

# Department of Biophysics

## Course structure and syllabus of M. Sc. in Biophysics

Minimum credit requirements: 96

Minimum duration: 2 years (4 semester)

### COURSE STRUCTURE:

#### SEMESTER –I

Course Code	Course Name	L – T – P	CH	CR	Remarks
BPT-I	Molecular Biophysics	3 – 1 - 0	4	4	
BPT-II	Cellular Biophysics	3 – 1 - 0	4	4	
BPT-III	Biostatistics & Computer fundamentals	3 – 1 - 0	4	4	To be offered by Statistics and Comp. Science faculty
BPT-IV	Biophysical Techniques & Instrumentation	3 – 1 - 0	4	4	
CBCT	Elective - I			4	To be offered by Physics faculty
BPP-1	Practical based on BPT-I	0 – 0 - 1	2	1	
BPP-2	Practical based on BPT-II	0 – 0 - 1	2	1	
BPP-3	Practical based on BPT-III	0 – 0 - 1	2	1	
BPP-4	Practical based on BPT-IV	0 – 0 - 1	2	1	
<b>Total Credit:</b>				<b>24</b>	

## SEMESTER- II

Course Code	Course Name	L – T – P	CH	CR	Remarks
BPT-VI	Biophysical Chemistry	3 – 1 - 0	4	4	
BPT-VII	Membrane Biophysics	3 – 1 - 0	4	4	
BPT-VIII	Molecular Enzymology	3 – 1 - 0	4	4	
BPT-IX	Molecular Genetics & Advanced Molecular Biology	3 – 1 - 0	4	4	
CBCT	Elective - II			4	To be offered by Physics & chemistry faculty
BPP-6	Practical based on BPT-VI	0 – 0 - 1	2	1	
BPP-7	Practical based on BPT-VII	0 – 0 - 1	2	1	
BPP-8	Practical based on BPT-VIII	0 – 0 - 1	2	1	
BPP-9	Practical based on BPT-IX	0 – 0 - 1	2	1	
<b>Total Credit:</b>				<b>24</b>	

### SEMESTER-III

Course Code	Course Name	L - T - P	CH	CR	Remarks
BPT-XI	Physiological Biophysics	3 - 1 - 0	4	4	
BPT-XII	Immunology &Immuno techniques	3 - 1 - 0	4	4	
BPT-XIII	Radiation Biophysics.	3 - 1 - 0	4	4	
BPT-XIV	Photo biophysics.	3 - 1 - 0	4	4	
CBCT	Elective - III			4	To be offered by Physics & Mathematics faculty
BPP-11	Practical based on BPT-XI	0 - 0 - 1	2	1	
BPP-12	Practical based on BPT-XII	0 - 0 - 1	2	1	
BPP-13	Practical based on BPT-XIII	0 - 0 - 1	2	1	
BPP-14	Practical based on BPT-XIV	0 - 0 - 1	2	1	

**Total Credit:**

**24**

## SEMESTER –IV

Course Code	Course Name	L – T – P	CH	CR	Remarks
BPT-XVI	Bioinformatics & Computational Biology.	3 – 1 - 0	4	4	
BPT-XVII	Medical Biophysics	3 – 1 - 0	4	4	
BPT-XVIII	Environmental Biophysics.	3 – 1 - 0	4	4	
BPT-XIX	Bioelectronics & Medical Instrumentation	3 – 1 - 0	4	4	
CBCT	Elective - IV			4	To be offered by Physics/ Mathematics faculty
BPP-16	Practical based on BPT-XVI	0 – 0 - 1	2	1	
BPP-17	Practical based on BPT-XVII	0 – 0 - 1	2	1	
BPP-18	Practical based on BPT-XVIII	0 – 0 - 1	2	1	
BPP-19	Practical based on BPT-XIX	0 – 0 - 1	2	1	
<b>Total Credit:</b>				<b>24</b>	

**Electives to be offered from the following units:**

Course Code	Course Name	L - T - P	CH	CR	Remarks
CBCT-V	Classical and Statistical Thermodynamics	3 - 1 - 0	4	4	In 1 <sup>st</sup> Sem.
CBCT-X	Quantum Mechanics for Bio-chemistry and Bio-physics	3 - 1 - 0	4	4	In 2 <sup>nd</sup> Sem
CBCT-XV	Mathematics in Biophysics	3 - 1 - 0	4	4	In 3 <sup>rd</sup> Sem
CBCT-XX	Mathematical Neuroscience	3 - 1 - 0	4	4	In 4 <sup>th</sup> Sem.

**(Electives are to be chosen out of the courses offered from the above list)**

CBCT (Choice Based Credit Transfer) courses offered by other departments

BPT Courses offered by the department of Biophysics

+ Course for which there is a separate practical unit assigned as Computer Laboratory

**L: Lectures T: Tutorials P: Practical CH: Contact Hours (all per week) CR: Credit**

\*Inclusive of tests, tutorials & seminars in each semester.

**Eligibility:**

1. B. Sc. Major Students (or equivalent standard) in Physics, Chemistry, Mathematics, Computer Science are eligible to pursue the course.
2. B. Sc. Major Students (or equivalent standard) in Botany, Zoology, Biotechnology, Biological Science having mathematics as one of the pass course subjects.

Gauhati University  
*M.Sc. [Biophysics] Semester 1 Syllabus*  
**Paper BPT-I: Molecular Biophysics.**  
**(L3-T1-P0-CH4-Credit 4)**

**Unit 1: Atomic & Molecular Structures.**

Structure of Atom, Schrodinger's theory, Quantum numbers, Pauli's exclusion principle, Hund's rule, Periodic table, Bonds between atom & molecules, Ionic, Covalent, Hydrogen, Electrostatic, Disulphide & Peptide bonds, Vander waals forces, Bond energies, Bond angles, Bayer's strain, Weak interactions, Molecular orbital theories, Hybridization of orbitals,  $\sigma$  and  $\pi$  bonds .

**Unit 2: Polymer Physics.**

Polymer in Biology, Chemical structure of polymer, persistence length of a polymer, conformation of a polymer, - random walk and entropic forces. Homopolymer: scaling and collapse, DNA collapse in solution

**Unit 3: Redox Potentials.**

Oxidation & Reduction, Equivalence of electrical & chemical energy, Electrochemical cell, Contact potentials, Galvanic cell, Potential of half cell, Redox potentials & its calculations by Nerst equation, Examples of Redox Potential in biological system.

**Unit 4: Bioenergetics.**

Energy requirements in cell metabolism, Role & Structure of mitochondria, High-energy phosphate bond, Electron transfer phenomenon & biological energy transfer.

**Unit 5: Molecular alphabets of Life.**

Amino acid, Nucleic acid bases & Lipids, Classification & Properties of Amino acid, Peptides & Polypeptides, Nucleosides, Nucleotides, Polynucleotides, Pentose & Hexose Polysaccharides, Amino acid to Peptides, Polypeptides, Different types of linkages.

**Paper BPP-1: - Practicals based on Molecular Biophysics.**  
**(L0-T0-P1-CH2-Credit 1)**

1. To verify the Lambert Beer's law.
2. To determine the beer's limit and measurement of molar and percent

extinction coefficient.

3. To estimate the percent purities of dyes and inorganic compounds.
4. To establish the absorption spectrum and determine the absorption maxima of p-Nitro phenol.
5. To study the characteristics of UV absorption spectra of Aromatic Amino Acids.
7. To study the characteristics of UV absorption spectra of Proteins.
8. To study the characteristics of absorption spectra of Nucleic Acids and Nucleotides.
9. To study the mutarotation of simple Sugars using Polarimetry.
10. Spectrophotometric assay of electron transport in intact Mitochondria using Dye Reduction methods.
11. Light induced proton pumping (uptake) in hypotonically swollen Chloroplast from Spinach Leaves.
12. To estimate light driven Chloroplast electron transport by Dye Reduction method.
13. Acid – Base titration using pH meter and Determine the pK values: - Strong acid Vs Strong base, Weak acid Vs Strong base, Mixture of Strong and Weak acid Vs Strong base.
14. To estimate the inorganic phosphate.
15. To analyze of Oil-Iodine number, saponification value & acid number.
16. Model building using Space filled & Ball and Stick models.
17. To estimate the DNA molecules.
18. To estimate the RNA molecules.
19. Studies the simple molecular structures using DTMM and other basic molecular modeling softwares

Recommended books: - Refer annexure for detail book titles.

1,2,4,5,6,7,10,11,14,15,18,19,20,21,23,24,26,29,30,31,32,58,60,61,6,70,72,73,7,4,105,114,115,118,155.

## **Paper BPT-II: Cellular Biophysics.** **(L3-T1-P0-CH4-Credit 4)**

### **Unit 1: Cell Organization.**

Cell as the basic structural unit, Origin and organization of Prokaryotic and Eukaryotic cell, Cell size and shape, Fine structure of Prokaryotic and Eukaryotic cell organization (Bacteria, cyan bacteria, plant and animal cell), Internal architecture of cells, Cell organelles, Compartment & assemblies membrane system, Ribosome, Polysomes, Lysosomes & peroxisomes, Connection

between cell & its environment, Glycocalyx, extra cellular matrix.

### **Unit 2: Cell Function.**

Behavioral Basis of Biological organization. The dynamic expression of cell organization. Flow of mass, Flow of energy. Chemical work, Transport, Electric work. Mechanical work, Regulatory work, other special forms of work.

### **Unit 3: Cell growth and division.**

Kinetics of cell growth, Cell cycle, Cell reproduction, Cell cycle parameters, Analysis of the cell cycle, Events in cell cycle, G, S, G<sub>2</sub>, cell division, Cytokinesis Control of cell cycle, Dividing & non dividing cells, Generation time, Synchronization of growth, Cell transformation & malignant tumor growth, Circulation & life time of cells in body, Cell aging & death, Apoptosis.

### **Unit 4: Cell differentiation.**

Primary & secondary induction, Differentiation of cultured cells, Experimental analysis of cell differentiation, Fertilization, Kinematics of sperm movement and motility, Molecular mechanism of fertilization.

### **Unit 5: Cell - Cell recognition.**

Cell adhesion, Cell signaling, Endocrine, Paracrine, Autocrine & synaptic transmission, Concept of receptors, characterization & function, Extracellular & intracellular, Receptor ligand interaction, concept of agonist & antagonist, G-proteins-Structure & Function, Adenylate cyclase system, cAMP-pK&cREB proteins. signal transduction Mechanisms of signal transduction pathways in development & disease, Signal-transducing machinery as targets for potential drugs.

### **Paper BPP-2: - Practicals based on Cellular Biophysics. (L0-T0-P1-CH2-Credit 1)**

1. To familiarize with bright field, phase contrast, fluorescence & polarizing microscopes.
2. To observe the stained & unstained Prokaryotes & Eukaryotes
3. To characterize the sub cellular fractions.
4. To study the chromosomal DNA morphology by Feulgen reaction (root tip cells)
5. To identify the cellular carbohydrate by the Acid Schiff (PAS) reaction.
6. Demonstration of Chemo taxis.
7. To identify the Cytochemical DNA/RNA with the Methyl green-pyromin



method.

8. Blood analysis: Estimation of RBC count, WBC count, Differential count, Hb%, Packed cell volume, E.S.R.
9. To measure the mean corpuscular diameter.
10. To count the Reticulocytes & Platelets.
11. Microscopic studies of Mitosis & Meiosis stages & determination of mitotic index.
12. To establish the cell growth curve & determination of generation time.
13. To maintain the cell culture protocols.
14. To study the charge characteristics of cells through micro Electrophoresis.
15. To study the histochemical localization of Alkaline & Acid Phosphatase, Glycogen & Lipids in the tissue.
16. To Isolate and characterize the bacteria from leaf tissue.

Recommended books: - Refer annexure for detail book titles.

3,5,6,7,10,11,15,16,18,21,22,24,27,29,30,58,61,64,68,69,72,77,78,110,118.

**Paper BPT-III: Biostatistics and Computer fundamentals  
(L3-T1-P0-CH4-Credit 4)**

**Unit 1: Preliminary Concepts.**

Biostatistics terminology, variables in biology, Levels and measurements of biological data, Classification, tabulation and frequency distribution of the data, graphical representation by histogram. Polygon, Ogive curve and pia diagram.

**Unit 2: Data Management.**

Measures of central tendency (Mean, Median, Mode) Measures of dispersion (Range, quartile deviation, mean deviation, standard deviation, coefficient of variation), Correlation and regression, Positive and Negative correlation and calculation of Karl-Pearsons Co-efficient of correlation, Linear regression and regression equation, multiple linear regression, Calculation of an unknown variable using regression equation, Types of estimation, Confidence interval level of confidence. Confidence interval estimate of mean and of proportion.

**Unit 3: Statistical Analysis.**

Tests of significance: - Small sample test, chi-Square test, F test, large sample test (z-test), Concept of probability and probability distributions, Studies in Binomial, Poisson and Normal distribution with illustrative examples.

**Unit 4: Errors in measurements.**

Errors, Accuracy, Precision, general theory of Errors, Classification, Ways of expression of precision, Accuracy detection of determinates errors, Statistical analysis of biochemical data with spread sheet applications regression analysis, Use of statistical packages, Data management with computer

**Unit 5: Computer fundamentals.**

Computer system at a glance processor (CPU, ALU) Memory (ROM, RAM, CACHE data and address bus) Storage, Input & Output devices, Computer peripherals, Binary code and binary system, Algorithms and Flow charts, Software & Hardware, Operating systems (Dos, Windows) Application software's (MS-office) Super computer, Mainframe computers, Mini computers, Micro computers, Workstation, Concept of multimedia and its applications. Network concepts (LAN, WAN) and its topology, Network media and hardware. Design and application of modern data communication over telephone lines and Digital telephone lines. Internet protocols HTML, XML, WWW (World Wide Web) Internet

connectivity, search engines. Interactive communication on Internet, Programming concepts in C++, Introduction to Bioperl, Biojava, Bioxml.

**Paper BPP-3: - Practicals based on Biostatistics and Computer fundamentals.**

**(L0-T0-P1-CH2-Credit 1)**

1. Representation of Statistical data by: - Histogram, Ogive curves, Pie diagram. (3 assignments)
2. Measurement of central tendencies: - Arithmetic & Geometric mean, Mode and Median. ( 3 assignments)
3. To calculate the measures of dispersion.:( 6 assignments)
  - a) Mean deviation.
  - b) Standard deviation and Coefficient of variation.
  - c) Quartile deviation.
4. Test of Significance. (6 assignments)
  - a) Chi-Square test.
  - b) t- test.
5. To evaluate the standard error & interpretation of results in terms of Accuracy and precision. (4 assignments)
6. Basic operating procedures of computer. To create File, Folder, Directories. (2 assignments)
7. Familiarity with the Basic operations of MS-office. (7 assignments)
8. Familiarity with use of Internet, Search engines, Web sites, Surfing, Browsing, Downloading text and Graphics. (4 assignments)
9. Creating Email account, Sending and Receiving mails.

Recommended books: - Refer annexure for detail book titles.

120,123,135,136,137,138,141,142,143,144,145,146,147.

## **Paper BPT-IV: Biophysical Techniques & Instrumentation**

**(L3-T1-P0-CH4-Credit 4)**

### **Unit 1: Spectroscopic Techniques.**

Principle, Instrument Design, Methods & Applications of UV-Visible Spectra, IR Spectra, Raman Spectra, Fluorescence spectra, NMR and ESR Spectra.

### **Unit 2: Hydrodynamic Techniques.**

Principle, Instrument Design, Methods & Applications of all types of Adsorption & Partition Chromatography, Centrifugation & Ultracentrifugation, Viscometry, Osmosis, Diffusion and Surface tension.

### **Unit 3: Electroanalytical Techniques.**

Principle, Instrument Design, Methods & Applications of Free & Zone (Paper, gel, Pulsed-field, PAGE, SDS-PAGE, Capillary) Electrophoresis, isoelectric focusing, Potentiometry, pH meter, ion selective electrodes, conductometry.

### **Unit 4: Optical Techniques.**

Principle, Instrument Design, Methods & Applications of Polarimetry, ORD, CD, Light scattering, Refractometry, Flowcytometry, Cytophotometry, Compound, Phasecontrast, Interference, Fluorescence, Polarizing, Scanning & Transmission Electron Microscopy, CCD Camera, Introduction to Atomic Force Microscopy.

### **Unit 5: Diffraction Techniques.**

Crystals, Molecular crystal symmetry, X ray diffraction by crystals, Bragg's Law, laue powder and rotation methods, Calculating electron density and patterson maps (Fourier transform and Structure factors, convolutions),phases, model building & evaluation, Neutron diffraction, Electron diffraction, Application in Biology.

**PAPER BPP-4: -Practicals based on Biophysical Techniques and Instrumentation.  
(L0-T0-P1-CH2-Credit 1)**

1. To familiarize in the use of pH meter and Colorimeter.
2. One-dimensional Paper chromatography of Amino acids.
3. Ascending Paper chromatography of Amino acids.
4. Descending Paper chromatography of Amino acids.
5. Two-dimensional Paper chromatography of Amino acids.
6. TLC of Amino acids.
7. Two-dimensional TLC of Amino acids.
8. TLC of Sugars/fruit juice.
9. Column Chromatography for Proteins, Pigments.
10. Paper Electrophoresis of Amino acids.
11. Paper Electrophoresis of Proteins.
12. Polyacrylamide Gel Electrophoresis (PAGE).
13. To study the conformational changes in biomolecules using Ostwald's Viscometer.
14. To demonstrate the CCD camera for Microscopic observation of dynamic Images.
15. To determine the sugar and protein concentration using Refractometry.
16. To obtain relation between concentration and Refractive Index (RI) using Refractometry.
17. To study the renal store using Infra-Red (IR) Spectroscopy.
18. To determine the oil content of oil seeds using Nondestructive IR Spectrophotometry.
19. To demonstrate the separation of Proteins using Capillary Electrophoresis.
20. To study the co-relation between Concentration, Size, Shape of the molecules and Viscosity characteristics using digital viscometer.

Recommended books: - Refer annexure for detail book titles.

1,5,7,8,9,14,15,17,19,21,26,28,29,60,69,98,101,140,1  
55.

*M.Sc. [Biophysics] Semester 2 Syllabus*  
**Paper BPT-VI: -Biophysical Chemistry**  
**(L3-T1-P0-CH4-Credit 4)**

**Unit 1: Water, Acids & Bases.**

Molecular structure, Association of Water molecules through H- bonding, Nature of hydrophobic interactions, Physico Chemical properties of Water, State of Water in biostructures & its significance.

Acids and Bases, Mole & Normality, Weak acids, Amphoteric electrolytes, pH, Calculation of pH from H & OH Concentration, measurements of pH, Henderson Haselbatch equation, Titration curve & pK values, Buffers & Stability of their pH, Numerical problems.

**Unit 2: Proteins.**

Structural level of proteins & stabilizing forces, Conformational properties of polypeptides, Ramchandran plot, Helical parameters & Conformation, organization & interaction of angles, Conformational structure of alpha-keratin, Silk fibrin, Collagen, Actin, Myosin, Folded conformation of globular proteins (e.g.- Haemoglobin, Myoglobin, Lysozyme, Cytochromes) mechanism & side chain conformation, Classification & role of Beta- bends & bulges, Super secondary structure, Domain & motifs, Proteins in solution & protein sequencing, Concept of protein evolution, Cytochrome & Haemoglobin evolutionary studies.

**Unit 3: Nucleic Acids.**

Double helical structure of DNA, Conformational parameters of Nucleic acids & their constituents, Chargff's rule, DNA polymorphism, DNA supercoiling, Hyperchromicity, Circular DNA, Types & structure of RNA, mRNA, rRNA, tRNA & modified nucleotides, nucleic acid sequencing.

**Unit 4: Other Biological Polymers.**

Structure and conformation of polysaccharide cellulose, Amylase, Chitin, Carbohydrates conjugates, Classification & biological role of vitamins & hormones.

**Unit 5: Macromolecular Interactions.**

Ligand interaction at equilibrium, Identical independent sites, Scatchard plot, Multiple classes of independent sites, Interaction between binding sites, Allosterism, MWC model, Sequential model, Oxygen Hemoglobin binding, Binding of two different ligands, Energetics and dynamics of binding, Structures of protein- ligand complexes, Relationship between protein conformations and binding, Binding of Immunoglobulins and DNA binding proteins, Free radicals in biology and medicine.

#### **PAPER BPP-VI:**

1. To prepare the buffers & measurement of pH.
2. To determine the titration curve of amino acids & calculate the pKa values.
3. To determine the titration curve of Proteins & calculate the pKa values.
4. To determine the T<sub>m</sub> of DNA.
5. Denaturation & Renaturation of DNA.
6. To isolate the Proteins- Casein from milk, Hb from RBC.
7. Study of UV absorption spectra of Proteins.
8. Study of UV absorption spectra of Nucleic acids.
9. To study the macromolecular interactions using ultrasonic interferometer.
10. To study the effect of temperature, concentration, macromolecular size, shape on ultrasonic velocity
11. To isolate the Phospholipids from Egg Yolk.
12. To study the interactions of Acridine orange with DNA.
13. To estimate quantitatively the Amino acids using the ninhydrin reaction.
14. To estimate proteins by Biuret assay.
15. To estimate the Protein by Folin's-Lowry method.
16. To prepare the Cytochrome C & its characterization.
17. To identify the C-terminal Amino acids of a protein.
18. To identify the N-terminal Amino acids of a protein.
19. To study the protein structure by using DTMM (Desk top molecular modeling)
20. To analyze the major types of vertebrate collagen by SDS PAGE.

Recommended books: - Refer Annexure for detail book titles.

1,2,4,5,6,7,12,14,15,18,19,20,21,23,24,26,27,29,30,32,58,60,65,69,70,73,74, 82,86,87,105,106,118,155.

## **Paper BPT-VII: - Membrane Biophysics (L3-T1-P0-CH4-Credit 4)**

### **Unit 1: Membrane Structure.**

Various membrane models, Carbohydrate, Lipids & Proteins, Components of cell membrane, Principles of membrane organization & stability, Biogenesis of cell membrane, Molecular motion in membrane & membrane fluidity, Protein lipid interactions, Phase properties of biological membranes.

### **Unit 2: Membrane potential.**

Nature & magnitude of cell surface charge, Hodgkin Huxley equation, membrane impedance, Relation between membrane potential & cell characteristics, Zeta, Stern & total electrochemical potential, Helmholtz-Smoluchowski equation; its correction by Debye-Huckle theory. Thermodynamic & kinetic approaches to membrane potential, Calculation of electrochemical potential by Nernst equation, Transmembranes potential & its measurement by microelectrodes.

### **Unit 3: Transport across the membrane.**

Diffusion, Fick's law. Diffusion in two compartment & multi compartment systems, Mechanisms of simple diffusion & facilitated diffusion, Diffusion of nonelectrolytes across the membrane, Rate theory of membrane transport, electrodiffusion, Osmosis, Osmotic pressure, Osmotic equilibrium, Donnan equilibrium, flow of water & of solute, Electroosmosis, Molecular basis of aqueous channels.

### **Unit 4: Active transport.**

Nature, Selective permeability of biomembrane, Selectivity & ion specificity of biomembrane, Role of carriers in ion transport (ex: -Valinomycin & gramicidin), Transporting ATPase-Na-K ATPase, Calcium ion transporting



ATPase of sarcoplasmic reticulum, Transport of macromolecules with & without vesiculation & by intermediate mechanism.

### **Unit 5: Membrane energetics.**

Flow sheet of membrane energetics, Chloroplast membrane & energy transduction, Energy transduction through mitochondrial membrane.

### **PAPER BPP-7: - Practicals based on Membrane Biophysics.**

1. To study the Erythrocytes Membrane Permeability and Transport effects of Hypotonic & Hypertonic shock.
2. To determine the osmotic fragility of RBC.
3. To determine the partial characteristics of Membrane Protein by SDS-PAGE.
4. To analyze the Erythrocytes membrane lipids by TLC.
5. To determine Osmolarity of solutions using Osmometer.
6. Passage of molecule through dialysis membrane and demonstrations of Donnan Membrane equilibrium.
7. To study the interactions of Detergent and other Membrane active agents with RBC membrane & effect of incubation time, Temperature & concentration.
8. To study the Permeability of model membrane (Liposome) anions.
9. To study the effect of cholesterol on the anion permeability of a Phospholipid membrane.
10. Preparation of Liposome.
11. To demonstrate the cell fusion using high DC (Direct current) field.
12. To isolate the chloroplast and characterize the chloroplast membrane protein.
  
13. To measure the Membrane potential using Fluorescence techniques.
14. To measure the membrane conductance.
15. To study the phase transition in lipid bilayer membrane.

Recommended books: - Refer Annexure for detail book titles.  
1,3,5,6,7,11,13,14,15,16,18,21,22,24,29,30,32,58,60,61,64,69,70,73,74,78,102,  
103,105, 106,107,108,110,111,112,113,115,116,117,118,155.

**Paper BPT-VIII: Molecular Enzymology  
(L3-T1-P0-CH4-Credit 4)**

### **Unit 1: Basic principles of chemical kinetics.**

Velocity, Order and Molecularity of a chemical reaction, Kinetic equations for zero, first, second & third order reactions, Determination of order of the reaction, Arrhenius equation, Activation energy & its estimation, Collision & transition state theories of reaction rate, Catalysts, Mode of action of catalysts, Nucleophilic, Electrophilic & Acid-Base Catalysis.

### **Unit 2: Enzymes as Biocatalysts.**

Remarkable properties of Enzymes as Catalysts, Active sites, three point attachment, Mechanism of enzyme action, Flexible enzymes, Induced-fit hypothesis, Catalytic efficiency of enzymes, Micro environmental approach to enzyme dynamics, Nomenclature & classification, Hydrolases & Transferases, Peptidases, Esterases, Kinase, ATPases, Oxidoreductases, Lyases, some examples of Isomerisation, Rearrangement & condensation reactions, Molecular dynamics & Transient states of Enzyme catalysis.

### **Unit 3: Enzymes Kinetics.**

Kinetics of single substrate reaction, Michaelis equation, steady state kinetics, transient phases of enzyme reactions, Lineweaver-Burk, Eadie-Hofstee plot, Woolf plot. Effect of pH, temperature, metal ions on enzyme activity. Enzymes turn over mechanisms of multisubstrate enzyme reactions (conceptual approach), kinetics of reversible enzyme inhibition, Mechanisms of action of Chymotrypsin and Ribonuclease.

### **Unit 4: Enzyme Regulation.**

Control of enzyme activity, feedback inhibition, kinetic behavior of allosteric enzymes, mechanism of allosteric interactions, subunit structures and protein assembly-Aspartic transcarbamylase, Proton ATPase, Metalloenzymes-carboxypeptidase A, Role of Zinc.

### **Unit 5: Enzyme Technology.**

Enzyme Immobilization techniques, use of isolated enzymes in industrial processes, Enzymes in clinical diagnosis, Isozymes, Abozymes, Ribozymes, Enzyme therapy, Extremozymes, Solventogenic and non-aqueous enzymes.

### **PAPER BPP-8: -Practicals based on Molecular Enzymology.**

1. To study the first order kinetics of inversion of cane sugar using

Polarometry and determination of rate constant K.

2. To determine the energy of activation for a chemical reaction.
3. To study the characteristics of different catalytic reactions (Nucleophilic, Electrophilic & Acid-Base).
4. To measure the Enzymatic activity.
5. To isolate and purify the Enzymes- Isolation of muraminidase from egg white.
6. To isolate & fractionate the dehydrogenase from Yeast.
7. To study the effect of temperature on Enzyme activity & Kinetics.
8. To study the effect of pH on Enzyme activity & Kinetics.
9. To study the effect of metal ions on Enzyme activity & Kinetics.
10. To study the Kinetics of Enzyme and determination of Kinetic parameters.
11. To study the effect of substrate concentration and Inhibitors on lactate dehydrogenase.
12. To prepare the Enzyme crystals and their microscopic characterization and storage.
13. To separate the isoenzymes from lactate dehydrogenase by Polyacryl amide Gel Electrophoresis (PAGE).
14. To study the protein inhibition by Polyacryl amide Gel Electrophoresis (PAGE).
15. To study the protein-ligand interactions by Scatchard plot.
16. Immobilization of Enzyme on Solid support.
17. Comparative study of properties of Immobilized and free Enzymes.

Recommended books: - Refer Annexure for detail book titles.  
2,5,11,12,15,18,21,24,25,26,30,56,60,64,66,67,69,71,73,74,82,83,84,85  
,86,119, 155

## **Paper BPT-IX:-Molecular Genetics & Molecular Biology (L3-T1-P0-CH4-Credit 4)**

### **Unit 1: Genome Structure and Organization.**

Nucleic acid as a genetic material in Prokaryotic, Eukaryotic and viral systems, Topology of nucleic acid, Concept of gene, chromosomal organization ( Exon& Intron), role of histones, DNA Replication models, DNA Replication mechanisms, Enzymes involved, Law of DNA constancy & C-value paradox.

## **Unit 2: Gene Expression & Mutagenesis.**

Central dogma, Genetic code, salient features of genetic code. Mechanisms of transcription (in Prokaryotes & Eukaryotes), Initiation, elongation & termination, RNA processing (capping, splicing, polyadenylation), Translation, Ribosomes structure & function of different components. Shine-dalgarno sequence, Post translational modification & control of translation, Control of gene expression in Pro & Eukaryotes.

Mutation: -molecular basis of mutation, types of mutations (spontaneous & Induced) Mutation rate & mutagenic agents, Ames tests for mutagenesis, Molecular mechanism of DNA Repair, Excision Repair in E.coli. Mismatch Repair. Chromosomal aberrations & syndrome in human beings.

## **Unit 3: Recombination.**

Transformation, Conjugation, Transduction, Transposition. Linkage & crossing over.

## **Unit 4: Recombinant DNA Technology.**

Gene cloning: - The basic step. Cutting DNA: - Restriction enzymes. Joining DNA molecules. Transformation. Gene cloning vectors, Plasmids, Phage vectors. Artificial chromosomes, Cosmids, Polymerase Chain Reaction (PCR) - Principle, method & application of PCR.

## **Unit 5: Applications of Genetic Engineering.**

Transgenesis - Production of transgenic animals & plants, Design of transgenic experiments, Embryo stem cells technology, Hybridoma technology, monoclonal Antibodies & applications, DNA profiling in forensic science, Application of genetic engineering in Agriculture, Medicine & Industry.

### **PAPER BPP-9: -Practicals based on Molecular Genetics & Advanced Molecular Biology.**

**(L0-T0-P1-CH2-Credit 1)**

1. To isolate the chromosomal DNA from Prokaryotes and Eukaryotes.
2. To isolate the RNA.
3. Induction of mutation and Isolation of Mutants.
4. To study the chromosomal aberrations due to radiation.
5. Conformation of Nucleic acid by Spectral study.
6. To isolate and characterize Plasmid DNA.

7. To hydrolyze the t-RNA and separation of Nucleotides by TLC and paper chromatography.
8. Experiments on transformation.
9. Restriction digestion and agarose gel electrophoresis of DNA
10. Demonstration on Southern Blotting.
11. Demonstration on Western Blotting.
12. To study the Giant chromosomes (Lamp brush or Polytene chromosome).
13. To isolate the Antibiotic resistant Mutants.

Recommended books: - Refer Annexure for detail book titles.  
5,10,11,21,23,24,29,30,31,55,58,59,61,62,63,72,76,79,80,81,88,118.

*M.Sc. [Biophysics] Semester 3 Syllabus*  
**Paper BPT-XI: -Physiological Biophysics**  
**(L3-T1-P0-CH4-Credit 4)**

**Unit 1: Neurobiophysics.**

General anatomy of brain, Central peripheral nervous system, Myelinated & unmyelinated nerve cells, Blood brain barrier generating nerve impulse, Synaptic transmission, Physicochemical basis of membrane potential, Resting and action potential, Propagation of action potential, Voltage clamp and patch-clamp techniques, Hodgkin-Huxley analysis, Motor and cortical control, Sleep and consciousness Neuromuscular junction, Excitation contraction coupling Neuronal networks, Processing of information, Memory and neuropeptides.

**Unit 2: Special senses.**

Biophysics of sensory mechanism and function of receptor cells, Cutaneous, Olfactory and gustatory sensations, Vision - Physical aspects, Neurophysiology colour vision, Visual evoked potentials. Audition: - Physical aspects, auditory transduction, Acoustic encoding.

**Unit 3: Cardiovascular and Pulmonary physiology.**

Physical characteristics of blood, Hemodynamics principles & equations, Genesis & spread of cardiac impulse, Cardiodynamics, Regulation of blood pressure & blood volume, Heart rate, Cardiac output & venous return, Cardiovascular responses to stress (exercise, shock & hypertension), Biophysical aspects of lung expansion respiratory mechanics &

gas exchange process, Gas diffusion & transport, Pulmonary circulation & ventilation, Respiratory control & response to stress, Pulmonary function test & its significance.

#### **Unit 4: Renal & Reproduction physiology**

Ionic composition & distribution of body fluids, Body fluid osmolality dialysis & dehydration. Biophysical aspects of renal filtration & blood flow, Renal tubular function, Concepts effective circulation volume, Autoregulation, Reabsorption & secretion, Renal regulations of acid base balance. Hormonal control of reproductive mechanisms, Morphology & dynamics of sperm, kinematics parameters of sperm movement & sperm motility, Basic principles of assisted reproductive technology- IUI, IVF techniques.

#### **Unit 5:Aviation, High Altitude, Space & Deep-sea physiology.**

Effect of low oxygen pressure on body, mountain sickness, clinical lessons at high altitude, Effect of acceleratory forces on the body in aviation & space physiology.Radiation & temperature, Problems at high altitude & space, weightlessness in space, Physiological adaptation to space flight.Physiology in deep sea diving & other high-pressure operations.

#### **PAPER BPP-11: -Practicals based on Physiological Biophysics. (L0-T0-P1-CH2-Credit 1)**

1. To record the Respiratory movements in man using stethograph.
2. To determine the Breath holding time in man.
3. To study the effect of maximum voluntary ventilation on respiration.
4. To study the effects of swallowing, yawning and talking on respiration.
5. To study the effects of exposure to cold and hot environment on human subject.
6. To measure the pulse rates at various parts of the human body using stethoscope.
7. To measure the Heart beat rate in man using stethoscope.
8. To record the compound action potential and conduction velocity in frog's sciatic nerve.
9. To record the simple muscle twitch and study of the effect of stimulus response relationship.
10. To study the properties and excitability patterns of muscle and nerve fibre types in intact and isolated preparations.
11. To study the genesis of tetanus.
12. To study the effect of free and after loading on frog's gastronemacus muscle.

13. To study the effect of Fatigue.

14. To study the physiological changes under extreme conditions (high RCF, low oxygen pressure, zero gravity conditions.)

Recommended books: - Refer Annexure for detail book titles.

5,7,29,34,35,42,51,95,105,121,122,124,131,156.

**Paper BPT-XII: - Immunology and Immunotechniques.  
(L3-T1-P0-CH4-Credit 4)**

### **Unit 1: - Concepts of Immunology.**

General principles of immune system, Molecules, Cells and tissues of immune system, Primary and Secondary lymphoid organs (Thymus, Bursa of fabricius, Lymph nodes, Spleen), B and T lymphocyte and their functions, Lymphocyte cell mediated cytotoxicity.

### **Unit 2: - Antigens and Antibodies.**

Concepts of antigen, Antigenic determinant, Antigenicity, Immunogen and Immunogenicity, Factors affecting Antigenicity, Hapten, Carrier effect, Cross reactivity, Adjuvants, Freund's adjuvants and its significance.

Immunoglobulin, Structure of Immunoglobulin, Types and properties of Immunoglobulin, Theories of Antibody formation, Clonal selection, Ig genes, Immunoglobulin synthesis and metabolism, Antibody diversity.

### **Unit 3: - Histocompatibility.**

MHC, MHC antigen: - Class I, Class II, Class III, Antigen presentation, MHC restriction, Immune response gene (Ir), Immune response, Humoral and cell mediated immune response, BCR, TCR & generation of biodiversity, lymphocytes, T cells regulation, Graft rejection, Allograft, Autograft and Xenograft, Immunological tolerance and autoimmunity, Hypersensitivity, Allergy and anaphylaxis, Blood transfusion.

### **Unit 4: - Antigen- Antibody reaction.**

Physico-chemical basis of Ag- Ab interaction, Avidity, strength of binding between Ag and Ab and its measurement, Detection of Ag-Ab interaction, Precipitation, Agglutination and Complement fixation, The complement system, Cytokines.

### **Unit 5: - Immunotechniques.**

Double, Single, Radial immunoprecipitation, Immunodiffusion and measurement of immune complex, Immunoelectrophoresis, Immunofluorescence, Radioimmunoassay, ELISA, Hybridoma technology and monoclonal antibodies, Abzyme technique.

#### **PAPER BPP-12: - Practicals based on Immunology and immunotechniques.**

##### **(L0-T0-P1-CH2-Credit 1)**

1. To prepare the blood film and identify the blood cells.
2. To observe and count the lymphocytes of blood.
3. To isolate the lymphocytes from blood and solid tissues.
4. To characterize the blood group antigens and determine the Rh factor.
5. To raise antisera and to collect the antibodies.
6. To isolate the IgG from chicken eggs/ serum.
7. To fractionate the serum by paper electrophoresis.
8. To fractionate the serum by Agarose gel electrophoresis.
9. To demonstrate Ag-Ab interaction by SRID (Single Radial Immuno Diffusion)
10. To demonstrate Ag-Ab interaction by Double diffusion.
11. To characterize Antigen- Antibody interaction by Immunoelectrophoresis.
12. To estimate Ag-Ab interaction quantitatively by Rocket Immunoelectrophoresis.
13. To demonstrate Ag-Ab interaction by Counter- Current Immunoelectrophoresis.
14. Electrophoretic characterization of Immunoglobulins by SDS – PAGE.
15. To study Antibody heterogeneity detected by isoelectric focusing.
16. To estimate the CH50 tube assay.
17. ELISA Demonstration.
18. Demonstration of RIA.

Recommended books: -

Refer Annexure for detail book titles.

5,33,39,50,54,73,92,100,105



## **Paper BPT-XIII: -Radiation Biophysics. (L3-T1-P0-CH4-Credit 4)**

### **Unit 1: Radiological Physics.**

Atomic structure models, Constituents of atomic nuclei, Isotope, Radioactivity, laws of Radioactivity, Alfa, Beta, Gamma rays, Properties of Electromagnetic radiation, Particle accelerate absorbed cyclotrons & synchrotrons, Radiation units- Units of radioactivity, exposure & dose, Dose equivalent unit, Particle flux & fluence, X & Gamma ray interaction with matter, Photoelectric & Compton effect, Ion pair production, dependence on atomic weight, Interactions, absorption & scattering of electron, Heavy charged particles & Neutrons, attenuation coefficient- linear, mass, electronic & atomic, HVL, Mean free path, Absorption edges, LET.

### **Unit 2: Radiochemistry & radiobiology.**

Radiolysis of water, Production of free radicals & their interactions, Competition kinetics, Kinetic constants studies of transient species, Pulse radiolysis, Diffusion kinetics & Physicochemical effects, Role of scavengers, G-value, Direct and Indirect action, Oxygen and temperature effect, OER, Action of radiation on living system – Viruses, Prokaryotic & Eukaryotic cells, Thetical models, Cellular radiation action, Radio sensitisation and protection, Target theory, Single hit & Multi hit theory, Multi target theory, Calculation of target, Mass, Volume & Molecular weight, Effect of radiation on Nucleic acids, Proteins, Enzymes & Carbohydrates, Cellular effects of radiation, Mitotic delay, Inhibition of mitosis, Giant cell formation, Cell death, Cell recovery & Modification of Radiation damage, Genetic Effect of radiolysis, Factors affecting frequency of radiation induced mutation, Chromosomal breakage and Aberrations, Somatic effect of radiation, Physical factors influencing somatic effects, Dependence on dose, Dose rate, Type & Energy of radiation, Temperature, Anoxia age, Acute radiation damage, LD-50, Radiation syndrome, Early and late effects of radiation, Effect of Chronic exposure to radiation, Dose effect relationship, Genetic burden, Concept of doubling dose & its effect on genetic equilibrium.

### **Unit 3: Radiation detection and Measurement.**

Principles of radiation detection and measurement, General requirements of Dosimeters, Radiation sources, Telegamma Unit (Cobalt unit), Gamma chamber, Nuclear reactors, Thermal & fast neutron sources, Basic principles, Design & Working of physical dosimeters- Ionization chamber, Proportional counters, GM- Counter, Concepts of Gas amplification, Resolving time & Dead

time, Scintillation Detectors, Thermoluminescent Dosimeter, Semiconductor, Surface barrier & Lithium detectors, Area survey meter & Pocket dosimeter, Film badge, General principle of chemical dosimetry, Salient Features of Chemical dosimeter, Dose evaluation formula for chemical dosimetry, Principles of radiolytic reaction, Experimental methods- Influencing factors of Fricke dosimeter methyl orange, FBX dosimeter, Free radical dosimeter, Ceric sulphate dosimeter, PMMA, PVC, chlorobenzene dosimeter, High & low dose indicators.

#### **Unit 4: Radiation safety measures**

Natural & Man-made radiation exposures or Principles of dose equivalent limit (DEL) radiation protection, Maximum permissible dose (MPD), Evaluation of external & internal radiation hazards, Radiation protection measures in industrial establishment, Radioisotope labs, diagnostic & therapeutic installation & during transportation of radioactive substances, disposal of radioactive waste, administrative & legislative aspect of radiation protection.

#### **Unit 5: Applications of Radioactivity**

Radioisotopes in biology, Agriculture, Plant breeding, Soil plant relationship & plant physiology, Medicine, (Therapy & diagnosis), Radioimmunoassay, Radio tracer techniques with illustrative examples, Autoradiography, General principles, Types & constitutions of photographic emulsion, Autoradiographic technique, Image quality, Resolution, Evaluation of autoradiograms, Specialized radioisotopic applications in industries.

#### **PAPER BPP-13: -Practicals based on Radiation Biophysics. (L0-T0-P1-CH2-Credit 1)**

1. To determine the incident UV flux using Actinometry system.
2. To determine the Dose rate of Gamma Source using a) Fricke Dosimeter.  
b) Methyl Orange Dosimeter.  
c) Free Radical Dosimeter (Alanine and Glutamine.) d) FBX Dosimeter.  
e) Ceric Sulphate Dosimeter.
3. To determine the G value using Methyl Orange Dosimetry.
4. To determine the effect of UV and Gamma rays on E. Coli. and elucidate cell survival curve.
5. To demonstrate the effect of UV and Gamma rays on cell division.
6. To demonstrate the effect of Gamma rays on Enzymes, Proteins and DNA.
7. To demonstrate the effect of Gamma rays on cell membrane.

8. To determine the threshold Plateau and Operating Voltage for given GM tube.
  9. To determine the Resolving time, Dead time and counter efficiency for given GM tube.
  10. To determine the Absorption Coefficient of a given material for  $\beta$ -particles.
  11. To determine the back scattering of a given material for  $\beta$ - particles.
  12. To determine the X-ray output measurement,
    - a) As a function of current & voltage
    - b) Variation of exposure rate across the X-ray beam.
    - c) Decrease of output as a inverse square of distance.
  13. To determine the HVL, HVT, TVT of a given material.
  14. To determine the penumbra in good and bad geometry.
  15. To use the personal dosimeter in radioprotection.
  16. Radiation protection survey of X-ray diagnosis unit, Cobalt therapy unit, Brachy therapy unit and other radiation facilities.
  17. To measure the Central axis of Dose, Depth of Dose, Plotting at isodose curves.
  18. To determine the value of LD50.
  19. To determine the focal spot size of a Diagnostic X-ray unit using a pinhole camera.
  20. To determine the calibration of various personnel monitoring systems; film badges, thermo luminescent Dosimeters, Pocket Dosimeters.
  21. To determine the surface Dose rate and Central axis depth dose of ophthalmic applicators.
  22. Modification of Radio sensitivity of Cell and Molecular system.
- Recommended books: - Refer Annexure for detail book titles.

5,36,37,41,44,45,46,52,75,89,90,93,95,96,104,125,134,139,157.

**Paper BPT-XIV: - Photo-biophysics.**  
(L3-T1-P0-CH4-Credit 4)

**Unit 1: - Photophysics.**

Nature and measurement of light, Light sources Optical components and their calibration radiometry, Actinometry, UV radiation dosimetry with poly sulphonification, Molecular structure and excited states, Physical properties of excited molecules, Photophysical processes, fluorescence, Photophosphorescence, Internal conversion, Intersystem crossing, Photophysical spectra, Action spectra, Optical activity, Photophysical kinetics of bimolecular processes.

### **Unit 2: - Photochemistry.**

Basic principles and laws of photochemistry, Quantum photochemical principles, Photochemical primary processes, Types of photochemical reaction, Photochemistry of amino acids and proteins, Photochemistry of DNA & RNA and its constituents, Recovery from photochemical damage, Photophysical and photochemical aspects of photosensitization, Chemiluminescence, Mechanism and significance, Techniques for study of transient species in photochemical reaction.

### **Unit 3: - Photobiological phenomenon.**

Photoactivation of biological systems, Photodynamic dyes and mechanism of photodynamic action on cells, Viruses, Proteins and nucleic acids, Concepts, Mechanism and Significance of photomorphogenesis, Photoperiodism, Phototaxis, Phototropism, Photosynthesis, Light acceptor, system, Photosystem as Photosynthetic reaction centre, Photophosphorelation, Bioluminescence.

### **Unit 4: - Circadian Rhythms and extraretinal photoreception.**

General features of circadian rhythms, Entrainment to environmental cycles, Mechanisms of circadian rhythms, Circadian organization in multicellular organism including human, Concepts of extraretinal photoreception with reference to invertebrates, Vertebrates, Possible sites of extraretinal photoreception.

### **Unit 5: - Photomedicine.**

Optical properties of skin, Acute and chronic effect of sunlight on skin, Photosensitivity, Phototoxicity photoallergy and clinical implication, Beneficial effects of sun and artificial light energy, Photoprotection, Photoimmunology.

### **PAPER BPP-14: -Practicals based on Photobiophysics. (L0-T0-P1-CH2-Credit 1)**

1. To study the Photo reactivation process in E. Coli

2. To study the effect of visible light intensity and time of irradiation on photo reactivation process.
3. To study the Photoacoustic Spectra of Oat Seedlings.
4. To study the Action Spectrum for Bacterial killing.
6. To study the Photo Inactivation of Enzymes.
7. To study the survival of E. Coli. as a function of fluence of UV radiation (254 nm) at different temperature.
8. To study the photomorphogenesis using seedlings.
9. To isolate chloroplast from spinach leaves.
10. To study bioluminescence of live fire flies by correlating light intensity with time.
11. To study chemiluminescence in a chemical transformation.
12. To isolate and characterize photosynthetic pigments by Chromatography and Spectrophotometry.
13. To study the spectrophotometric assay of Hill reaction and estimation of chlorophyll.
14. To demonstrate Hill reaction using Oxygen Electrode.
15. To study the effect of Inhibitors and Light Intensity on Hill reaction.
16. Effect of Lasers on Biomolecules and Cellular Systems.
17. To study the characteristics of Fluorescence spectra of Auto fluorescent and induced fluorescent substances.

Recommended books: - Refer Annexure for detail book titles. 1,45,48,49,53,90,91,97,148.

*M.Sc. [Biophysics] Semester 4 Syllabus*

**Paper BPT-XVI: -Bioinformatics and Computational Biology.  
(L3-T1-P0-CH4-Credit 4)**

**Unit 1: Information theory and Bioinformatics Network.**

Information theory, Relation between information & entropy, Redundancy theorem & noise, Information content of biological system, Biological data exploration through internet Resources –EMBL net, NCBI, BTIS network, Bioinformatics landscape intrinsic & extrinsic view, Cheminformatics & medical informatics.

### **Unit 2: Biological databases.**

Sequence databases, Protein sequence databases, Structural databases, PDBs, Motif databases, Protein motif database, Genome databases, Proteome databases etc.

### **Unit 3: Genomics and Proteomics.**

Genome information resources, Functional Genomics DNA sequence analysis, Gene bank, CDNA library pharmaco Genomics, ESTs analysis method for recognition of functional signals, Consensus sequences, approaches to gene identification using internet resources, Concept & applications of DNA micro array technology, Protein sequences information & features, Proteomic analysis using internet resources, Prediction of protein structure, Protein folding, Problem & functional sites, Phylogeny, Methods of phylogenetic analysis, Application of sequence analysis & phylogenetic information.

### **Unit 4: Bioinformatics tools.**

Pair wise Alignment, Alignment algorithms, sequence analysis tools, BLAST (Basic Logical Alignment Search Tool) FASTA, Multiple Alignment, Sequence analysis using EMBOSS, DNA micro array technique.

### **Unit 5: Molecular Modeling.**

Introduction to computer graphics, Visualization of bimolecular structures, Concepts in molecular modeling, Energy minimization, Dynamic stimulation & conformational analysis, Applications of molecular modeling packages, structural similarity & overlaps, structural prediction & molecular docking, Applications of protein modeling.

### **Paper BPP-16: Practicals based on Bioinformatics and Computational Biology.**

(L0-T0-P1-CH2-Credit 1)

1. Internet search for Bioinformatics resources.
  2. DNA and Protein sequence, file format conversion.
  3. EST's Contig assembly and ORF analysis.
  4. Nucleic acids and Protein sequence database search.
  5. Biophysical parameters and Protein diagnostics.
  6. Multiple sequence alignment and Conserved Amino acid residues.
  7. Cladograms and Dendrograms and evolutionary relationship.
  8. The PROSITE Database.
  9. Conserved Domains and Protein super families.
  10. Two-dimensional and three dimensional structure, Prediction resources.
  11. Protein structure model from x-ray diffraction and NMR data.
- Recommended books: - Refer Annexure for detail book titles.

5,11,70,73,126,127,128,129,130,135,149,150,151,152,153,154.

**Paper BPT-XVII: -Medical Biophysics.  
(L3-T1-P0-CH4-Credit 4)**

**Unit 1: Electrophysiology.**

Principles of Electrocardiography, Heart- an electric potential sources, ECG waveforms, Standard lead systems, ECG preamplifiers, ECG readout devices, ECG machine, Measurements, Trouble-shooting, Principles of Electroencephalography, EEG Electrodes, 10-20 Electrode system, EEG Amplitude & Frequency band, Multichannel EEG recording, EEG in Sleep, Diagnostic Application of EEG, Recording of visual & auditory evoked Potentials, EEG Telemetry system, EEG System artifacts, Faults, Trouble shooting & Maintenance, Other electrophysiological recordings, EMG, ERG, EOG & their applications.

**Unit 2: Medical-Imaging Techniques.**

Physical aspects of Medical-imaging, Principle, Practical System, Medical utility of X-ray imaging, Fluoroscopy, Xeroradiography, Computerized Axial Tomography, Mammography, Angiography, Myelography, Magnetic resonance

**Unit 3: Nuclear Medicine.**

Basic principles of Nuclear Medicine, Diagnostic use of Radioisotopes In-vivo & In-vitro procedures, (Single isotope, Double isotope methods) , Radio immunoassay counting system, General principles & procedures of organ

scanning, Renal imaging, Cardiac imaging, Thyroid scanning, Blood volume determination by isotope method, Rectilinear scanners & Gamma scintillation camera, Positron emission Tomography (PET), Single Photon emission computer Tomography (SPECT), Radiopharmaceuticals & their Diagnostic applications.imaging, Ultrasonography.

#### **Unit 4: Radiotherapy.**

Concepts of teletherapy& Brachytherapy, Co-60 Therapy, Basic principles & scope of radio therapy, Benign& Malignant tumors, Tissue tolerance dose & Tumor lethal dose, Medical dosimetry, Dose fractionation, Palliative& Curative therapy, Treatment planning, Isodose distribution, Patient data, Correction & Setup, Field shapping, Skin dose and field separation, brachytherapy, Sources, Calibrations, Dose distribution implant dosimetry.

#### **Unit 5: Biomechanics and Ergonomics.**

Physical forces exemplified in man, Human musculo- skeletal system, Integrity of Joints, Articular surfaces, Mechanical properties of bones, Degrees of freedom of movements at various joints, Axes & planes, Center of gravity, Base support, Segmental Weights & Lengths, Posture alignment of body segments, Locomotion, Basic determinants of gaits, Gait cycle and Swing phases, Time sequence, Neural control of gaits, Prostheses &Orthoses, Ergonomics, Muscle mechanics, Load velocity relation, Length tension relation, Entire State, Role of elastic components in muscle contraction, Ergonomic problems of computer users.

#### **BPP-17: -Practicals based on Medical Biophysics. (L0-T0-P1-CH2-Credit 1)**

1. To record and analyze the Electrocardiogram and to draw the mean Electrical axis.
2. To measure the Evoked potentials.
3. To record and analyze Electroencephalographic (EEG) activity from the cortical areas of the brain.
4. To evaluate the auditory responses.
5. To assess the ventilatory functions using pulmonary function tests.
6. To study the effect of Ergography.
7. To study the effect of Electromyography.
8. To measure the Output of Gamma ray teletherapy units.
  - b) Beam collimation and alignment.
  - c) Electron contamination of beam.
  - d) Electron build up in the wall of Dosimeter.
9. To measure the central axis depth dose and plotting of isodose curves For a teletherapy unit using ion chamber &/or film.



10. Treatment planning procedures for:
  - a) A simple pair of two opposing fields.
  - b) Arc and rotation fields.
  - c) With tissue compensation.
  - d) With Wedge fields.
11. Treatment planning procedures with inhomogeneity corrections after localization of tumour.
12. Brachytherapy source: 1) Check for integrity of the source, 2) Calibration using an Isotope calibrator, 3) Plotting of Isodose curves using Ion chamber and/or film.
13. Brachytherapy treatment planning for 1) Manual after loading applicator, 2) Remote after loading applicator.
14. To prepare and use of surface moulds.
15. Thyroid uptake measurements: Resolution and Sensitivity of Collimators.
16. Techniques for organ Scanning (Bone, Liver, Brain, Whole Body).

Recommended books: - Refer Annexure for detail book titles.  
5,7,34,35,38,46,47,52,95,109,132,156,160,161,162,164,165,166,167,  
168,169.

**Paper BPT-XVIII Environmental Biophysics.  
(L3-T1-P0-CH4-Credit 4)**

**Unit 1: Biophysical Ecology.**

Micro climate & energy environment, Influence of physical factors, Interaction between environment & biosystem, solar radiation, Photochemical filtering of solar radiation. Atmospheric absorption, spectrum & thermal emission spectra, atomic scattering, Comparative distribution of natural light, spectral properties of liquid water, plant & animals, Green house effect.

**Unit 2: Environmental radiation.**

Nonionising radiation, sources consequences of UV absorption by living system, Diurnal radiation climate, Ozone umbrella & it's significance, Natural Radiation back ground of ionizing radiation- Radioactivity in ambient air, Cosmic radiations, Terrestrial radioactivity, Radiation from man made resources, Detection & measurement of radiation level, Consequences of ionizing radiation absorption by living system. Characteristics of microwave and radio frequency radiation sources, interactions with living system, biological effects, safe exposure limits and prevention of health hazards. Electric and magnetic field, Sources, measurement, biological effects at molecular, cellular and organism level. Protective standards and measures.

### **Unit 3: Sound pollution**

Physical aspects of transmission of sound in air and water, sound pollution, noise and its sources, types of noise, sound measurement, effect of noise on CNS, Sleep disorders, reproductive, cardiovascular and endocrine system, noise control measures, noise adaptation and audition elements.

### **Unit 4: Biophysics at Low and High temperature.**

Coupling between temp, water and life, Aqueous solution at subzero temperatures, Biomolecules at sub optimal temperature, Single cell responses to chill and freezing, Freeze avoidance and freeze tolerance in living system, Cryopreservation and cryoprotectants, Thermophiles and Thermo resistance mechanism, Thermo stability of enzymes and other biomolecules, Heat hardening of plant cells.

### **Unit 5: Analytical methods in environmental studies.**

Principle, instrumentation, method spectrum interpretation and application of mass spectrometry, Atomic absorption, Flame emission, Plasma emission, Spectrometry, X-ray fluorescence, PIXE, Neutron and proton activation analysis.

### **BPP-18: -Practicals based on Environmental Biophysics. (L0-T0-P1-CH2-Credit 1)**

1. Measurement of Light Intensity and effect of various factors.
2. Effect of High and Low temperature on Biomolecules and cells.
3. Measurement and Detection of Noise at various places by sound meter.
4. Effect of electric and magnetic field on Biomolecules and cellular system.
5. Trace element analysis of Polluted water by polarography.
6. Determination of Nitrates and water sample by UV Spectroscopy.
7. Analysis of trace elements in Animal and Plant tissue by Atomic absorption spectroscopy.
8. Radiation Exposure survey using area survey meters and Dosimeters.
9. Effect of distance on incident UV flux using Actinometry.
10. Determination of Calcium, Sodium, Potassium & Lithium by Flame photometry.
11. Determination of Element concentration by X-ray Fluorescence method.
12. Effect of lead on Nerve conduction velocity in animals.
13. Effect of microwaves and radio frequency radiations on biomolecules and cellular systems

14. To study the Effect of sound pollution on auditory impairment by Audiometry.
15. Preparation and use of Cryoprotectants for cell preservation.
16. Demonstration of Neutron activation analysis for elemental estimation.
17. To study the effect of Ultrasound on Biomolecules and Cellular Systems.

Recommended books: - Refer Annexure for detail book titles.

5,8,36,37,41,45,52,57,89,93,94,99,104,109,125,132,139 157,158,159,160.

## **Paper BPT-XIX Bioelectronics and Medical instrumentation. (L3-T1-P0-CH4-Credit 4)**

### **Unit 1: Basic Electronics.**

P-N Junction, Transistor characteristics, Transistor as Amplifier, Cascade Amplifiers, DC coupling, Field effect Transistors, Light sensitive semiconductor devices, Oscillators -Phase shift, Wein Bridge, Relaxation Oscillators, Operational Amplifiers, Circuits and characteristics of OP-Amplifiers in different configuration, Concept of Digital Electronics, Binary number system, Binary Arithmetic, Analog to Digital conversion, Digital to Analog conversion, Counters, Shift Registers, Memory, Introduction to Microprocessor, CRO- Design Working and Applications.

### **Unit 2: Bioelectric Signal Monitoring and Recording.**

Origin and Characteristics of Bioelectric signals & recording, Electrodes - types Design and properties and Utility, Skin contact impedance of Electrodes, noise suppression techniques, recording system, Medical Display systems, Patient Monitoring systems, Biomedical Telemetry, Computer Applications in medical field, Patient Safety.

### **Unit 3: Physiological Transducers.**

Transducers and Measurement of Physiological event, Transducers-properties and the principle of Transducers, Resistive Transducers, Thermo resistors, Thermistors, Metallic strain gauges, Potentiometric Transducers magneto resistive transducers, piezoelectric transducers and their Biomedical applications, Inductive Transducers, Signal inducers, Mutual inducers, Capacitive Transducers, Biological capacitors, Signal Conditioners for Transducers, Transducer Amplifiers.

### **Unit 4: Diagnostic Equipments.**

Principle, Working of Blood flow Meters, Pulmonary function analyzers, Blood gas analyzer, Oximeters, Audiometer.

**Unit 5: Therapeutics Equipments.**

Cardiac pace makers, Defibrillators, Hemodialysis machines, Short wave and Micro wave Diathermy, Ultrasonic Therapy, Pain relief through electrical stimulation, Surgical Diathermy, Laser, principle of operation, Types, Laser tissue interaction, Biomedical applications in surgery and therapy.

**BPP-19: -Practicals based on Bioelectronics and Medical Instrumentation.  
(L0-T0-P1-CH2-Credit 1)**

1. Introduction to Electrical & Electronic Components.
2. To study the different waveforms and their characteristics.
3. LDR, LED & photodiode characteristics.
4. Temperature sensors and their characteristics.
5. Operational Amplifier, Buffer, Adder & Sub tractors.
6. Frequency response of AC Amplifier using OP Amplifier.
7. Instrumentation Amplifier with Transducer Bridge.
8. Measurement of Pressure, Movement, Force, Frequency & Time using different transducers.
9. Principle of measurement of pH.
10. Principle of measurement of resistance/conductivity.
11. To study the Micro voltmeter.
12. To study the timer.
13. To study the Electronic pulse detector.
14. To study the Binary up/down counter.
15. To study the diode laser characteristics.

Recommended books: - Refer Annexure for detail book titles.  
5,34,35,40,47,52,96,109,133,169,170,171.

**PAPER CBCT-V: -Classical & Statistical Thermodynamics**

**(L3-T1-P0-CH4-Credit 4)**

**Unit-I**

Classical Thermodynamics: Review of the laws of thermodynamics, free energy, chemical potential and entropies. Partial molar quantities and their significances. Determination of these quantities, concept and determination of fugacity.

### **Unit- II**

Non-ideal systems: Excess function for non-ideal solutions. Activity, activity coefficient, Debye-Hückel theory for activity coefficient of electrolytic solutions; determination of activity and activity coefficients; ionic strength. Application of phase rule to three component systems; second order phase transitions.

### **Unit- III**

Statistical Thermodynamics: Statistical concepts and examples. Simple random walk problem in one dimension. General discussion of mean values and its use for the random walk problem. Specification of the state. Statistical ensembles. Basic postulates. Probability calculations. Behaviour of the density of states. Exact and inexact differentials. Equilibrium conditions and constraints. Reversible and irreversible processes. Distribution of energy between systems in equilibrium. Isolated system. System in contact with heat reservoir. Canonical distribution and its simple applications. Ensembles used as approximation. Calculation of thermodynamic quantities, Gibbs paradox, Validity of the classical approximation, Equipartition theorem and its applications: Specific heats of solids, Maxwell velocity distribution.

### **Unit- IV**

Quantum Statistics of ideal gases. Identical particles and symmetry requirements. Quantum distribution functions. Maxwell-Boltzmann, Photon, Bose-Einstein, and Fermi-Dirac statistics. Quantum statistics in the classical limit. Electromagnetic radiation in thermal equilibrium inside an enclosure. Consequences of Fermi-Dirac equation.

## **Paper CBCT-X:-Quantum Mechanics for Bio-chemistry and Bio-physics (L3-T1-P0-CH4-Credit 4)**

### **Unit -I**

Review of essential mathematical concepts. Origin of the quantum theory. Postulates of quantum mechanics and Schrödinger equation; its application on some model systems viz., free-particle and particle in a box,

tunneling, the harmonic oscillator, the rigid rotator, and the hydrogen atom.

### **Unit- II**

The variation theorem; linear variation principle; perturbation theory; applications of variational methods and perturbation theory to the helium atom. Ordinary angular momentum, generalized angular momentum,

### **Unit- III**

Eigen functions, and eigen values of angular momentum operator, Ladder operator, addition of angular momenta. Spin, antisymmetry, Pauli exclusion principle, Slater determinantal wave functions.

### **Unit - IV**

Term symbol (RS and jj coupling) and spectroscopic states, term separation energies of pn and dn configurations, magnetic effects: spin-orbit coupling and Zeeman splitting. Virial theorem. Born-Oppenheimer approximation, VB and MO theory, H<sub>2</sub><sup>+</sup>, H<sub>2</sub> molecule problem, Hückel molecular orbital theory and its application to ethylene, butadiene and benzene. Hybridisation and valence MOs of H<sub>2</sub>O, NH<sub>3</sub> and CH<sub>4</sub>. Introduction to the SCF.

## **Paper CBCT-XV: - Mathematics in Biological Process (L3-T1-P0-CH4-Credit 4)**

### **Unit – I: Dynamics under the influence of stochastic forces:**

Introduction of reaction processes in the bulk, either in physiological liquids, membranes or proteins. Newton's equation and Langevin's equation. Stochastic differential equations, simple description of noise. Ito calculus and Ito rules. Fokker-Planck Equations. Stratonovich Calculus.

### **Unit – II: Einstein Diffusion Equation**

Derivation and boundary conditions, Einstein Diffusion equation., Fluorescence Microphotolysis, Free Diffusion around a spherical object. NMR and Rotational Diffusion. Derivation of the Smoluchowski Diffusion Equation for potential field.

### **Unit- III: Rates of Diffusion-Controlled Reactions**

Reference of metabolism of the biological cell to equations of this

unit.Relative Diffusion of two Free Particles.Relative Motion of two Diffusing Particles with Interaction.Diffusion – Controlled Reactions under Stationary Conditions.

#### **Unit – IV: Curve Crossing in a Protein: Coupling of the Elementary Quantum Process to Motions of the Protein:**

Introduction of curve crossing in a protein. The Generic Model: Two-State Quantum System Coupled to an Oscillator. Molecular dynamics in studies of the photosynthetic reaction, - two state system coupled to a stochastic medium. Two state system coupled to a single quantum mechanical oscillator.

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### **Paper CBCT-XX:Mathematical Neuroscience. (L3-T1-P0-CH4-Credit 4)**

#### **Unit- I**

Biophysics of neurons and neural networks, Biology of neural cells, neuron as a circuit, modeling of the ion channels, synapses on integrate-and –fire models: synchronizing multiple neurons.

#### **Unit-II**

Cable Theory, The cable equation. The linear cable equation, parameters of the cable equation. Step current and semi-infinite cylinder, pulse current semi-infinite cylinder, steady-state finite cylinder, equivalent cylinder theorem. Biological evidence

#### **Unit-III**

Abstract neural networks, Firing –rate model, Types of networks, Linear

recurrent networks, nonlinear recurrent networks. Nonlinear recurrent network. Associative memory. Stochastic network: Boltzmann machine, Excitatory-Inhibitory networks.

#### **Unit-IV**

Plasticity and learning, memory and learning, plasticity rules, Basic Hebb rules, covariance rule. The BCM rule, Synaptic normalization, Timing-based rules, application of Hebb rule.

#### **Unit- V**

Supervised learning as an optimization problem, The perceptron learning rule, The Delta rule, Conditioning and reinforcement learning.

Ref: 173

### **ANNEXURE: - Recommended Books and Journals.**

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  23. Saenge W. (1984), Principles of Nucleic acid structure, Springer-Verlag.
  24. Schule G.E. and schirmer R.H. (1984), Principles of protein structure, Springer-Verlag.
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  28. Spragg S.E. (1980), Physical Behavior of macromolecules with biological functions, John Willey and sons.
  29. Stanford J.R. (1975), Foundation of Biophysics Academic press.
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  31. Szekely M. (1984), From DNA to protein, Macmillan.
  32. Volkenstein M.V. (1977), Molecular Biophysics, Mir Publication.
  33. Bach J. F. (1978), Immunology, John Willey and sons.
  34. Basar E. (1976), Biophysical and physiological system Analysis, Addition-Wesley.
  35. Cameron J. R. and skofronick J.G. (1978), Medical Physics, John Willey and sons.
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46. Martin A. &Harbisan S.A. (1982), An introduction to Radiation Protection, Chapman and hall Publication.
47. Moore B.M., Panker R.P. and Pullman B.R. (1981), Physical aspects of medical imaging, John willey and sons.
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  172. Lecture in Theoretical Biophysics, K. Schulten and I. Koszin
  173. Lecture notes on mathematical neuroscience by ngoc mai tran

**JOURNALS:** - Recent advance Pertaining to various sections are generally reported in the following journals; Students are encouraged to keep themselves abreast of the subject from them.

Nature

Science

Scientific American

Journal of Molecular Biology

Journal of Biological Chemistry

Annual Review of Biochemistry

Biochemica Biophysica Acta

Radiation Research

Immunology Today.

International Journal of Radiation Biology.

Radiation and Environmental Biophysics.

Photochemistry and Photobiology.

Physiological Reviews.

Current Science.

Resonance.

Annual Reviews in Biophysics and Bimolecular Chemistry. Indian Journal of Biophysics and Biochemistry.

Indian Journal of Experimental Biology.

Proceedings of Indian National Science Academy Part-B (Biological Sciences). Annual Review in Plant Physiology.

Annual Review in Microbiology.



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