UNIVERSITY OF MUMBAI

No. UG/ 71 of 2016-17

CIRCULAR:-

A reference is invited to the Syllabi relating to the M.Sc. degree programmes **vide** this office Circular No.UG/25 of 2013-14 dated 13th May, 2013 and the Head, University Department of Bio-Physics and the Principals of affiliated Colleges in Science and Heads of the recognized Science Institutions concerned are hereby informed that the recommendation made by Board of Studies in Bio-Physics in at its meeting held on 25th May, 2016 has been accepted by the Academic Council at its meeting held on 24th June, 2016 **vide** item No.4.33 and that in accordance therewith, the revised syllabus as per Choice Based Credit System for (Sem. I to IV) of M.Sc. degree Programmes in the course of Bio-Physics, which is available on the University's web site (www.mu.ac.in) and that the same has been brought into force with effect from the academic year 2016-17.

19/9/16

(Dr.M.A.Khan)
REGISTRAR

MUMBAI – 400 032
21st September, 2016

To,

The Head, University Department of Bio-Physics and the Principals of affiliated Colleges in Science and Heads of the recognized Science Institutions concerned.

A.C/4.33 /24/06/2016

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No. UG/71 -A of 2016-17 MUMBAI-400 032 21st September, 2016

Copy forwarded with compliments for information to:-

1) The Dean, Faculty of Science,
2) The Chairman, Board of Studies in Bio-Physics
3) The Director, Board of College and University Development,
4) The Professor-cum- Director, Institute of Distance and Open Learning (IDOL),
5) The Controller of Examinations,
6) The Co-Ordinator, University Computerization Centre.

19/9/16.

(Dr.M.A.Khan)
REGISTRAR

PTO....

UNIVERSITY OF MUMBAI

Syllabus for the M.Sc. Part - I
Program: M.Sc.
Course: Biophysics

(Chose Based credit System with effect from the academic year 2016–2017)

Preamble

The subject of Biophysics is one of the important interdisciplinary areas in teaching, training and learning which is considered to be important in terms of human resource development and National development. Biophysics is the physics of life phenomenon studied at all level, from molecules and cell to the biosphere as whole. It is the branch of knowledge that applies the principles of physics and chemistry and the methods of mathematical analysis and computer modeling to understand how biological systems work.

The main emphasis of biophysics is on the quantitative analysis of the physical and chemical aspects of the functions of biological molecules, organisms and entities. The techniques and methodologies that biophysics relies on are closer to Physics and Chemistry, but areas of application are in the biological, medical and related sciences

Biophysicists use mainly that technique includes UV visible spectroscopy, Gel electrophoresis, X-ray crystallography, macrocalorimetry, Atomic Force Microscopey, FTIR, Raman, SPR, NMR, Fluorescence spectroscopy, Fluorescence Microscopy & spectroscopy, hydrodynamics techniques etc., are used to study problem in exciting areas in biophysics ranging from structure aided drug design to cell signalling and transcriptional silencing etc. Biophysicist's are employed in Universities, R & D industry, Medical centres/Colleges, Research Institutes and Government Organisation etc.

The two year programme of M.Sc. (Biophysics) is prescribed according to the choice based credit system of the University of Mumbai from the academic year 2016-17. The course has been divided in to four semesters. The program has a total of 14 core papers, 14 number of laboratory courses , research projects, review of literature and elective papers like Virology, Bacteriology, Medicine chemistry & drug design, Ethics and IPR etc. Invited lectures by subject expert in various areas as well as seminars and workshops add value to the course and enhance their potential. In addition the students are encouraged to attend seminars outside the department as well as attend summer internship in prestigious laboratories in India as well as abroad.

The programme endeavours to provide students a broad based training in Biophysics with strong background of basic concepts as well as exposing them to recent advances in the field. The programme is focussed on recent developments in the areas of biophysics. In addition, theoretical knowledge, significant emphasis has been given to provide hands on experience to the students in the frontier areas of Biophysics. A multidisciplinary approach has been employed to provide best leverage to students to enable them to move into advanced and frontier areas of biological research in future. Another important feature of course is that a sufficient number of elective papers have been introduced as results student may particular subject of their interest. Hence, apart from the core and elective papers an additional paper is introduced on soft skill as per the guideline given by University of Mumbai. This will enable the addition of new dimension in learning and research skill of students.

Revised syllabus of M.Sc. Biophysics
(Choice Based Credit system)

Semester I

Paper code	Paper nomenclature	Lectures	Credit	Practical/Laboratory course	Hrs	Credit	Total Credit
BP-CCT 101	General physico-chemical Principles	60	04	Lab course (**BP-LBC)** 101	60	02	06
BP-CCT 102	Biomathematics & Biostatistics	60	04	Lab course (**BP-LBC)** 102	60	02	06
BP-CCT 103	Cellular Biophysics	60	04	Lab course (**BP-LBC)** 103	60	02	06
BP-CCT 104	Methods in Biophysics	60	04	Lab course (**BP-LBC)** 104	60	02	06
	Total						**24**
	Semester II						
BP-CCT 201	Membrane Biophysics & Ion channels	60	04	Lab course (**BP-LBC)** 201	60	02	06
BP-CCT 202	Molecular Biophysics	60	04	Lab course (**BP-LBC)** 202	60	02	06
BP-CCT 203	Biochemistry	60	04	Lab course (**BP-LBC)** 203	60	02	06
BP-CCT 204	Recombinant DNA Technology & Protein Engineering	60	04	Lab course (**BP-LBC)** 204	60	02	06
	Total						**24**

Semester III

Paper code	Paper nomenclature	Lectures	Credit	Practical Paper	Hrs	Credit	Total Credit
BP-CCT 301	Core Core theory	60	04	Lab course (**BP-LBC)** 301	60	02	06
BP-CCT 302	Core Core theory	60	04	Lab course (**BP-LBC)**	60	02	06

				302			
BP-CCT 303	Core Core theory	60	04	Lab course (**BP-LBC)** 303	60	02	06
				Literature review / research project	60	02	02
BP-ELC 301	Elective -1	30	02				
BP-ECL 302	Elective -2	30	02				
BP-ELC302	Elective -3, 4.....n	30	02				
	Total						**20+4* =24 (*electives)**
	Semester IV						
BP-CCT 201	Core Core theory	60	04	Lab course 401	60	02	06
BP-CCT 202	Core Core theory	60	04	Lab course 402	60	02	06
BP-CCT 203	Core Core theory	60	04	Lab course 403	60	02	06
				Research project		02	02
BP-ELC 401	Elective -1	30	02				
BP-ELC402	Elective -2	30	02				
BP-ECL 403	Elective-3 ,4.....n	30	02				
							20+ 04* =24 (*electives)

No of credit: M.Sc. I (Sem I & II) = 48
No of credit MSc II (Sem III & IV) = 40
No of credit for electives (Sem III & IV) = 08
Total credits: = 96
BP-CCT: Biophysics core course theory
BP-ELC: Biophysics elective course
BP-LBC : Biophysics Lab course

Evaluation: The students will be evaluated internally and externally. The internal evaluation is done by teachers and external evaluation done by the committee appointed by the University norms. Standard passing and scale as per the university norms.

Syllabus details Semester I

Course Code	Title	Credits
BP-CCT 101	**General Physico-chemical Principles** **Total lectures: 60**	**04**
Unit I: Structure and Bonding The electronic structure of atom, Ionic bond, Covalent bonds, Hydrogen bonds Van der Waals forces, Electric dipoles, Polarization and induced Dipoles, Casimir interactions. General understanding of Quantum mechanics, Pauli Exclusion Principle, Ionization energy, Electron affinity and Chemical bonding, Electronegativity and strong bond, Secondary bonds. Interatomic potentials for strong bonds, Interatomic potential for weak bonds, Non-central forces, Bond energies, Spring constants. **(15L)**		
Unit II: Thermodynamics & Principles of kinetics and Molecules Thermodynamic equilibrium, laws of thermodynamics and living system, Entropy, Enthalpy and free energy, Internal energy, Carnot cycle, Chemical potential, Oxidation reduction potential. 0^{th}, I^{st}, 2^{nd}& 3^{rd} order reaction, Activation energy and Rate constant, Diffusion, Osmosis, Osmotic pressure, Osmoregulation, Surface tension, Dialysis, Adsorption, Viscosity, Thermal conduction, Sedimentation filtration of biological fluid, Hydropathy, Biological importance of hydropathies. Precipitation, Biological significance of precipitation, Colloids & their types, Kinetic & electrical properties of colloids, Stability of colloids, Gibbs Donnan Equilibrium in living systems. **15L**		
Unit III: Solvent, Solute & Solution in Biological System Liquids, Solvents, Solubility, Saturated and unsaturated Solutions, Super saturated solutions, Dilute and concentrated solution, types of solutions, Methods of expression of concentration of solution, Molality, Mole fraction. Hydrogen ion concentration, Dissociation of water, (water as electrolyte), concentration of equilibrium, Mechanisms of Ionization and Characterization, Acid & Basic solutions, pH and its biological importance, General concept of acid, bases and their dissociation constant, Bronsted-Lowry theory, Inductive effect of groups on acid strength, (Carboxyl group, Carbonyl group). Salts & their characteristics & importance in biological system. Biological Importance of Acids & Bases, Biological & buffering system, Buffer solution, mechanism of buffer action, Factors influencing buffer capacity and pH, Henderson and Hasselbadch equation, Buffer systems in the body. (Bicarbonate, Phosphate, Protein buffer, Ammonia buffer, etc.) **15L**		
Unit IV: Radioactivity Energy of Radiation, Radioactive emission, α-ray, β-ray, ϒ-ray, and their properties, detection of nuclear radiation, Geiger-Muller counter, Proportional counter,		

Scintillation counter, Liquid Scintillation counter, Crystal counter, Radioactive decay, (α, β,decay), Half-life, Units of measurements of radioactivity, types of radioactivity, Isotopes, Isobar, Isotones and their characteristics. Radioactive equilibrium, Variety of isotopes, Radioactive isotopes, Nuclear reaction and production of artificial radioactivity, Autoradiography. **15L**	
References: 1. Physical Chemistry for Life Sciences,Peter Atkins and Julio de Paula, 2006, Oxford Press 2. Introduction to Biophysics by Cortell 3. Molecular and Cellular Biophysics, Meyer B Jackson (2006), Cambridge) 4. Tex Book of Biophysics , R N Roy, New Central Agency (P) Ltd, Culcutta **5.** Physical Chemistry for the Biosciences, Raymond Chang,(2004), University book Science Biological Thermodyanamics, Donald, T Hayine, (2007), Cambridge	

Course Code	Title	Credits
BP-CCT 102	**Biomathematics & Biostatistics** **Total lectures: 60**	**04**
Unit I:Biomathematics Limits of functions, derivatives of functions. Probability Calculation, Differential and integral calculus, Derivative and its physical significance, basic rules for differentiation (Without derivation) Maximum and Minimum their application in chemistry, Geometric meaning of integration, application in biology and chemistry. **(15L)**		
Unit II: Biostatistics I 1. Introduction, scope, application and use of statistics, collection and classification Of data, census and sampling, graphs and diagrams, arithmetic mean, median standard Deviation. 2.Correlation and regression for ungrouped data, scatter diagram, calculation and interpretation of correlation coefficient, linear regression coefficients and equation of the Lines of regression, nonlinear relationship transformable to liner form ($Y=Ab^x$, Ya^xb) 3. Probability, definition, addition and multiplicative laws (without proof). Random variable and its distribution, binominal probability distribution, examples and conditions means and variances, continuous variable, normal distribution, use of normal probability table for finding probabilities. **(15L)** --- Unit III: Biostatistics II: 1. Population parameter and sample statistics, sampling techniques, simple random sampling stratified random sampling, systematic sampling standard error of mean. 2. Estimation, Point & interval, confidence interval for proportion.		

3.Hypothesis attesting, Type I and Type II errors levels of significance, one-tailed and two tailed test, application to single proportion, equality of the population means and two population proportions. 4. Chi-square test for independent attributes in r x c table, special case of 2 x 2 tables. 5. Students test for significance of correlation coefficient y for p=0 (small sample test) (15L) --- Unit IV: Biostatistics III 1.Fishers z transformation coefficient for getting yp-0 in large samples test of significance for y (p=0) 2..Design of experiment: Principle and concepts of completely randomized design, randomized block design and Latin square design, 3.variance ratio F-test-Analysis of variance in one-way classification . 4.Non-parametric test: Distribution-free method, sign test for method pairs, Wilcoxon test for unpaired data Run test. **(15L)**	
References: 1. Biostastistics:A foundation for analysis in the Health Sciences, 7th Ed.(1998) Wayne D, Wiley 2. DNA Microarrays, David Bowtell & J Sambrook (2002), CSHL Press 3. Principles of Statistics, 2nd Ed. M Pagano & K Gauvreau (2007), Thomson Publ	

Course Code	Title	Credits
BP-CCT 103	**Cellular Biophysics** **Total lectures: 60**	**04**
Unit I: **General organization of cells** Origin and evolution of cell, shape and size of cell; General organization of prokaryotic and eukaryotic organisms basic concepts and their detailed structure and functions, Prokaryotic cell wall, Eukaryotic cell wall, their functions, ribosomes, physical and biological properties of protoplasm. Cytoskeleton – basic components, properties and functions in prokaryotic and eukaryotic cells. **(15L)**		
Unit II: Cell Differentiation Cell differentiation, localization of cytoplasm determinants in eggs, localization of yolk and cytoplasm in different types of cells, Nucleocytoplasmic interaction and cell function, Extracellular matrix – its development, mechanism of alpha adrenergic and related response, modulation of extracellular matrix by tumor cells – Fibroblast interactions, growth factors in cultured cells – early cytoplasm, single and cytoskeleton response; Role of cytoskeleton in maintaining cell-shape, contraction,		

behavior, apoptosis and mortality, impact of xenobiotic on the components of cytoskeleton. **(15L)**	
Unit III: Cell growth and cell division Kinetics of cell growth, role of protein kinase in cell growth, cell cycle, cell cycle events G_1, S, G_2, cytokines, control of cell cycle in dividing and non-dividing cells, synchronization of cell growth, cell transformation, malignant tumor growth, apoptosis. Intra and extracellular factors and signals affecting cell growth, cell division, cellular behavior during cytokinesis, chemotaxis and asymmetrical cell division. (**15L)**	
Unit IV : Cell-Cell Communication Strategies of chemical signaling: endocrine, paracrine and synaptic. Signaling mediated by intracellular receptors: mechanism of transduction by cell surface receptor protein, role of calmodulin, Calcium and cyclic nucleotides, phosphoinositol cycle, sodium proton exchanger, molecular events involved during sperm-ovum (egg) interaction, implications and the mechanisms of sperm-zone interaction, role of soluble factors produced by follicle somatic cells on gamete interactions, factors influencing sperm –ovum (egg) recognition and binding, morphological intercellular connections in different types of cell and tissues. **(15L)**	
References: 1. Molecular Biology of the Cell, Bruce Albert, Alexander Jhonson et al (2002), Taylor & Francis Group. 2. The Cell Molecular Approach, G Cooper & R Hausman (2007) ASM Press 3. Molecular Biology , D Roberties, 8th Ed. SAE 4. Biochemistry by Strayer 5. Introduction to Biological Membrane, D Chapman 6. Molecular Cell Biology, Lodish 7. Molecular and Cellular Biophysics, Meyer B Jackson (2006), Cambridge)	

Course Code	Title	Credits
BP-CCT 104	**Methods in Biophysics** **Total lectures: 60**	4
Unit I: Spectroscopy Principle, instruments and application of spectroscopic instruments: UV Visible: absorption of light, radiation sources, sample holders, monochroamtors, radiation detectors, single and double beam instruments, colorimeter. IR spectroscopy: Rotational and vibration spectra, Instrumental features, applications. Raman effect, strokes and anti-strokes lines, advantages, applications. CD ORD principles and applications. Fluorescence: Fluorescence and phosphorescence, bioluminescence and chemiluminiscence phenomenon, quenching, energy transfer, and applications. Atomic absorption spectroscopy: Principle and instrumentations.		

(15L)	
Unit II: Microscopy Principle, instrumentation and application of microscopy, image formation, magnification, resolving power. optimum resolution, image defects, different types of Microscopy: Dark field ,Phase contrast, polarization microscopy, Interference microscopy, Fluorescence microscopy, Electron microscopy: Electron guns, Electron lens, electrostatic focussing, magnetic focussing, SEM, STEM, Atomic force microscopy. **(15L)**	
Unit III: Separation techniques I Electrokinetics methods: electrophoresis, electrophoretic mobility (EPM), factors affecting EPM, Paper, PAGE, SDS-PAGE, Disc gel, gradient gel, electrophoresis of nucleic acid and its application, Pulse field electrophoresis, single cell gel electrophoresis, Isolectrophoresis, preparative electrophoresis, 2-D gel electrophoresis, Capillary, Iso-Electric focusing, applications in biology and medicine. Chromatography, TLC, adsorption, partition, ion exchange , gel filtration, affinity and FPLC, GLC **(15L)**	
Unit IV: Separation techniques II HPLC: mobile phase systems, modes of operations, application, Hydrodynamics method :fundamental principles' Centrifugation: principle, preparative centrifuge, analytical, ultracentrifuge, sedimentation and diffusion, Ultracentrifugation and their applications in molecular weight, size determination. Viscosity and its application, dialysis, solvent fractionation, isoelectric precipitation, (**15L)**	
References 1. Methods in Molecular Biophysics, Igor N S, N Zaccai & J Zaccai, (2007) Cambridge 2. Principle of Biochemistry, D Voet, J Voet and CW Pratt, 3rd Ed, 3. DNA Clonning, Grover Vol. I, II, III 4. Advanced Methods in Protein Microsequencing, Witmann 5. Essential Biophysics, Narayanan, New Age Publ 6. Handbook of Molecular Biophysics (Methods & Application), 2009, HG Bohr, Wiley	

Syllabus details Semester II

Course Code	Title	Credits
BP-CCT 201	**Membrane Biophysics & Ion channels** **Total lectures: 60**	4
Unit I:*: Membrane structure and Models* Membrane architecture, Lipid vesicles and planar bilayer membrane, membrane permeability, transmembrane helices, hydropath Plot, Membrane asymmetry, Membrane fluidity, Functional reconstitution of membranes. Models of membrane		

fusion: bilayer fusion, viral fusion, cellular fusion, SNAREs, cell-cell fusion, fusion in mitochondria, Lipid bilayer and early models, Fluids mosaic model, Evidence from model system and biomembranes. Membrane Channels, voltage gated channels, ligand gated channels, channel conductance, **(15L)**	
Unit II: Physics of membrane Membrane deformations: bending, sharing shape fluctuation etc, Differential geometry of membranes, Elastic properties, Elastic constants, Charge-induced microstructures and domain. Hysteresis of domains formation, Lateral phase separation, Critical concentrations fluctuation, selective lipid protein interactions, Membrane melting. **(15L)**	
Unit III: **Membrane transport** Transport system with non-electrolytes and electrolytes. Transport with chemical reaction system: Primary and secondary active transport. Transports of molecules by simple and facilitated diffusion, Transport by flux coupling. Transport by phosphotransferase system, Transport by vesicle formation, Ionophores, epithelial transport. Electron Transport & oxidative phosporylation: Reduction potential and free energy changes in redox reaction, organization of electron treansport chain, chemiosmotic coupling, proton gradient drive and synthesis of ATP, P/O ratio for oxidative phosporylation, Cytosolic NADH electron feeding into electron transfer. **(15L)**	
Unit IV: Electrical properties of membranes & Lipid Membrane Technology Cell surface charge, Resting membrane potential, Action potential, properties of action potential, Nernst equation, Goldman equation, Nernst-Plank equation, Hodgkin-Huxely equation, Hodking-Kartz experiment, Voltage clamp, Na+, K+ conductance, Membrane impedance and capacitance, Transmembrane potential, Zeta, stern and total electrochemical potential, Chemical synapse, post synaptic potential, Historical perspective of lipid model systems lipid monolayer. Liposomes: small and large unilamellar and multilamellar vesicles, planner lipid bilayer, Application of liposomes in biology and medicine. (**15L**)	
References: 1. Molecular & Cellular Biology, D Roberties, 2. Biophysical Aspects of Transmembrane signaling, Sandor D (2005), Springer 3. Biophysics, Vasant Pattabhi, Gautam (2002), Narosa 4. Biomembrane structure and Function, Chapman D. 5. Introduction to Biological Membrane, Jain R K 6. Biophysics, Hopp, Lohman, Mark and Ziegler 7. Advances in Biophysics, Vol 18, 15 8. Molecular and Cellular Biophysics, Meyer B Jackson (2006), Cambridge)	

9. Text Book of Physiology, Guyton & Hall, 11th Ed. 2006	

Course Code	Title	Credits
BP-CCT 202	**Molecular Biophysics** **Total lectures: 60**	4
Unit I: Principles of proteins structure and conformations Basics aspects of protein structure, Polypeptide chain geometrics, estimates of potential energy, results of potential energy calculations, hydrogen bonding, hydrophobic & hydrophilic interactions and water as universal solvent in biological systems, Disruption of hydrophobic interactions by urea, ionic interactions, hydrophobic versus ionic interactions, Disulfide bond, Ways of pairing N-half cystine, formation of specific disulfide link, prediction of protein structure. (**15L)**		
Unit II: Protein structure & stability Principles of ionization equilibrium ionization of side chain, equilibria in proteins. Predicting properties from amino acid composition, Usual amino acids. Primary structure sequencing of polypeptide, hemoglobin, homologies in proteins, Secondary structure alpha and beta conformation, collagen structure, stability of alpha helix, Ramchandran plot, Tertiary structure, structure of myoglobin and hemoglobin, Quaternary structure, symmetry consideration, Analysis of subunits and chain arrangement of subunits, stability of globular quaternary structure. Protein folding rules, pathways and kinetics (**15L)**		
Unit III: Enzyme structure & mechanisms Enzymes, classification & structure, active site and its identification, mechanisms of enzyme action with special reference to chymotrypsin, carboxypeptidase and lysozyme, Enzyme kinetics, Michaelis-Menten equation, Inhibitors, kinetics of competitive, non competitive and uncompetitive inhibitors, Allosteric cooperative behaviour, ligand protein interaction, Hill equation, Mettaloenzymes. Determination V_{max}, K_m, various graphical plots. **(15L)**		
Unit IV: Glycobiology & Lipids carbohydrates, classification and types, stereochemistry, mutarotation, glycoprotein and proteoglycan, Biosynthesis of glycoprotein, structure and roles of polysaccharides, lipids: types of lipids, classification and biological significance **(15L)**		
References: 1. Biophysical Chemistry, The Behaviour of biological macromolecules, Vol I,II, III, Cantor and Schimmel, (2008), W H Freeman & Co 2. Applied Biophysics, A Molecualr Approach for Physical Scientist, Tom A Weigh, (2007), Wiley		

3. Introduction to Protein Sciences, Arthur M Lesk (2004), Oxford Press
4. Molecular and Cellular Biophysics, Meyer B Jackson (2006), Cambridge)
5. Chemical Biophysics, Daniel A Beard and Hong Q (2008), Cambridge Univ Press
6. Proteins Structure & Function, David Whitford (2005), Wiley
7. Introduction to Protein Structure, Carl Brenden & John Tooze (1999), Garland Publ, NY
8. Essentials of Biophysics, P Narayanan (2005), New Age Publ.
9. Physical Chemistry for Biomedical Sciences, S R Logan, (1998), Taylor & Francis.
10. Handbook of Molecular Biophysics (Methods & Application), 2009, HG Bohr, Wiley
11. Principal of Protein Structure, GE Schulz, RH Schirmer (2004), Springer

Course Code	Title	Credits
BP-CCT 203	**Biochemistry** **Total lectures: 60**	4
Unit I: Hormones action cAMP/cGMP, G protein and G protein family receptor, G protein cascades, c-AMP and protein kinase, protein phosporylation, Inositol triphosphate and DAG signals **(15L)**		
Unit II: **DNA structure, Replication and Repair** Nucleic acid composition, DNA, RNA base compositions, Chargaff's rule, primary and secondary structure of nucleic acids, sequence information, DNA motifs, DNA repeats and their significance. A, B & Z DNA structure, major & minor groves in DNA, Protein DNA interactions, supercoiling of DNA, Topoisomerase I and relaxed DNA, DNA gyrase, eukaryotic gene. Replication in vivo, semi-conservative mechanism of replication. Direction of replication. Discovery of DNA polymerase I and its function. DNA synthesis in vitro, other DNA polymerases, role of various proteins/enzymes in DNA synthesis. Model of DNA synthesis, molecular basis of mutations, DNA repair mechanisms, reverse transcription. (**15L)**		
Unit III: RNA synthesis & Translation RNA polymerase and its action, promoter sites of DNA template, sigma factor, elongation and termination of RNA chain, processing of precursors-RNA,sn-RNA and tRNA, mRNA. RNA polymerase I and transcription of mRNA in eukaryotic cells. Transcription factors in eukaryotes. Ribozyme and self splicing, genetic code-discovery and silent features. Recent advances, amino acid activation, fidelity of aminoacyl, tRNA synthesis, tyrosyl AMP complex, tRNA structure and function. Ribosomal RNA structure, Architecture of Electron Microscopy and neutron diffraction. Initiation of protein synthesis, translocation and peptide bond formation, termination and stop codon, protein synthesis in eukaryotes. **(15L)**		
Unit IV :**Regulation of Gene expression in prokaryotes & Eukaryotes** Operator-operon concept, Negative and positive control of transcription with		

example of lac operon and Arbinose operon. Control of transcription, control of regulatory protein, transcription termination, repressor, croprotein. Eukaryotic RNA, role of histone, nuclosome, bidirectional replication, repetitive DNA, transcription; factor IIIA. **(15L)**	
Reference: Molecular cloning by Maniatis Vol. I, II, III DNA cloning by Glover vol. I, II, III Genome analysis a practical approach by devis. Protein engineering practical approach by Reas. Advanced method in protein micro sequence by Witmannn. Principles of Biochemistry, Leninger (2008(, Freeman Publ	

Course Code	Title	Credits
BP-CTT 204	**Recombinant DNA Technology & Protein Engineering** **Total lectures: 60**	4
Unit I: Preparation, DNA analysis & Enzymatic Manipulation of DNA & RNA Genomic DNA from mammalian tissue plant tissue and bacteria resolution recovery of large and small fragments of DNA using various Electromagnetic techniques, chemical synthesis of oligonuleotides, genes and their uses analysis of DNA sequences by blotting and hybridization. Restriction endonuclease and mapping enzymes for modification and radioactive labeling of nucleic acids, construction of hybrid DNA molecules. Polymerase chain reaction (PCR). Preparation and analysis of RNA. (15L)		
Unit II: a) Construction of Recombinant DNA libraries & In *vitro* Mutagensis Genomic and c-DNA libraries preparation, inserting DNA from genomic DNA and RNA production of library and amplification. Screening of Recombinant DNA Libraries: Screening by DNA hybridization, Immunological assay and protein activity. Mutagenesiss with degenerate oligonuleotides, region specific Mutagenesis, linker scanning Mutagenesis. **b) Introduction of DNA into Mammalian cell and System for study of cloned Genes**: Transformation of DNA using calcium Phosphate, DEAE, Dextrin and Elecroporation and its optimization and uses. Bacterial Yeast expression vectors gene transfer Into cultured cells. Development and use of transgenic animals. Manipulation and gene expression in prokaryotes, Heterogenous protein production in eukaryotic		

cells. **(15L)**	
Unit III: Micro sequencing Methods for proteins & Engineering proteins for purification Modern advancement such as Tar Sequencing Strategies. DABITC/ PITC methods. Solid phase microsequencing; Fast atom Bombardment (FAB) mass spectra in protein sequencing. Choice of purification tag, Enzyme purification Tags. Affinity purification tag, ion exchange, hydrophane IC, covalent and chelate. Purification tags; PEG enzyme and PEG enzyme conjugates. **(15L)**	
Unit IV: Chemical Approach to protein Engineering: & **protein engineering for thermo stability** Functional group modification chimeric Protein, protein engineering of Ab, Directed Mutagenesis and Protein Engineering. Directed Mutagenesis procedure adding disulfide bonds, reducing number of free sulphydryl residues, increasing /modifying Enzyme activity/specificity. Chimeric antibody, replacement of FC domains, Catalytic Antibodies (enzymes), Idiotype vaccines. Hybridoma technology. stability estimates from denaturation curve , Engineering physical and biology properties of protein by chemical modifications. **(15L)**	
Reference: 1. Molecular Clonning,Sambrook and Russell Vol 3, Cold Sprong Harbour lab press 2. Molecular and Cell biology, Lodish et al, (2004) Freeman 3. Electrophoresis in Practice, Reiner Westermeirer, (2005) Wiley 4. Methods in Molecular Biophysics Igor N S et al (2007), Wiley Molecular cloning by Maniatis Vol. I, II, III DNA cloning by Glover vol. I, II, III Genome analysis a practical approach by devis. Protein engineering practical approach by Reas. Advanced method in protein micro sequence by Witmannn. Principles of Biochemistry, Leninger (2008(, Freeman Publ	

Semester I Lab course details

Paper code	LAB COURSE -101	Credits	
BP-LBC-101	1. PH Meter: Standardization of pH meter, Preparation of Buffers, 2. pH titration curve of acid-base 3. Determination values of Iso-electric point: Amino acids, proteins, phosphoric acids. 4. Viscosity: Determination of viscosity of biofluids and chemicals 5. Colorimeter: Verification of Beer's-Lambert law, determination of absorption maxima of coloured compounds, determination of molar extinction coefficient. 6. Estimation of percent purities of dyes and inorganic compound	**02**	
	LAB COURSE -102		
BP-LBC-102	1. Calculation of measures of dispersion: a) Mean deviation b) std deviation and coefficient variation c) Quartile deviation 2. Test of significance: a) Chi-square test b) t-test 3. To evaluate standard error and interpretation of results of accuracy and precision	**02**	
	LAB COURSE -103		
BP-LBC-103	1. Microscopy: Familiarization with bright field , phase contrast, fluorescent, polarization microscopes. 2. Classification of gram –ve & +ve oganganisms 3. Observe cell growth/ survival by colony forming assay 4. Estimation of cell viability by dye exclusion and colony formation assay. 5. Observe cell death by physical and chemical agents 6. Observe cell division and determine mitotic index (Demonstration) 7. Observe RBC, WBC and DLC 8. Determination of cellular	**02**	

	carbohydrates by Acid shifts (PAS) reaction.		
	LAB COURSE -104	**Credits**	
BP-LBC 104	1. Fractionation of proteins using: PAGE, PAPER electrophoresis 2. TLC: Amino acids/ sugars/ fruit juice/oil 3. Column chromatography for protein /pigment 4. To study of conformational changes in biomolecules using oswall viscometer 5. Refractoemetry: study of sugars / proteins/ amino acids 6. 2-D gel electrophoresis of protein & Iso-electric focusing (Demonstration)	**02**	

Semester II Lab courses

	LAB COURSE -201	**Credits**	
BP-LBC- 201	1. Study of thermal denaturation of DNA and protein 2. Mutarotation of glucose and amino acids 3. Study of DNA-Protein interaction using fluourimetry 4. Study of fluorescence sensitivity and quenching 5. Absorption spectra of Hb, DNA,RNA etc 6. Study of interaction of acridene orange with DNA 7. Identification of C-terminal and N-terminal amino acid	**02**	
BP-LBC -202	**LAB COURSE 202** 1 Enzyme Assays (LKH, beta galacotsidase, acid phophatase, arginase, Succinic De – hydrogenase): Time , Temp, enzyme concentration, cofactors. LKH: Km & Vmax. 2. Estimation of Protein by Lowery/Biuret/ Bradford methods 3. Isolation of casein protein from milk, 4.Assessment of antioxidants /Lipid peroxidation from given samples		

	LAB COURSE 203		
BP-LBC 203	1. Isolation of DNA (Nuclear and mitochondrial) 2. Detection of DNA modification 3. Determination of base composition of Nucleic acids 4. Low protein concentration detection by Western blot & silver staining 5. Restriction endonuclase digestion and separation of fragments by gel electrophoresis 6. Gel filtrations chromatography 7. To find out capacity & nature of the given ion exchange resin. 8. DEAE cellulose chromatography of DNA 9. Amplification of DNA by PCR (Demonstration)		
	LAB COURSE 204	**2**	
BP-LBC 204	1. Preparation of liposome's / artificial membrane: Lipid mixture/ BSA / Ovalbumin (Demo) 2. Fluorescence anisotropy and polarization measurement 3. Protein tryptophan fluorescent measurement. 4. Study of membrane fluidity. 5. Effect of hypertonic/ hypotonic/isotonic conditions on RBC membrane. 6. Purification of substances by dialysis 7. Study of volume regulation of erythrocyte and osmotic fragility. 8. Ionophore effect on erythrocyte. 9. Osmolarity: Determination of osmotic pressure of salts. 10. Study of diffusion of biomolecules/ions (Fick's Law) 11. Study of phase transition of membrane phospholipids 12. To study the membrane potential using fluorescence spectroscopy	**2**	