UNIVERSITY OF MUMBAI

Syllabus for the M.Sc. Part - II
Program: M.Sc.

Course: Life Sciences
Specialisation:
Biological Macromolecules
[Semesters III and IV]

(Credit Based Semester and Grading System with effect from the academic year 2013-2014)

M.Sc. Part – II Life Sciences Syllabus
Restructured for Credit Based and Grading System
To be implemented from the Academic year 2013-2014

SEMESTER III

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
PSLSCBMT301	I	Biomathematics	4	
	II	Research Methodology		
	III	Biostatistics		
	IV	Population Biostatistics		
PSLSCBMT302	I	Chemical Bonds and Spectroscopic Techniques	4	
	II	Biomembrane		
	III	Cell Matrix		
	IV	Protein Trafficking and Targeting		
PSLSCBMT303	I	Bioenergetics and Carbohydrate Metabolism	4	
	II	Lipid Metabolism		
	III	Electron Transport Chain and Oxidative Phosphorylation		
	IV	Metabolic Regulation and Metabolic Disorders		
PSLSCBMT304	I	Protein Structure and Folding	4	
	II	Supramolecular Assemblies and DNA-protein Interactions		
	III	Complex Proteins		
	IV	Protein Engineering		
PSLSCBMP301	Biomathematics and Biostatistics		2	
PSLSCBMP302	Bioanalytical Techniques & Cell Dynamics		2	
PSLSCBMP303	Metabolism & Biomolecular Structure		2	
PSLSCBMP304	Dissertation on Literature Review		2	

SEMESTER IV

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
PSLSCBMT401	I	Bioinformatics - I	4	
	II	Bioinformatics - II		
	III	Intellectual Property Rights		
	IV	Bioethics		
PSLSCBMT402	I	Cell Division and Apoptosis	4	
	II	Programmed Cell Death and Cancer		
	III	RNAi and Epigenetics		
	IV	Cell Biology Techniques		
PSLSCBMT403	I	Amino Acid Metabolism	4	
	II	Nucleotide Metabolism		
	III	Nitrogen Assimilation in Plants		
	IV	Photosynthesis and Secondary Metabolism		
PSLSCBMT404	I	Structure of DNA and Replication	4	
	II	Kinetics and Mechanism in Biological Systems		
	III	Methods in Proteomics and Genomics		
	IV	Nanobiology		

PSLSCBMP401	Bioinformatics	**2**	
PSLSCBMP402	Molecular Cell Biology and Metabolism	**2**	
PSLSCBMP403	Biomolecular Function	**2**	
PSLSCBMP404	Dissertation on Project	**2**	

M.Sc. Part - II Life Sciences Syllabus
Restructured for Credit Based and Grading System
To be implemented from the Academic year 2013-2014

SEMESTER III DETAILED SYLLABUS

Course Code	Title	Credits
PSLSCBMP 301	**Biomathematics / Research methodology / Biostatistics (60L)**	**4**
Unit I: **Biomathematics** **(15L)** • Matrices, Rank of Matrices by Diagonalisation method Limit and derivatives, Differentiation (including differentiability), Successive Differentiation and their application in biological research. Integration – Definite and Indefinite; Application of integration to find area and application in biological research. • Differential equations --homogeneous and Linear ODE's and its simple applications to biological problems		
Unit II: **Research Methodology** **(15L)** • Meaning of Research, Objectives of research, motivation in research; • Types of research - Descriptive, Analytical, Applied, Fundamental, Quantitative, Qualitative, Conceptual, Empirical and Other Types of Research; • Research Approaches; Research Methods vs. Methodology; • Research Process: Steps of research process; Criteria of Good Research; Sampling, Sample size determination, Plan for data collection, Methods of data collection, Plan for data processing and analysis; • Ethical considerations during research		
Unit : III **Biostatistics** **(15L)** • **Basics:** Introduction, scope, applications and uses of statistics, census and sampling surveys, • **Data, graphical presentation of data:** collection and tabulation and graphical representation of data, frequency distribution • **Practice of statistical methods** in biological research, Measures of central tendency (grouped and ungrouped data), samples and populations; Central tendency measures: Arithmetic mean, median, dispersion and its measures: variance and standard deviation, coefficient of variation. Standard error. Skewness and kurtosis • Population parameters and sample statistics, sampling techniques: simple random sampling; stratified random sampling, systematic sampling. Estimators of population mean & proportion (without proof), confidence intervals for population mean & proportion. Regression and correlation and its application in biology; types of correlation, correlation coefficient and scatter diagram.		

Unit : IV **Population Biostatistics** **(15L)** • Concept of probability, Theories of Probability – addition and multiplication theorems. Random variable and its distribution, Probability distributions – Binomial, Poisson and Normal; • **Test of hypothesis:** Z-test, t-test, X^2 test and F test. Difference between parametric and non-parametric statistics. • **Analysis of variance (ANOVA**), one-way ANOVA, Tukey's post hoc test, two-way ANOVA Basic introduction to Multivariate statistics. Non parametric tests: Sign test and Run test.	

Practicals:

PSLSCBMPP301	**<u>Biomathematics and Biostatistics</u> (60L)** 1. Solve sums on derivation and integration related biological data. 2. Formation of frequency distribution and calculation of descriptive measures – mean, median, mode, variance, standard deviation and standard error from a given data 3. Large and small sample tests for sample mean and proportion 4. Calculation of correlation coefficient and regression, coefficients and tests of significance 5. ANOVA – one way and two way classification; Estimation of genetic components and heritability from ANOVA data 6. Devise a research methodology for the project to be undertaken as the dissertation 7. Non Parametric tests: Sums on Sign test and Run test.	**2**	**04**

Course Code	Title	Credits
PSLSCBMT 302	**Bioanalytical Techniques and Cell Dynamics (60L)**	**4**
Unit I: **Chemical Bonds and Spectroscopic Techniques** **(15L)** Inter atomic interactions, ionic, covalent and metallic bonds; Importance of weak, non-covalent bonded interactions in biomolecules, such as van der Waals forces and hydrogen bonding; Energies and geometrics of these		

	interactions and their roles in structure and conformation of biomolecules: Concept of pH, pKa and buffers Principle, methodology and applications of Fluorescence, Infrared, Raman, ESR, Atomic absorption spectroscopy; Use of lasers for spectroscopy **Optical Activity:** Importance of chirality in biomolecules; Principles and applications of ORD and CD – protein folding, folding intermediates, hierarchical and non-heirarchical folding mechanisms.	
	Unit II: **Biomembrane** **(15L)** **Biomembranes:** Structure and assembly; Orientation of membrane proteins, their solubilisation with detergents and enzymes; Membrane reconstitution; Liposomes and their application in biology and medicine **Nuclear pore complex:** Role in macromolecular exchange and regulation	
	Unit : III **Cell Matrix** **(15L)** **Molecules of the matrix:** Proteins of the microfilament, microtubules and intermediary filaments; Structure, properties and assembly of actin and tubulin, examples and roles of these filaments in cell structure and function, eg., dynamics and roles of kinesin and dynein; Organization of proteins on microvillus **Extracellular Matrix:** Structure; Cell-cell/cell-matrix interactions; Intracellular transport – cilia and flagella	
	Unit : IV **Protein Trafficking and Targeting** **(15L)** Intracellular Protein Trafficking and protein targeting; Secretory pathways in prokaryotes and eukaryotes; Signal sequences; Targeting of mitochondrial, chloroplast, peroxisomal and nuclear proteins; SNAPs and SNAREs **Covalent modification of proteins:** Phosphorylation, adenylation, methylation, ribosylation	

Practicals:

PSLSCBMP 302	**<u>Bionanalytical Techniques and Cell Dynamics</u> (60L)** 1. pka values ofAla or Gly by Titration Curve 2. Determination of melting temperature (Tm) of DNA 3. Spectroflourimetric analysis of proteins 4. Preparation of lipid bilayer vesicles (liposomes) using the purified lipids 5. Effect of detergents on membranes 6. Fractionation of cell organelles from animal/plant tissues and identification by marker enzymes	**2**	**04**

	7. Estimation of inorganic phosphorus by Fiske and SubbaRao method		

Course Code	Title	Credits
PSLSCBMT 303	**Bioenergetics and Metabolism (60L)**	**4**
Unit I: **Bioenergetics and Carbohydrate Metabolism (15L)** **Bioenergetics:** Concept of free energy, standard free energy, determination of ΔG for a reaction; Relationship between equilibrium constant and standard free energy change, biological standard state & standard free energy change in coupled reactions; Biological oxidation-reduction reactions; Redox potentials; Relation between standard reduction potentials & free energy change; High energy phosphate compounds – introduction, phosphate group transfer, free energy of hydrolysis of ATP and sugar phosphates alongwith reasons for high ΔG **Carbohydrate Metabolism:** Glycolysis in higher organisms and microorganisms; Pentose phosphate pathway and its regulation; Gluconeogenesis, glycogenesis and glycogenolysis, glyoxylate and Gamma aminobutyrate shunt pathways; Cori cycle; Anaplerotic reactions; Entner-Doudoroff pathway; Glucuronate pathway; Metabolism of disaccharides; Hormonal regulation of carbohydrate metabolism		
Unit II: **Lipid Metabolism (15L)** **Fatty acid catabolism:** Hydrolysis of tri-acylglycerols; α-, β-, ω- oxidation of fatty acids; Oxidation of odd numbered fatty acids – fate of propionate; Role of carnitine; Degradation of complex lipids; Formation of ketone bodies; Energetics of beta oxidation **Fatty acid biosynthesis**: Acetyl CoA carboxylase; Fatty acid synthase; ACP structure and function; Lipid biosynthesis; Biosynthetic pathway for tri-acylglycerols, phosphoglycerides, sphingomyelin and prostaglandins; Metabolism of cholesterol and its regulation; Biosynthesis of bile acids and steroid hormones; Alternative pathway for isoprenoid biosynthesis in chloroplast		
Unit : III **Electron Transport Chain and Oxidative Phosphorylation (15L)** **TCA cycle:** Central role of TCA cycle in energy generation and biosynthesis of energy rich bond; Integration/regulation of carbohydrate, lipid and protein metabolism **Electron Transport Chain** in Mitochondria and chloroplast: Organisation and role in electron capture **Oxidative Phosphorylation:** Electron transfer reactions in mitochondria;		

F_1F_0 ATPase - Structure and mechanism of action;Chemiosmotic theory; Inhibitors of respiratory chain and oxidative phosphorylation - Uncouplers and ionophores; Regulation of oxidative phosphorylation.	
Unit : IV **Metabolic Regulation and Metabolic Disorders (15L)** **Metabolic Regulation:** Metabolic control analysis using mutants and transgenic organisms, modeling of metabolic regulation; Structural control analysis and kinetic analysis models. **Metabolic Disorders:** Molecular genetics of metabolic disorders; Inborn errors of metabolism; Glycogen storage diseases; Principles and methods of gene therapy in Thallassemia, Cystic fibrosis, Adenosine deaminase deficiency, Gaucher's disease. **Free radicals in biological system:** Antioxidants; Enzymic and non-enzymic components of antioxidative defense mechanism	

Practicals:

PSLSCBMP 303	**<u>Metabolism & Biomolecular Structure</u> (60L)** 1. Determination of pyruvate by 2,4-dinitrophenyl hydrazine method 2. Isolation of cholesterol and lecithin from egg yolk 3. Measurement of free radicals by spectrophotometric method 4. Analysis of free radical scavengers and antioxidant enzymes (Assay of any one - peroxidase, catalase, phenol oxidase, ascorbic acid oxidase) 5.Determination of N- and C-terminal amino acids (demonstration) 6. Effect of metal ions on the activity of enzymes/proteins 7. Protein purification methods: A. Isolation of casein from milk B. Purification of an enzyme by ion exchange chromatography/affinity chromatography C. Use of ammonium sulphate precipitation and dialysis D. Use of gel filtration E. SDS-PAGE 8. Polyacrylamide gel electrophoresis under non denaturing conditions A. Silver staining B. Activity staining of enzymes C. Determination of effect of acrylamide	**2**	**04**

	concentration on the mobility of proteins 9. Expression of foreign protein in *E. coli*		

Course Code	Title	Credits
PSLSCBMT 304	**Biomolecular Structure (60L)**	**4**
Unit I: **Protein Structure and Folding (15L)** **Protein Structure:** Description and characteristic features of specific protein motifs and domains; Ramachandran plot; N and C terminal analysis of proteins **Protein Folding:** Folding pathways; Intermediates of protein folding; Compact Intermediates; Molten globule structure; Role of chaperons, heat shock proteins and enzymes in protein folding		
Unit II: **Supramolecular Assemblies and DNA-protein Interactions (15L)** **Viruses:** Viral assembly; Capsid; Capsomereeg., TMV, HIV, Adenovirus **Prokaryotes and Eukaryotes:** Ribosomal assembly; Biosynthesis and processing of rRNA; Macromolecular interactions in regulating translation **Nucleic Acid Binding Motifs in Proteins:** Leucine zipper; Zinc fingers; Helix-turn-helix; Beta barrel; OB fold and their role in regulation of gene expression		
Unit : III **Complex Proteins (15L)** **Metalloproteins:** General principles of metal coordination; Heme- and non-heme proteins **Transport proteins:** Oxygen transport proteins from vertebrate and invertebrate (haemoglobin, hemocyanin, hemoerythrin, cytochrome C and cytochrome oxidase) **Bacterial two-component signalling** systems and their role in regulating sugar transport, catabolite repression, phosphotransferase system, chemosensory mechanisms and sensory modulation of C-N metabolism.		
Unit : IV **Protein Engineering (15L)** Design and construction of novel proteins and enzymes; Conformation of proteins in general and enzymes in particular; Effect of amino acids on		

structure of proteins; Energy status of a protein molecule, Structure-function relations of enzymes **Physical methods** such as X-ray crystallography for determination of protein structure; Site directed mutagenesis for specific protein function; Basic concepts for design of a new protein/enzyme molecule; Specific examples of enzyme engineering –Dihydrofolatereductase	

Practicals:

PSLSCBMP 304	**Dissertation in Literature Review (60L)** 1. Project dissertation of literature review	**2**	**04**

SEMESTER IV DETAIL SYLLABUS

Course Code	Title	Credits
PSLSCBMPT401	**Bioinformatics and IPR and Bioethics (60L)**	**4**
Unit I: **Bioinformatics – I** **(15L)** • **Introduction to Bioinformatics:** Definition and History of Bioinformatics, Internet sources for Bioinformatics. • **Biological databases:** (a) Nucleic acid databases **(**NCBI, DDBJ, and EMBL). (b) Protein databases (Primary, Composite, and Secondary) (c) Specialized Genome databases: (SGD, TIGR, and ACeDB) (d) Structure databases (CATH, SCOP, and PDBsum) • **Alignment problem and solutions:** Alignment: Basics and techniques, Local alignment and Global alignment. Pairwise sequence alignment: NEEDLEMAN and Wunsch algorithm, Smith and Waterman algorithm, The Dot Plot, Dynamic Programming Algorithm. Multiple Sequence Alignment (MSA): Definition, Objective, Consensus. • **Phylogenetic Analysis:** Phylogenetic-trees, Terminology of tree-reconstruction, rooted and un-rooted trees. Algorithms /methods of phylogenetic analysis: UPGMA, Neighbor-Joining Method.		

Unit II: **Bioinformatics – II** **(15L)** • **Protein structure analysis and prediction**: Identification/assignment of secondary structural elements from the knowledge of 3-D structure of macromolecule using DSSP and STRIDE methods. Prediction of secondary structure: PHD and PSI-PRED methods. Tertiary (3-D) Structure prediction: Fundamentals of the methods for 3D structure prediction. Homology Modeling, fold recognition, threading approaches, and ab-initio structure prediction methods. • **Genomics**: Basic concepts on identification of disease genes, role of bioinformatics-OMIM database, identification of SNPs, SNP database (DbSNP), SNP arrays. • **Drug discovery and Development** : Introduction to Drug Design and Development, Drug targets, Lead Identification and Modification, Computer-Aided Drug Design, Drug Delivery, Pre-clinical and Clinical Testing • **Applications Of Bioinformatics**: Pharmaceutical industries, immunology, agriculture, forestry; Biosensing	
Unit : III **Intellectual Property Rights** **(15L)** • Introduction to IPR; Types of Intellectual property – Patents, Trademarks, Copyrights and related rights; Traditional vs. Novelty; Importance of intellectual property rights in biology and environmental sciences; • GATT and WTO and IPR provisions under TRIPS; Madrid agreement; Hague agreement; WIPO treaties; Budapest treaty; Indian Patent Act (1970) • **Patents:** Definition, patentable and non-patentable inventions; types of patent application – Ordinary, Conventional, PCT, Divisional, and Patent of addition; • Concept of Prior Art; Precautions while patenting - disclosure / non-disclosure; Time frame and cost; • Patent databases, Patent infringement – meaning, scope, litigation, case studies; Patenting rules in different countries	
Unit : IV **Bioethics** **(15L)** • Bioethics: Definition – moral, values, ethics and ethics in biology; Role and importance of ethics in biology; Basic Approaches to Ethics; Posthumanism and Anti-Posthumanism; • Bioethics in healthcare, agriculture, modern biology, biotechnology, animal welfare & right / animals in research, wildlife conservation and management, commercialism in scientific research	

• Bioethics and cross-cultural bioethics – Autonomy, Rights, Beneficience, Do No Harm, Justice, Confidentiality, Animal Rights, Environmental ethics, Mixed Perception of Benefit & Risk, • Reasoning behind Acceptance or Rejection of Genetic Manipulation, Concerns about Consuming products of GMOs. Past and Present 'Bioethical Conflicts' in Biotechnology- Interference with Nature , Fear of Unknown, Regulatory Concerns, Human Misuse	

Practicals:

PSLSCBMPP401	**Bioinformatics (60L)** 1. Biological Databases with Reference to Expasy and NCBI 2. Queries based on Biological databases 3. Sequence similarity searching using BLAST 4. Pairwise sequence alignment 5. Multiple Sequence and Phylogenetic Analysis 6. Gene Prediction 7. Secondary Structure prediction 8. Tertiary Structure Prediction 9. Homology Modeling Using Modeller 10. Case study – Various Applications of Bioinformatics 11. Case study – Bioethics for GMO 12. Case study – IPR and India	**2**	**04**

Course Code	Title	Credits
PSLSCBMT 402	**Molecular Cell Biology (60L)**	**4**
Unit I: **Cell Division and Apoptosis (15L)** Cell cycle and division: Eukaryotic cell cycle and its control points; Signalling in cell cycle regulation and role of kinases and phosphatises; Role of M phase kinase or maturation promoting factor (MPK/MPF), cyclins, CDCs, CDKs, Lamins and their genes; Regulation of phase transition during the cell cycle; Growth factor induced cell division; Cellular reorganization during mitosis		

Advances from yeast, animal and mammalian cell cycle studies; Cancer as an aberration in cell cycle regulation	
Unit II: **Programmed Cell Death and Cancer** **(15L)** **Apoptosis**: Factors inducing apoptosis; Genes and proteins involved in apoptosis; Receptors with death domains and their signalling pathways; Role of apoptosis in development and disease. **Carcinogenesis**: Characteristics of cancerous cells; Agents promoting carcinogenesis; molecular basis of cancer therapy, Tumor markers - AFP, CEA, hCG. DNA damage and repair mechanisms	
Unit : III **RNAi and Epigenetics** **(15L)** **Regulatory RNAs:** Historical background; RNA interference as regulatory mechanism in eukaryotes; Slicer and dicer; Synthesis and function of RNAi molecules in plants;Chromatin remodelling in human disease and diagnosis **Epigenetics:** Background, chromosomal inheritance taking fission yeast as an example; DNA methyltransferases, DNA methylation maintenance;Histone modification and regulation of chromatin structure; Bivalent histones;Histone demethylation	
Unit : IV **Cell Biology Techniques** **(15L)** **Flow Cytometry and FRET:** Principles, Instrument overview, Principle of fluorescence, Sample preparation, Data analysis, Applications of flow cytometry; Fluorescence Resonance Energy Transfer - Principle, Mechanism and Applications; Surface Plasmon resonance **Molecular Techniques:** DNA microarrays; Gene knockdown; *in situ* hybridization	

Practicals:

PSLSCP 402	**<u>Molecular Cell Biology and Metabolism</u>** **(60L)** 1. Nucleic acid isolation and blotting A. Isolation of RNA from *E. Coli* B. Spectrophotometric characterization of RNA C. Capillary blotting (Southern/Northern) of nucleic acids from agarose gels D. Preparation of cDNA and RT-PCR 2. Isolation of DNA and demonstration of apoptosis of DNA laddering 3. MTT assay for cell viability and growth 4. UV damage and repair mechanism in *Escherichia coli* or *Serratia marcescens* 5. Determination of Molar absorption coefficient of	**2**	**04**

	tyrosine 6. Measurement of DNA by DPA method 7. Assay of alanine and aspartate aminotransferases 8. Measurement of activity of plant nitrate assimilation enzymes A. Isolation of nitrate reductase from plants B. Effect of environmental factors and hormones (CO_2, light, pH, growth hormones) 9. Plant pigments A. Extraction of plant pigments from spinach B. Separation by column chromatography C. Determination of absorption spectra of plant pigments		

Course Code	Title	Credits
PSLSCBMT 403	**Nitrogen Metabolism and Plant Biochemistry (60L)**	**4**
Unit I **Amino Acid Metabolism** **(15L)** Amino acid catabolism: Proteolysis; General reactions of amino acid metabolism - Transamination, decarboxylation, oxidative & non-oxidative deamination of amino acids; Acetyl CoA, alpha ketogutarate, acetoacetyl CoA, succinate, fumarate and oxaloaccetate pathway; Urea cycle and its regulation; Ammonia excretion. Biosynthesis of amino acids: Biosynthesis of aromatic amino acids and Histidine; One carbon atom transfer by folic acid (Biosynthesis of glycine, serine, cysteine, methionine, threonine.); Conversion of amino acids to specialized products; Inborn errors of protein metabolism		
Unit II: **Nucleotide Metabolism** **(15L)** Nucleotide Metabolism: Biosynthesis and degradation of purines and pyrimidine nucleotides and their regulation; Purine salvage pathway; Role of ribonucleotidereductase; Biosynthesis of deoxyribonucleotides and polynucleotides; Inhibitors of nucleic acid biosynthesis; Inherited disorders of nucleotide metabolism; Anticancer drugs		
Unit : III **Nitrogen Assimilation in Plants** **(15L)** **Nitrogen Fixation:** Nitrogenase complex; Electron transport chain and mechanism of action of nitrogenase; Structure of 'NIF' genes and its regulation; Hydrogen uptake and bacterial hydrogenases **Nitrate assimilation in plants:** Structural features of nitrate reductase and nitrite reductase, incorporation of ammonia into organic compounds, regulation of nitrate assimilation; Ammonium assimilating enzymes – glutamine synthetase, glutamate synthase and GDH		

Unit : IV **Photosynthesis and Secondary Metabolism** **(15L)** Photosynthesis: Light harvesting complexes; Photosynthetic electron transport and production of NADH and ATP; Carbon fixation by C_3 and C_4 pathways; Photorespiration; Bioluminescence. Special features of secondary plant metabolism, terpenes (classification, biosynthesis), lignin, tannins, pigments, phytochrome, waxes, alkaloids; Biosynthesis of nicotine; Functions of alkaloids; Cell wall components.	

Practicals:

PSLSCBMP 403	**PRACTICAL VII: Biomolecular Function (60L)** 1. Analysis of DNA A. Estimation of DNA and RNA by UV absorption method B. Determination of purity of nucleic acids C. Conformational analysis of plasmid DNA by agarose gel electrophoresis 2. Enzyme inhibition A. Inhibition of enzyme activity B. Determination of Ki values 3. Immobilization studies: A. Preparation of urease entrapped in alginate beads and determination of percent entrapment B. Study of the kinetics of the rate of urea hydrolysis by urease entrapped alginate beads C. Study of reusability and storage stability of urease entrapped alginate beads D. Immobilization of urease by covalent attachment to solid support 4. 2-D Gel electrophoresis (Demonstration) 5. Study of nanoparticles A. Synthesis of Silver nanoparticles B. Spectroscopic characterisation	**2**	**04**

Course Code	**Title**	**Credits**
PSLSCBMT 404	**Biomolecular Function (60L)**	**4**
Unit I: **Structure of DNA and Replication (15L)** **DNA Conformation:** A/B/Z/D forms of double helical structure of DNA; Triple helix; DNA supercoiling and topoisomerases **DNA Replication:** DNA polymerase; Replication fork and assembly; Fidelity of replication; Telomere replication; Telomerase and its role in cancer and aging		
Unit II: **Kinetics and Mechanism in Biological Systems (15L)** **Enzyme Kinetics:** Enzyme catalysis and factors contributing to high catalytic rates; Molecular aspects of catalysis for specific enzyme substrate complexes (Lysozyme, carbonic anhydrase, carboxypeptidase and chymotrypsin) Multisite binding of ligands to proteins; Bohr's effect; Models of Allostery - MWC and KNF models Hill's equation coefficient		

Immobilised enzymes: Methods and applications	
Unit : III **Methods in Proteomics and Genomics** **(15L)** **Proteomics:** Peptide synthesis and sequencing; 2-D gel electrophoresis; Isoelectric focussing; Mass spectrometry **Genomics:** Oligonucleotide synthesis; DNA chips/microarrays; DNA hybridization; Automated DNA sequencing; Pulse field gel electrophoresis	
Unit : IV **Nanobiology** **(15L)** **Introduction:** Nanoscience; Nanobiotechnology; Nanodevices; Biomaterials; Biology at nano-interface **Application:** Gold bonding proteins; Nanopharmaceuticals such as liposomal formulations; Membrane nanodiscs; Biosensors; BioMEMS	

Practicals:

PSLSCBMP 404	**Dissertation of Research Project** **(60L)** 1. Project studies: presentation and preparation of report of observations and results	**2**	**04**

REFERENCES

PSLSCBMT301

1. Kothari, C.R.,1985, Research Methodology- Methods and Techniques, New Delhi, Wiley Eastern Limited.
2. Das, S.K. , 1986, An Introduction to Research, Kolkata, Mukherjee and Company Pvt. Ltd.
3. Misra R.P., 1989, Research Methodology: A Handbook, New Delhi, Concept Publishing Company
4. Kumar, R., 2005, Research Methodology-A Step-by-Step Guide for for Beginners,(2nd.ed.),Singapore, Pearson Education.
5. Bhattachraya, D.K., 2006, Research Methodology,(2nd.ed.),New Delhi, Excel Books.
6. Panneerselvam R.,2012, Research Methodology, New Delhi, PHI Learning Pvt. Ltd.
7. Khan, Irfan Ali, 2008, Fundamentals of Biostatistics, Ukaaz Publications
8. Rosner B.A., 2011, Fundamentals of Biostatistics, Cengage Learning
9. Katz J.M., 2009, Form Research to Manuscript: A guide to scientific writing, USA, Springer Science
10. Saravanavel, P. 1990. Research methodology. Allahabad, Kitab Mahal

PSLSCBMT302

1. Bio-organic chemistry: Dugas and Penney: Springer Verlag
2. Lehninger's Principle of Biochemistry: Nelson & Cox
3. Principles and Techniques of Biochemistry and Molecular Biology: Wilson and Wilson
4. Physical Biochemistry: David Friefelder

5. Biophysical Chemistry: David Sheehan
6. Cell: A Molecular Approach: G. Cooper, ASM Press
7. Cell and Molecular Biology: Gerald Karp
8. Cell Biology: David Sadava
9. Molecular cell Biology: Harvey Lodish. W. H. Freeman; Sol edition (2007)
10. Protein Targeting, Transport, and Translocation: Ross Dalbey (Editor), Publisher: Academic Press; 1 edition (May 13, 2002)
11. Fundamentals of Biochemistry: Voet and Voet

PSLSCBMT303

1. Biochemistry: Lubert Stryer. W. H. Freeman; 6 editions (2006).
2. Fundamentals of Biochemistry: Voet and Voet
3. Biochemistry: Kuchel and Ralston, 1998. 2nd ed. Schaum's Outlines McGraw Hill.
4. Harper's Biochemistry: Murray, et al. 2003. 28th ed. McGraw Hill.
5. Lehninger's Principle of Biochemistry: Nelson & Cox
6. Understanding the Control of Metabolism: David A Fell, Portland Press
7. Human Physiology: Guyton
8. Text Book of Biochemistry with clinical correlation: Thomas M Devlin, John Wiley
9. Biochemistry: Zubey, GL WCB Publishers.

PSLSCBMT304

1. Principles of Protein Structure: Schulz and Schirmer
2. Genes XI: Benjamin Lewin
3. Molecular Cell Biology: Lodish, Baltimore
4. The Chemical Reactions of Living Cells: David E Metzler
5. Protein Engineering and Design: Sheldon Park and Jennifer Cochlan
6. Protein Engineering- Principle and Practice: Jeffrey Cleland
7. Modern Protein Chemistry: Practical Aspects Published: September 12, 2001 by CRC Press - 272 Pages Edited By: Gary C. Howard
8. Proteins: Structures and Molecular Properties: Thomas E. Creighton Publisher: W. H. Freeman 1992 Edition: Second Edition
9. Protein Engineering Protocols (Methods in Molecular Biology) Kristian Müller (Editor), Publisher: Humana Press; Softcover reprint of hardcover 1st ed. 2007 edition (November 10, 2010)
10. Structural Aspects of Protein Synthesis Anders Liljas (Author) Publisher: World Scientific Pub Co Inc; 1 edition (November 2004)

PSLSCBMT401

1. Fundamentals of Bioinforamtics: Harisha S.
2. Bioinformatics and Molecular Evolution: Higgs & Attwood
3. Bioinformatics: Harshwardhan Pal

PSLSCBMT402

1. Cell: A Molecular Approach:G. Cooper, ASM Press
2. Cell and Molecular Biology: Gerald Karp

3. Cell Biology: David Sadava
4. Molecular cell Biology by Harvey Lodish. W. H. Freeman
5. Molecular Biology of the Cell: Bruce Alberts
6. Analysis of Genes and Genomes: Richard J Reece, JOHN WILEY& SONS, LTD., 2004

PSLSCBMT403

1. Campbell and Farrell: Biochemistry 4th ed. Brooks/Cole Pub Co.
2. Plant physiology: Taiz & Ziger
3. Biochemistry and molecular Biology of Plant:Buchanan
4. Plant physiology: M. Devlin
5. Plant Biochemistry: Heldt
6. Biochemistry: Lubert Stryer. W. H. Freeman; 6 editions (2006).
7. Fundamentals of Biochemistry: Voet and Voet
8. Biochemistry: Kuchel and Ralston, 1998. 2nd ed. Schaum's Outlines McGraw Hill.
9. Harper's Biochemistry: Murray, et al. 2003. 28th ed. McGraw Hill.
10. Lehninger's Principle of Biochemistry: Nelson & Cox

PSLSCBMT404

1. Molecular biology: Robert F. Weaver McGraw Hill 4 edition (2007)
2. Advanced molecular biology: R. M. Twyman, (1998)
3. Genes XI: B. Lewin Oxford University Press, Cell Press, London (2000).
4. Enzymes: Dixon and Webb, Academic Press (1964)
5. Understanding enzymes: Palmer.Prentice Hall; 4 Sub edition (1995)
6. Enzymes: P.Asokan. China publications (2003).
7. Enzymes: Boyer. Academic Press; 3rd edition (November 1983)
8. DNA Structure & Function: R.R.Sinden (Academic Press)
9. Analysis of Genes and Genomes: Richard J Reece, JOHN WILEY& SONS, LTD., 2004
10. Nanoscience: Nanobiotechnology and Nanobiology: Boissaeu, Houdy & Lehmani
11. A-Z Nanobiology: Albert Shawn

OVERALL EXAMINATION AND MARKS DISTRIBUTION PATTERN

Semester III

Course	PSLSCEBTT301			PSLSCEBTT302			PSLSCEBTT303			PSLSCEBTT304			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	**400**
	PSLSCEBTP301			**PSLSCEBTP302**			**PSLSCEBTP303**			**PSLSCEBTP304**			
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	**200**

Semester IV

Course	PSLSCEBTT401			PSLSCEBTT402			PSLSCEBTT403			PSLSCEBTT404			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	**400**
	PSLSCEBTP401			**PSLSCEBTP402**			**PSLSCEBTP403**			**PSLSCEBTP404**			
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	**200**

MODALITY OF ASSESSMENT:

THEORY EXAMINATION PATTERN:

A] Internal Examination for Theory: **40 marks**

No.	Particulars	Marks
1.	Active participation in routine Class instructional deliveries	05
2.	Overall conduct as a responsible learner, Communication & leadership qualities in organizing related academic activities.	05
3.	One seminar based on curriculum to be assessed by the teacher of the institution teaching P.G. learners/ publication of a research paper/ presentation of a research paper in seminar or conference	30
	a. Selection of the topic, Introduction, write up, references (15)	
	b. Presentation with the use of ICT (15)	

B] External Examination - 60 % [Semester End Theory Assessment]: **60 marks**

1. Duration - These examinations shall be of two and half hours duration.

2. Theory question paper pattern :-

(a) There shall be **five** questions each of **12** marks. On each unit there will be one question & fifth one will be based on all the four units .

(b) All questions shall be compulsory with internal choice within the questions. Each question will be of **24** marks with options.

(c) Questions may be sub divided into sub questions **a, b, c & d only, each carrying six marks OR a, b, c, d, e & f only** each carrying **four** marks and the allocation of marks depends on the weightage of the topic.

PRACTICAL EXAMINATION PATTERN

A] Internal Examination:

There will not be any internal examination/ evaluation for Practicals.

B] External (Semester end practical examination) Per course:

No.	Particulars	Marks
1.	Laboratory work	40
2.	Journal	05
3.	Viva	05

SEMESTER III:

Practical examination will be held at the college / institution at the end of the Semester.

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head of the Department/ Co-ordinator of the department, failing which the student will not be allowed to appear for the practical examination.

Research proposal (Dissertation based on Literature Review): Candidates are required to present duly certified research proposal (as per the BCUD format) with relevant references (minimum 25) and make the power point presentation of the same for the evaluation by the examiner (the research proposal must be included with literature survey of the selected research topic).

SEMESTER IV:

Practical examination will be held at the college / institution at the end of the semester. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head of the Department/ Co-ordinator of the Department, failing which the student will not be allowed to appear for the practical examination.

Research Project work (Dissertation based on Research): Candidates are required t present duly certified dissertation report based on the topic of research along with the laboratory notebook containing raw data and make the poster presentation of the research work for evaluation by the examiner.