaya et al – Biophysical Chemistry, Himalaya Publishing Home, New Delhi
11. Rodney Boyer Experimental Biochemistry Pearson Publ. Sawheny and Singh
12. Practical Biochemistry by David Plummer
13. Physics of Diagnostic images by Dowsett.
14. Medical imaging by Christenson.

Course Code: **MSBCSE201T**	Course Title: **Bioinformatics**	
Course Credit: **4**	Total contact hours: 60 Hrs	

Sr. No.	Course Contents (Topics & subtopics)	Reqd. hours
UNIT I	• Introduction to Biological databases- What is database? • Types of Databases. • Biological databases and pitfalls of them. • Information \ retrieval from biological databases	**15 Hrs**
UNIT II	• Sequence Alignment- Pairwise and multiple sequence alignment. • Database similarity searching- BLAST \ FASTA □Scoring functions. • Significance of sequence alignment. • HMM (Hidden Markov Model).	**15 Hrs**
UNIT III	• Gene and Promoter prediction- Gene prediction in Prokaryotes & Eukaryotes. • Promoter prediction in Prokaryotes & Eukaryotes. • Gene expression profiling and its applications. • Microarray technology. Human genome analysis	**15 Hrs**
UNIT IV	• Structural Bioinformatics : • Protein structure visualization • Protein secondary prediction –Globular protein & transmembrane proteins. • Protein tertiary structure prediction Homology Modelling, Threading, Fold recognition, Ab Initio protein structure prediction.	**15 Hrs**
	Suggested readings	
	1.Mount DW (2004). Bioinformatics: Sequence and Genome Analysis (Second Ed.). Cold Spring Harbor Laboratory Press. 2.Pevsner J (2015). Bioinformatics and Functional Genomics. Hoboken NJ: Wiley-Blackwell. 3.Lesk AM (2002). Introduction to Bioinformatics. Oxford University Press. 4.Baxevanis AD and Ouellette BF (2001). Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience. 5.Bourne PE and Gu J (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss. 6.Lesk AM (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press.	

Semester- II Practical

MSBCLB201P

1. To determine the enzyme activity of –
   i) α-Amylase.
   ii) β-Amylase.
2. To investigate the effect of activator/co-factor on enzyme activity.
3. To investigate the effect of inhibitor on enzyme activity.
4. To study the partial purification of enzyme by salt precipitation.
5. To determine the specific activity of Acid/Alkaline phosphatase.
6. To determine the effect of pH on enzyme activity.
7. To determine the effect of temperature on enzyme activity.
8. Determination of Km of enzyme –
   i) Amyloglucosidase
   ii) Invertase
9. To isolate the enzyme from sweet potato.
10. To study the immobilization of enzyme by gel entrapment method.

MSBCLB202P

1. Estimation of DNA by DPA method.
2. Estimation of RNA by orcinol method.
3. Isolation of genomic DNA from plants,/animals / microorganisms.
4. Isolation of RNA from Baker's yeast.
5. Staining of cellular DNA and RNA
6. Separation of DNA/RNA by gel electrophoresis technique.

MSBCLB203P

1. Extraction and quantification of photosynthetic pigments.
2. Isolation and characterization of symbiotic bacteria from root nodules.
3. Enrichment, isolation and characterization of nonsymbiotic bacteria from soil.
4. Colorimetric estimation of Indole-3 Acetic Acid.
5. Separation of chlorophyll pigments by adsorption chromatography.
6. Separation of amino acids/ sugars by paper chromatography.
7. Separation of oils by TLC.
8. Demonstration of SDS PAGE techniques of protein purification

MSBCLB204P

1 Structure of proteins - identification of chains helices, special groups, metal ions etc. CATH / SCOP classification of a given protein.

2 Motif finding- Prosite

3 BLAST

4 MSA- Clustal Omega & Phylogenetic Tree- Tree view

5 Protein Structure Visualizer- PyMOL

6 Homology Modelling- MODELLER.

Suggested Readings for Practical syllabus

1. J Jayaraman-Laboratory Manual in Biochemistry, New age international publishers.

2. Holme David J – Problem solving in analytical biochemistry, H & Longman Sc. And Tech, Essex

3. Ninfa Alexander J and Ballou David P – Fundamental Laboratory Approaches for Biochemistry and Biotechnology, Fitzgerald Science Press, Bethesda

4. Upadhyaya et al – Biophysical Chemistry, Himalaya Publishing Home, New Delhi

5. Rodney Boyer Experimental Biochemistry Pearson Publ. Sawheny and Singh

6. Practical Biochemistry by David Plummer

7. Henry Richard et al – Clinical Chemistry, Principles and Techniques, 2nd edition, Harper and Row, New York

8. Kamal SH – Clinical Biochemistry for Medical Technologies, Churchill Livingston, London

9. Rodrigues Fred K Carbohydrate chemistry with clinical correlations, New Age International, New Delhi

10. John Bernard Henry, Clinical Diagnosis and Management by Laboratory Methods, Saunders publications, 20th edition

11. Total synthesis of natural products, Vol I-John Apsinon

12. Chemical Process Industries – Norris Shreeve& Joseph Brink

13. Roger's Industrial Chemistry Vol I & II – Edited by CC Furnas

14. Animal Biotechnology – Edited by AK Srivastava, oxford & IBH publishing Co, New Delhi, 2005

15. Proteins, Biochemistry & Biotechnology – Gary Walsh, John Wiley & Sons, 2002

16. Biotechnology, An Introduction – Susan R Barnum, Vikas Publishing House, International Student Edition

17. Enzymes, Biochemistry, Biotechnology, Clinical Biochemistry – Trevor Palmer, First East-West Press Ed. 2004.

18. Mount DW (2004). Bioinformatics: Sequence and Genome Analysis (Second Ed.). Cold Spring Harbor Laboratory Press.

19. Pevsner J (2015). Bioinformatics and Functional Genomics. Hoboken NJ: Wiley-Blackwell.

20. Lesk AM (2002). Introduction to Bioinformatics. Oxford University Press.

21. Baxevanis AD and Ouellette BF (2001). Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience.

22. Bourne PE and Gu J (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.

23. Lesk AM (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press.

* Teachers may suggest alternative/additional practical/references.