



Dr. Homi Bhabha State University, Mumbai

SYLLABUS

As per NEP 2020 Guidelines

For

M. Sc. Biochemistry

M.Sc. I

Semester I and II

Choice Based Credit System

(CBCS)

To be implemented from

July, 2023

CREDIT PATTERN

SEMESTER-I

Course Code	Course Title	Credits		Workload	
		Theory	Practical	Theory	Practical
DSC-1 (MSBCDC101)	Biomolecules	4	2	4	08
DSC-2 (MSBCDC102)	Cell Biology and Microbiology	4	2	4	08
DSE-1 (MSBCDE101 / MSBCDC102)	Bioorganic chemistry and Nanobiotechnology	4	2	4	08
	Pharmaceutical Biochemistry, Nutrition and Dietetics	4		4	
RM (MSBCRM101)	Research Methodology	4	00	4	00
Total		20	6	20	24
		26		44	

SEMESTER-II

Course Code	Course Title	Credits		Workload	
		Theory	Practical	Theory	Practical
DSC-3 (MSBCDC201)	Enzymology and Analytical techniques	4	2	4	08
DSC-4 (MSBCDC202)	Molecular Biology	4	2	4	08
DSE-2 (MSBCDE201 / MSBCDE202)	Bioinformatics, Genomics and Proteomics	4	2	4	08
	Entrepreneurship development, IPR and Biosafety	4		4	
OJT/FP (MSBCOJ201)	OJT/FP	00	4	00	16
Total		16	10	16	40
		26		56	

M. Sc. Biochemistry Part I (Semester I)

Course Code: MSBCDC101T	Course Title: Biomolecules	
Course objectives – To make students understand the perspective of life through chemistry of biomolecules like carbohydrates, lipids, proteins, DNA, RNA etc., along with their classifications, types, properties etc. To make student understand the basics of Biomolecules via study of structures and functions.		
Course Credit: 4		Total contact hours: 60 Hrs
Sr. No.	Course Contents (Topics & subtopics)	Reqd. Hours
Unit I	Carbohydrates	15 Hrs
	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.	
UNIT II	Amino acids and Proteins	15 Hrs
	Chemical structure and general properties of amino acids, pI of amino acids Classification of proteins- 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. Secondary structure - alpha helix and beta pleated structure, triple helix (collagen) and super secondary structures. Tertiary structure - forces stabilising tertiary structure, 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 stabilizing quaternary structure. Structure function relationship - myoglobin and hemoglobin.	
UNIT III	Lipids and Nucleic acids	15 Hrs

	<p>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. Structure of nucleoside, nucleotide. 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, T_m and its relation to GC content Chemical and enzymatic degradation of nucleic acids</p>	
UNIT IV	Vitamins and Minerals	15 Hrs
	<p>Fat soluble Vitamins: Vit A, D, E and K: Biosynthesis and role of these vitamins in biological functions</p> <p>Water Soluble Vitamins: Vit B and C: Biosynthesis and role of these vitamins in biological functions</p> <p>Minerals: Micro and Macroelements and their importance in biological functions</p>	
Suggested readings		
<ol style="list-style-type: none"> 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 outcomes (Students will be able to.....)		
<ol style="list-style-type: none"> 1. After studying this course students should be able to get the knowledge about the formation and composition of living matter. Moreover, student should learn about the basic knowledge about biomolecules, their structures, functions and importance in biological system. 		

Course Code: MSBCDC102T	Course Title: Cell biology and Microbiology	
Course objectives – To impart the knowledge of functioning of basic unit of life and to make students familiar with basics of Microbiology,		
Course Credit: 4	Total contact hours: 60 Hrs	
Sr. No.	Course Contents (Topics & subtopics)	Reqd. Hours
UNIT I	CELL BIOLOGY	15 Hrs
	<p>Cell as a basic unit of life.</p> <p>Cell organization of prokaryotic and eukaryotic cells. Structure and functions of cell and cell organelles –mitochondria, chloroplast, lysosomes, golgi bodies, cytoskeleton, cell wall, nucleus.</p> <p>Plasma Membrane: Organisation of lipids in micelles, liposomes. Components, properties and characterization of lipid bilayer. Asymmetry, fluidity, lipid-lipid and lipid-protein interactions. Merits and demerits of various membrane models.</p> <p>Cell cycle, cell division - mitosis and meiosis.</p>	
UNIT II	Membrane transport	15 Hrs
	<p>Transport across biomembranes: Active, passive and facultative transport and ion channels. Symport and antiport system.</p> <p>Transport of water, glucose and amino acids.</p> <p>Organisation, mechanism and significance of $\text{Na}^+ - \text{K}^+$ ATPase, $\text{Na}^+ - \text{H}^+$ ATPase, and $\text{Ca}^{++} - \text{ATPase}$ pumps. Special bacterial transport systems. Permeases, Phosphotransferase system, transport through binding proteins.</p> <p>Transport of macromolecules. Endocytosis, pinocytosis and phagocytosis, receptor mediated endocytosis, transcytosis.</p> <p>Fates of receptors and ligands.</p>	
UNIT III	Cell signalling and cytoskeleton	15 Hrs
	<p>Signalling molecules and cell surface receptors – hormones, growth factors</p> <p>Receptor Families: G Protein – coupled receptors, Activation & inhibition of adenylyl cyclase, Activation of phospholipase C Activation of gene transcription – CREB proteins</p> <p>Cell adhesion – Cadherins, Selectins and Integrins</p> <p>Extracellular matrix of cells – Proteoglycans, collagens, elastin, fibronectin and laminin</p> <p>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.</p>	

	Cell-cell interactions - tight junctions, gap junctions, desmosomes and spot desmosomes.	
UNIT IV	Microbiology	15 Hrs
	<p>Structure, classification and general characteristics of Bacteria, Mycoplasma, Protozoa, Archaea, Yeast and Fungi.</p> <p>Methods in microbiology: Pure culture techniques, principles of microbial nutrition, Sterilization methods, Microbial contamination control and Sterility testing.</p> <p>Microbial growth: Definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yield, synchronous growth, continuous culture.</p> <p>Virology: Classification, General properties and structure of plant, animal and bacterial viruses, Bacteriophages - lytic cycle & lysogeny, Oncogenic viruses.</p> <p>Cultivation of viruses: cell culture, chick embryo and animal inoculation.</p> <p>Persistent, chronic and acute viral infections. Host- Virus Interactions, Mechanism of interferon and antiviral therapy.</p>	
Suggested readings		
<ol style="list-style-type: none"> 1. Textbook of Medical Physiology by A.C. Guyton and J. E. Hall, W.B. Saunders Publication, 9th Edition, 1996. 2. Physiology Illustrated by Lipfold and Cogdell. 3. Cells by David Prescott. 4. Cell Structure and Function by Loewy and Gallant. 5. Essential Cell Biology by Albert Bray et al, Garland Publication New York 1997 6. Introduction to Modern Virology by Dimmock and Primrose. 7. Molecular Virology by Alan Cann. 8. Madigam M.T., Martinko J.M and Parker J. (2001) Biology of Microorganisms 9th ed. Prentice Hall Int. (U.K.) Ltd, London. <p style="text-align: center;">General Microbiology by Stanier.</p>		
Course outcomes (Students will be able to.....)		
<p>After studying this course, the student should understand -</p> <ol style="list-style-type: none"> 1. The basic structure of cell, cell organelles, cell cycle and cell division. 2. The dynamics of plasma membrane structure, the role of plasma membranes in cellular transport, cell signaling, cytoskeleton and the cell-cell interactions. 3. Basics of microbiology and virology. Culture techniques for microbes and viruses, nutritional requirements of microbes and viruses. 		

Course Code: MSBCDE101T	Course Title: Bioorganic Chemistry and Nanobiotechnology	
Course objectives – To make students aware with the biochemical basis of Evolution, energy generation in cell, applications of biochemistry w.r.t. Biosensors, Biomimetics, Biotransformation. To make students familiar with the Nanotechnology.		
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. pH, Handerson Hasselbatch equation, 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 and Biotransformation	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 bioluminescent organisms, Mechanism of Bio-luminescence in specific organisms, Evolution and Bioluminescence. Use and applications of bioluminescence Biotransformation: Microbial biotransformation: Biodegradation of pollutants: enzymes involved in microbial biotransformation of pollutants.	

	Bioremediation, Bioaccumulation and biomagnifications, Bioaugmentation, Types of bioremediations, methods of bioremediation: in-situ and ex-situ.	
UNIT IV	Nanobiotechnology	15 Hrs
	<p>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.</p> <p>Use of bacteria, fungi, Plants, and products derived from them for nanomaterial synthesis.</p> <p>Mechanism of synthesis of nanomaterials by biological systems.</p> <p>Bioinspired nanomaterials: DNA and peptide based.</p> <p>Interaction between biomolecules and nanoparticle surfaces.</p> <p>Nanomaterials in food industry, Packaging, Environment, agriculture and medical fields.</p>	
Suggested readings		
<ol style="list-style-type: none"> 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. Tymoczko, and Lubert Stryer: 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. Nanotechnology: Principles and Practice by Sulabha Kulkarni, Springer. 		
Course outcomes (Students will be able to.....)		
Biochemical basis of evolution, generation of energy in living things, basic features of protein structure and function relations, role of enzymes in living system, cell integrity, permeability and signalling.		

Course Code: MSBCDE102T	Course Title: Pharmaceutical Biochemistry, Nutrition and dietetics	
Course objectives – To impart the knowledge of pharmacology w.r.t. pharmacokinetics, drug metabolism, drug action, clinical trials. To impart the knowledge about the nutrition and dietetics.		
Course Credit: 4	Total contact hours: 60 Hrs	
Sr. No.	Course Contents (Topics & subtopics)	Reqd. hours
UNIT I	Xenobiotic metabolism	15 Hrs
	<p>Xenobiotics- definition and Types (carcinogens, drugs, environmental pollutants, food additives, hydrocarbons and pesticides). phase I and phase II reactions,</p> <p>Enzymes involved in xenobiotic metabolism</p> <p>Major organs involved in xenobiotic metabolism: gastrointestinal tract; cardiovascular system; respiratory system; urinary tract; nerve and muscle; central nervous system; endocrine system; reproductive system.</p> <p>Generation of free radicals, Oxidative stress, Oxidative stress damage produced by reactive oxygen species (ROS), reactive nitrogen species, free radical scavenger systems (enzymatic & nonenzymatic). Oxidative damage to protein and DNA, Lipid peroxidation.</p>	
Unit II	Drug metabolism	15 Hrs
	<p>Pharmacokinetics:</p> <p>Pharmacokinetics and drug metabolism, fundamental concepts in drug absorption, distribution, metabolism & elimination (ADME) Kinetics of drug following different modes of drug administration.</p> <p>Introduction to important Pharmacokinetics parameters, PK of oral administration & bioavailability, objectives of Pharmacokinetics</p> <p>Pharmacodynamics:</p> <p>Mechanism of Drug Action and structure-Function Relationship: Molecular basis of drug action & pharmacological selectivity</p> <p>Drug receptor theory, stimulus response, classification of receptors & strategy in receptor binding studies, receptor preparation & receptor binding kinetics</p>	
Unit III	Clinical research- Importance, significance & rationale	15 Hrs
	<p>Types of clinical research.</p> <p>Models used in clinical research,</p> <p>Clinical Trials- Stages/ Phases I to IV,</p> <p>Ethical issues in clinical trials</p>	
Unit IV	Human Nutrition and Dietetics	15 Hrs
	<p>Importance and functions of food, food quality: Chemical and Biochemical Indices.</p>	

	<p>Role of Carbohydrates, lipids, proteins, vitamins and minerals in human nutrition.</p> <p>Nutrition during pregnancy, lactation, infancy, childhood, adolescence, adulthood, ageing.</p> <p>Nutrition for health, weight management, Exercise, Sports performance and bone health.</p> <p>Nutrigenomics: Nutrient gene interaction, Drug Nutrient Interaction.</p> <p>Obesity and Eating disorders (Anorexia nervosa, Bulimia nervosa).</p> <p>Recommended Dietary allowances (RDA), factors affecting RDA, Methods used to calculate RDA, Practical application of RDA, Reference man and woman</p> <p>Food safety: Laws and regulations, regulatory agencies.</p>	
Suggested readings		
<ol style="list-style-type: none"> 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, Hyderabad. 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. 2. Robinson C.et al, Normal and Therapeutic Nutrition, 16th Ed., 1982,Macmillan Publishing Co. 3. Shils M.E.et al, Modern Nutrition in Health and Disease, 1998, Leaand Febiger, Philadelphia. 4. Swaminathan M., Essentials of food and Nutrition, 2nd Ed., 1985,Ganesh and Co. 5. Pharmaceutical chemistry, G Melentyeva L LAntonova MirPublishers, Moscow. 6. Chemical Pharmacology, R B Barlow, 2nd Ed, Methven and CO. New Fettes Lane. 7. Medicinal Chemistry, Vol I, 3rd Ed, Alfred Burga, Wiley Intersciences. 8. Pharmacology, B Suresh, 1st Ed. Shanti, Publication. 		
Course outcomes (Students will be able to.....)		
<p>After studying this course, the students should be able to gain the knowledge about basics of pharmacokinetics and pharmacodynamics. The students will get acquainted with the basics of nutrition and dietetics.</p>		

Course Code: MSBCRM101T	Course Title: Research Methodology	
Course objectives – To introduce the concepts of project design, research hypothesis, objectives, methodology, research data analysis and significance of the research. To impart skills of statistical treatment & statistical analysis of biological data.		
Course Credit: 4	Total contact hours: 60 Hrs	
Sr. No.	Course Contents (Topics & subtopics)	Reqd. hours
UNIT I	Research Fundamentals	15 Hrs
	Defining research, Purpose of research, Scientific method and scientific principle, Characteristics of a good research. Design of Research Problem. Significance, Identification and basic characteristics of research problem, formulation of research problem. Research hypothesis- statement and significance, characteristics of good research hypothesis. Importance of a Good Literature Review, Types of Literature Reviews- Argumentative Review, Integrative Review, Historical Review, Methodological Review, Systematic Review, Theoretical Review, Structure and Writing Style- Organization of Literature Review, Common Mistakes to avoid. Research methods: Experiments, Surveys, Observations, Case studies, Interviews and focus groups, Secondary data analysis, Mixed methods).	
Unit II	Literature survey, Data collection and Processing	15 Hrs
	Literature survey: Reasons for literature survey, Literature forms, Sources. Design of Experiments. Different research designs, Experiments, dependent, independent and controlled variables, Randomization Statistical replication, blocking, one factor at a time experiments, multifactorial experimental designs. Data manipulation, analysis and Inference drawing. Data entry and quality control, exploratory data analysis, descriptive data analysis, data visualization, hypothesis testing- parametric and non-parametric test, Statistical learning-regression models, neural networks, principal component analysis, classification strategies.	
Unit III	Research Ethics	15 Hrs
	Philosophy and ethics. Scientific conduct and Misconduct. Publication ethics and misconduct. Conflicts of Interests and authorships. Databases and Research Metrics. Open access publishing.	
Unit IV	Biostatistics	15 Hrs

	<p>Statistical population, sample from population, Random sample. Central Tendency: Mean, Median and Mode, Standard Deviation, Variance.</p> <p>Hypothesis testing - Theory of errors- Type I and Type II errors, Null hypothesis, P values-one v/s two tail P values.</p> <p>t-test (paired & unpaired), Z-test, Chi square test.</p>	
Suggested readings		
<ol style="list-style-type: none"> 1. Research methodology, Methods and techniques – CR Kothari Willey Eastern Ltd, Mumbai. 2. Research methods – Ram Ahuja, Rawat Publications, New Delhi. 3. Research Methodology – SM Israney, universal Publishing Corporation. 4. Lemeshow S, Homer DW, Klar J and Lwanga SK, (1996) adequacy of sample size in health studies. John Wiley and Sons, Chichester. 5. Machin, D., Campbell MJ, Fayers P, Pinol A., (1998) Statistical Tables for the design of Clinical Studies, Second Edition, Blackwell Oxford. 6. Quinn & Keough, Experimental Design and Data Analysis for Biologists, Cambridge University Press. http://www.lacbiosafety.org/wp- 7. Statistical methods for research workers – RA Fisher, 14th edition, Oliver Boyd publication 8. Statistical methods in research and production – Davelr OL & Goldsmith PL, Longman. 9. Methods in biostatistics for medical students and research workers. 10. BK Mahajan, Jaypee Brothers, New Delhi. 11. Genetics and Biostatistics – Meyyan Pillai, Saras Publication, Kanyakumari 12. Statistical methods in biological array – Davids J Finney, 3rd edition Charles Griffin & co, London. 13. Statistics for Biology – Bishop ON, 1983, Longman. 14. A Textbook of Biostatistics by A Annadurai, New Age Publication. 		
Course outcomes (Students will be able to.....)		
<p>At the end of the course student should be able to formulate a research proposal based on hypothesis, objectives, data analysis tools and significance of the research.</p> <p>Students will understand the significance of statistical treatment of biological data and understand the data from the statistical point of view.</p>		

Semester- I Practical

MSBCLB101P:

1. Estimation of –
 - a. Amino acids by Ninhydrin method.
 - b. Proteins by Bradford.
 - c. Proteins by Folin-Lowry methods.
 - d. Total sugar content by Anthrone method.
 - e. Glucose by Folin-Wu methods.
 - f. Vitamin A and D from food sample.
2. Isolation, extraction and partial purification of –
 - a. Starch from Potato.
 - b. Casein from milk.
 - c. Gluten from wheat flour.

MSBCLB102P:

1. Basics of Microbiology techniques: Instruments in the microbiology lab, sterilization techniques, media preparation, Aseptic cultures (streak plate and spread plate technique), maintenance of Microbial cultures,
2. Isolation and characterization of symbiotic bacteria from root nodules.
3. Enrichment, isolation and characterization of bacterial from food sample/ waste water.
4. Gram staining of the bacterial culture.
5. Isolation of coliphages from sewage sample.

MSBCDE101P/ MSBCDE102P:

1. Determination of pka values of Ala or Gly by Titration Curve.
2. Estimation of Sodium Benzoate from Jam/ Jelly.
3. Bioremediation of textile dyes by bacteria/fungi/plants, calculation of percentage decolorization.
4. Biosynthesis of metal nanoparticles by bacteria/fungi/plants.
5. Percentage Purity of Starch from Starch Hydrolysate by Willstatter's method.

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 of sample size in health studies. John Wiley and Sons, Chichester.
19. Quinn & Keough, Experimental Design and Data Analysis for Biologists, Cambridge University Press. <http://www.lacbiosafety.org/wp->

M. Sc. Biochemistry Part I (Semester II)

Course Code: MSBCDC201T	Course Title: Enzymology and Analytical Techniques	
Course objectives – To impart the basic knowledge of enzymes and how they function in our body. To make students realize the practical/industrial applications of enzymes. To impart the theoretical knowledge of various tools & techniques used for Biochemistry research. To make students understand how to separate, isolate, purify and characterize the biomolecules.		
Course Credit: 4	Total contact hours: 60 Hrs	
Sr. No.	Course Contents (Topics & subtopics)	Reqd. Hours
UNIT I	Enzymes Catalysis and Enzyme Kinetics	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. 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. Michaelis-Menten Equation - form and derivation, steady state enzyme kinetics. Significance of V _{max} and K _m . Bisubstrate reactions. Enzyme inhibition- types of inhibitors. Enzyme activity, international units, specific activity, turnover number. Enzyme inhibition.	
UNIT II	Structure function relationship & Enzyme Immobilization	15 Hrs
	Lysozyme, phosphorylase, glutamine synthetase, Multi enzyme complexes - pyruvate dehydrogenase and fatty acid synthetase. isotherms, co-operativity, Hill and Scatchard plots and kinetics of allosteric enzymes. Product inhibition, feedback control, enzyme induction and repression and covalent modification. Allosteric enzymes & regulation. 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.	
UNIT III	Centrifugation, Chromatography and Electrophoreses	15 Hrs
	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 Focusing, Immunoelectrophoresis.	
UNIT IV	Spectroscopic techniques & Radioisotope techniques	15 Hrs
	<p>Beer-Lamberts Law, its verifications and deviations, concept of Absorptions, Transmission, Scattering, Phosphorescence, Fluorescence, Luminescence. Principle Instrumentation, working and application of – UV, Visible and IR Spectroscopy, Turbidometry and Nephelometry. Spectrofluorometric, Flame Spectrophotometry, Atomic Absorption Spectrometry, Luminometry.</p> <p>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 Spectrometry (MALDI-TOF-MS), Inductively Coupled Plasma Mass Spectrometer (ICP-MS).</p> <p>X-Ray Diffraction Spectra, Optical Rotatory Dispersion, (ORD), Circular Dichroism (CD).</p> <p>Nature of radioactivity & its detection and measurements of Radioactivity, Radioactive decay, Interaction of radioactivity with matter GM Counter, Scintillation Counter, Autoradiography, Application of Radioisotopes in Biological Science. Safety Measures in Handling Isotopes.</p>	
	Suggested readings –	
	<ol style="list-style-type: none"> 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 dataanalysis 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 by Peter K. Robinson. 2015. 13. Enzyme Assays - High-throughput-screening, Genetic selection and 	

	<p>Fingerprinting by Jean-Luis Reymond.</p> <p>14. Enzymes-Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer, Philip L. Bonner. 2007. -Woodhead Publishing.</p> <p>15. Methods in Enzymology by Colowick P & Kaplan.</p> <p>16. Van Holde KE – Principles of Physical Biochemistry, Prentice Hall, 1998</p> <p>17. Wilson K & Walker J – Principles and Techniques of Practical Biochemistry. Cambridge Low Price Edition.</p> <p>18. Skoog Douglas A – Principles of Instrumental Analysis Harcourt Brace publishers, London.</p> <p>19. Harvey David – Modern Analytical Chemistry, International edition, McGraw, Hill, Boston</p> <p>20. Srivastava VK and Kishore K – Introduction to chromatography: Theory & Practice, S Chand & Co, New Delhi</p> <p>21. Holme David J – Problem solving in analytical biochemistry, H & Longman Sc. AndTech, Essex</p> <p>22. Brave Robert D – Introduction to Instrumental Analysis, McGraw Hill Book Co, New York</p> <p>23. Upadhyaya et al – Biophysical Chemistry, Himalaya Publishing Home, New Delhi.</p> <p>24. Rodney Boyer Experimental Biochemistry Pearson Publ. Sawheny and Singh.</p>	
	<p>Course outcomes (Students will be able to.....)</p>	
	<p>Students will be enlightened with the basic knowledge of biochemical reactions, their nature, kinetics of the reactions, reactions mechanisms that enzymes follow, requirements of the enzymatic reactions, applications of enzymes for industrial purpose.</p>	

Course Code: MSBCDC202T	Course Title: Molecular Biology	
Course objectives – To impart basic knowledge of genetics. To make students aware with the Mendelian genetics, the central dogma of life.		
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's 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	
	<ol style="list-style-type: none"> 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 <u>Geoffrey L. Zubay.</u> 	
	Course outcomes (Students will be able to.....)	
	Student will receive the basic knowledge of Mendelian genetics, and they will be able to understand the mechanisms with which the central dogma of life functions and how it is regulated at molecular levels.	

Course Code: MSBCDE201T	Course Title: Bioinformatics, Genomics and Proteomics	
Course objectives – To determine how all the genes in a genome act and how their products interact to produce a functional organism. To understand the different methods of sequencing, microarrays, protein fingerprints and the role of bioinformatics tools applied to analyze.		
Course Credit: 4	Total contact hours: 60 Hrs	
Sr. No.	Course Contents (Topics & subtopics)	Reqd. Hours
UNIT I	Introduction to Bioinformatics	
	Introduction to Biological databases- What is database? Types of databases. Biological databases and pitfalls of them. Information \ retrieval from biological databases, Sequence Alignment- Pairwise and multiple sequence alignment Scoring functions. Significance of sequence alignment. HMM (Hidden Markov Model). Database similarity searching- BLAST \ FASTA,	15
UNIT II	Genomics	
	Introduction to Genomics and transcriptomics, Importance, Scope and applications. Gene and Promoter prediction- Gene prediction in Prokaryotes & Eukaryotes. Promoter prediction in Prokaryotes & Eukaryotes. Gene expression profiling and its applications. Human genome analysis NGS: Introduction, types and applications.	15
UNIT III	Proteomics	15
	Introduction and Importance of proteomics, strategies in analysis of proteome: 2-D PAGE, Mass spectrometry, Protein sequencing method (Edman degradation, MALDI TOF/TOF). Protein solubility and interaction with solvents and solutes, activity of proteins. Two-dimensional polyacrylamide gel electrophoresis, Sample Preparation, Solubilization, Reduction, Resolution, Reproducibility of 2-DE-Detecting proteins in polyacrylamide gels, Image analysis of 2-DE gels. 2-DE gel electrophoresis coupled with mass spectrometry. Microarray technology: Types of micorarrays, Designing a microarray experiment, Microarray Technology in Treating Disease. Applications of proteomics - drug development and toxicology, Pharmaceutical Applications, Proteomics in drug Discovery in human, phage antibodies as tools, Glycobiology and Proteomics in plant genetics and breeding. Introduction, scope, importance and applications of metabolomics.	
UNIT IV	Structural Bioinformatics	15

	<ul style="list-style-type: none"> • Protein structure visualization • Protein secondary prediction –Globular protein & transmembrane proteins. • Protein tertiary structure prediction Homology Modelling, Threading, Fold recognition, Ab Initio protein structure prediction. 	
	Suggester readings –	
	<ol style="list-style-type: none"> 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. 7. S. B. Primrose and R.M. Twyman - Principles of Genome Analysis and Genomics, 7 th Edition, Blackwell Publishing, 2006. 8. S. Sahai - Genomics and Proteomics, Functional and Computational Aspects, Plenum Publication, 1999. 9. Andrezej K Konopka and James C. Crabbe, Compact Hand Book - Computational Biology, Marcel Dekker, USA, 2004. 10. Pennington & Dunn - Proteomics from Protein Sequence to Function, 1 st edition, Academic Press, San Diego, 1996. 11. Database Annotation in Molecular Biology: Principles and Practice, Arthur M. Lesk 12. Bioinformatics : Sequence and genomic analysis by D. W. Mount, Cold Spring Harbour Laboratory Press. 13. Recombinant DNA (Second Edition), James D. Watson and Mark Zoller. 14. Gene Cloning and DNA Analysis – An introduction (Fourth Edition), T.A. Brown. 15. Protein array, Biochips and Proteomics by Smith and Albala (Eds), Marcel Dekkar, New York. Introduction to proteomics: Tools for new biology by Daniel C. Liebler, Humana Press. 	
	Course outcomes (Students will be able to.....)	
	Students will gain a basic knowledge about bioinformatics, genomics and proteomics. He/she will be able to perform basic applications related to the subject.	

Course Code: MSBCDE202T	Course Title: Entrepreneurship Development; IPR and Biosafety	
Course objectives –		
To impart the knowledge of Entrepreneurship.		
To make students understand IPR.		
To inculcate within students the biosafety in a laboratory.		
Course Credit: 4	Total contact hours: 60 Hrs	
Sr. No.	Course Contents (Topics & subtopics)	Reqd. Hours
Unit I	Entrepreneurship Development – Idea to Prototype stage	15 Hrs
	Charms of becoming an intrapreneur/ entrepreneur. Entrepreneurship: scope in local and global Market. Steps in setting up of a business. Traits of successful intrapreneur/ entrepreneur. Team building. Selection of Product/ Service, core competence, product life cycle, new product development process, mortality curve, creativity and innovation in product modification/development Life time value. Preparation of business plan and techno economic feasibility study. Marketing strategies. One Case report Preparation.	
UNIT II	Entrepreneurship Development – GTM and Scale up	15 Hrs
	Integrated futuristic planning, angel investors, and role of incubation Centers. Agencies for entrepreneurship guidance, training, registration. Support agencies for technical consultation, technology transfer and quality control. Support agencies for marketing and finance. Introduction to product compliance and regulatory approvals. Scale- 5 to 50 to 500 Managing finance: Sources of finance types, advantages and disadvantages, methods of cost control & importance, managing working capital. Material management, Time management, Information systems	
UNIT III	IPR	15 Hrs
	IPR: Definition, functions and Importance. Forms of protection: Patents, copyrights, trademarks, designs Patenting biological discoveries, Biopyracy Patent laws: International and Indian patent laws Patenting procedure: Form filling	
UNIT IV	Biosafety	15 Hrs
	Biological hazards, Biocontainment, Bioprotection International Cartagena Protocol on Biosafety, Indian biosafety laws Biological warfare and Bioterrorism Biosafety levels Applications of biological safety in Environment, food, agriculture and livestock	
	Suggested readings	

	<p>1. Hisrich Robert D. Entrepreneurship. Mc Graw Hill</p> <p>2. S.S. Khanka. Entrepreneurship and small business management</p> <p>3. Poornima Charanthimath Entrepreneurship development small business Entrepreneurship Pearson Education, India</p> <p>4. The Lean start up by Eric Ries</p> <p>5. http://copyright.gov.in/Documents/handbook.html</p> <p>6. https://www.wipo.int/copyright/en/</p> <p>7. https://www.wipo.int/edocs/pubdocs/en/copyright/484/wipo_pub_484.pdf</p> <p>8. Indian Copyright Act:</p> <ul style="list-style-type: none"> • http://www.copyright.gov.in/Documents/CopyrightRules1957.pdf <p>9. Famous Copyright Infringement Cases:</p> <ul style="list-style-type: none"> • https://www.irro.org.in/lessons-to-learn-from-famous-copyright-infringement-cases/ <p>Additional reading:</p> <p>Process selection: Technology life cycle, forms and cost of transformation, factors affecting process selection. Factors affecting selection of location for an industry. Importance of material handling and its relevance with facility location. Calculate capacity of plant and its relation with economies of scale. Including flexibility in capacity.</p>	
	Course outcomes (Students will be able to.....)	
	<p>Student will get a basic idea about entrepreneurship, how to go for startup, what are the requirements of the market and what's the standards of the products to be sold in the market. Student will also get acquainted with basics of patenting and patent laws. He will be able to gain the knowledge about different types of biohazards, biological safety and biological warfare.</p>	

Course Code: MSBCOJ201P	Course Title: On Job Training (OJT) / Field Project (FP)	
Course objectives – To inculcate in students a practical approach to acquiring new competencies and skills needed for a job in a real, or close to real, working environment. Make students learn and understand how to use particular tools or equipment in a live-work practice, simulated, or training environment.		
Course Credit: 4	Total contact hours: 180 Hrs	
Sr. No.	Course Contents (Topics & subtopics)	Reqd. Hours
	Industrial training/Laboratory training/Field visits/Industrial visits	180
	Course outcomes (Students will be able to.....)	
	Students will come to know about the industrial requirements.	

Semester- II Practical

MSBCLB201P:

1. To determine the enzyme activity of Acid phosphatase.
2. To investigate the effect of activator/co-factor on α -Amylase enzyme activity.
3. To investigate the effect of inhibitor on β -Amylase 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. Determination of K_m of enzyme –
 - a) Invertase
8. 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.

MSBCDE201P / MSBCDE 202P:

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.