

**Dr. Babasaheb Ambedkar Marathwada University,  
Aurangabad.**

**FACULTY OF SCIENCE**

**SYLLABUS**

**M. Sc. (BIOPHYSICS) FIRST AND SECOND YEAR**

[Revised Syllabus progressively effective from June 2011 onwards]

## **M.Sc. [BIOPHYSICS] SYLLABUS**

### **Eligibility Criteria:**

A Candidate shall be held eligible for admission to Two year course for the Master's Degree in Biophysics under faculty of Science, if candidate has Passed the B.Sc. Examination with Physics or Chemistry or Zoology or Biochemistry or Botany or Microbiology or Mathematics or Electronics or Biotechnology or Bioinformatics as one of the Optional Subjects. **OR** Passed B.Sc. Biotechnology or Bioinformatics [Integrated] Examination **OR** Passed B.Pharm.Examination

### **General Instructions:**

- 1.M.Sc. Biophysics course is divided into four semesters.
- 2.Each Semester consists of Four Theory Papers each of 50 marks and four Practical papers each of 20 marks and one Mini-Project of 20 marks consolidating to 300 marks
3. Every theory paper will have workload of 60 periods each of 60 minutes duration distributed unit wise as indicated in this syllabus.[4 periods/wk X 15 weeks=60 (45 lectures +15 tutorials)] This workload is inclusive of test, tutorial & seminars to be conducted as mandatory PG activities. Every practical Paper will have workload of 90 periods each of 60 minutes duration.(6 periods/wk X 15 weeks=90)
- 4.The weekly workload is [a] Each theory paper in every semester is 4 periods/wk each of 60 minutes duration[b] Each practical paper in every semester is 6 periods/wk each of 60 minutes duration [c] A Mini-Project in every semester is 2 periods/wk each of 60 minutes duration
6. It is essential to complete a minimum of **ten** practicals in each practical paper of every semester
7. Every student should deliver minimum ONE seminar per semester on Emerging topics related to biophysics.
8. There should be five regular tests per paper and five tutorials per paper during each semester.
9. It is mandatory for students to have minimum 75% attendance in each Semester.
10. The students should successfully complete minimum one month in-plant training or two weeks Research Methodology/Radiotherapy/Bio-analytical Instrumentation/Medical Imaging/Bioinformatics/Molecular modeling training in summer/winter vacations during the course.

# M.Sc. BIOPHYSICS SYLLABUS [Revised] AT A GLANCE

## SEMESTER – I

Paper Code	Name	Max. Marks	Exam Duration	Teaching WL/Week*
BPT-I-R	Molecular Biophysics & Biophysical Chemistry	50	3 Hrs.	4 Hrs.
BPT-II-R	Cellular Biophysics	50	3 Hrs.	4 Hrs.
BPT-III-R	Biostatistics, Biomathematics & Computers	50	3 Hrs.	4 Hrs.
BPT-IV-R	Molecular Enzymology.	50	3 Hrs.	4 Hrs.
BPP-1-R	Practical based on BPT-I-R	20	6 Hrs.	6 Hrs.
BPP-2-R	Practical based on BPT-II-R	20	6 Hrs.	6 Hrs.
BPP-3-R	Practical based on BPT-III-R	20	6 Hrs.	6 Hrs.
BPP-4-R	Practical based on BPT-IV-R	20	6 Hrs.	6 Hrs.
BPMP-1	Mini Project I	20	6 Hrs	2 Hrs

## SEMESTER – II

Paper Code	Name	Max. Marks	Exam Duration	Teaching WL/Week*
BPT-V-R	Membrane & Ion Channel Biophysics	50	3 Hrs.	4 Hrs.
BPT-VI-R	Molecular Genetics & Advanced Molecular Biology.	50	3 Hrs.	4 Hrs.
BPT-VII-R	Research Methodology & Communication	50	3 Hrs.	4 Hrs.
BPT-VIII-R	Biophysical Techniques & Instrumentation.	50	3 Hrs.	4 Hrs.
BPP-5-R	Practical based on BPT-V-R	20	6 Hrs.	6 Hrs.
BPP-6-R	Practical based on BPT-VI-R	20	6 Hrs.	6 Hrs.
BPP-7-R	Practical based on BPT-VII-R	20	6 Hrs.	6 Hrs.
BPP-8-R	Practical based on BPT-VIII-R	20	6 Hrs.	6 Hrs.
BPMP-2	Mini Project II	20	6 Hrs	2 Hrs

### SEMESTER – III

Paper Code	Name	Max. Marks	Exam Duration	Teaching WL/Week*
BPT-IX-R	Physiological Biophysics	50	3 Hrs.	4 Hrs.
BPT-X-R	Photobiophysics	50	3 Hrs.	4 Hrs.
BPT-XI-R	Elective A-I [One from the list below]	50	3 Hrs.	4 Hrs.
BPT-XII-R	Elective A-II [One from the list below]	50	3 Hrs.	6 Hrs.
BPP-9-R	Practical based on BPT-IX-R	20	6 Hrs.	6 Hrs.
BPP-10-R	Practical based on BPT-X-R	20	6 Hrs.	6 Hrs.
BPP-11-R	Practical based on BPT-XI-R	20	6 Hrs.	6 Hrs.
BPP-12-R	Practical based on BPT-XII-R	20	6 Hrs.	6 Hrs.
BPMP-3	Mini Project III	20	6 Hrs	2 Hrs

Electives A :

- |   |                          |
|---|--------------------------|
| 1. Immunology & Immunotechniques        | 2. Radiation Biophysics  |
| 3. Protein engineering                  | 4. Electrophysiology     |
| 5. Cellular & Molecular Neurophysiology | 6. Clinical Biochemistry |

### SEMESTER – IV

Paper Code	Name	Max. Marks	Exam Duration	Teaching WL/Week*
BPT-XIII-R	Bioinformatics & Computational Biology.	50	3 Hrs.	4 Hrs.
BPT-XIV-R	Recombinant DNA technology & Genetic Engineering	50	3 Hrs.	4 Hrs.
BPT-XV-R	Elective B-I [One from the list below]	50	3 Hrs.	4 Hrs.
BPT-XVI-R	Elective B-II [One from the list below]	50	3 Hrs.	4 Hrs.
BPP-13-R	Practical based on BPT-XIII-R	20	6 Hrs.	6 Hrs.
BPP-14-R	Practical based on BPT-XIV-R	20	6 Hrs.	6 Hrs.
BPP-15-R	Practical based on BPT-XV-R	20	6 Hrs.	6 Hrs.
BPP-16-R	Practical based on BPT-XVI-R	20	6 Hrs.	6 Hrs.
BPMP-4	Mini Project IV	20	6 Hrs	2 Hrs

Electives B :

- |  |                               |
|--|-------------------------------|
| 1 Environmental Biophysics                 | 2. Medical Biophysics         |
| 3 Bioelectronics & Medical Instrumentation | 4. Neurobiophysics            |
| 5. Molecular Modeling & Drug Designing     | 6. Genomics & Proteomics      |
| 7. Micro array Technology & Data Analysis  | 8. IPR, Bioethics & Biosafety |

## **Standard of Passing and Award of Division:**

[a]The minimum marks for passing in each Paper/ Practical shall be 40% of the maximum marks prescribed for the Paper/ Practical.

[b]A candidate who secures 40% or more but less than 50% of the aggregate marks prescribed for I, II, III & IV Semesters taken together shall be awarded a **Pass division**.

[c]A candidate who secures 50% or more but less than 60% of the aggregate marks prescribed for I, II, III & IV Semesters taken together shall be awarded a **Second division**.

[d]A candidate who secures 60% or more than aggregate marks prescribed for I, II, III & IV Semesters taken together shall be awarded a **First division**.

[e]A candidate who secures 75% or more than aggregate marks prescribed for I, II, III & IV Semesters taken together shall be awarded **Distinction**.

*Dr. Babasaheb Ambedkar Marathwada University,  
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M.Sc. [Biophysics] Semester 1 Syllabus

**Paper BPT-I-R: Molecular Biophysics & Biophysical  
Chemistry**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

**Unit 1 : Basic concepts**

**Atomic & Molecular structure** :Structure of atom, Schrödinger's theory , Quantum numbers, Pauli's exclusion principle , Hund's rule , Periodic table, Concept of bonding; valence of carbon; hybridizations of carbon; hybridizations of nitrogen & oxygen; molecular orbital theories, hybridization of orbitals,  $\sigma$  &  $\pi$  bonds, polar & non polar molecules; inductive effect; resonance. Secondary bonding: weak interactions, hydrogen bonding; dipole-dipole & dipole-induced dipole interactions; London dispersion forces. Bonds within molecules- Ionic, covalent, Hydrogen, Electrostatic, Disulphide & peptide bonds, Vander Waals forces , Bond lengths & Bond energies , Bond angles, Bayer's strain , Structural isomerism; geometrical isomerism; optical isomerism & optical activity.

**Acid & Bases**, mole concept, Molarity & Normality, weak acids, Ampholyte, pH, Calculations of pH from H & OH concentrations , measurements of pH , Henderson – Haselbatch equation , Titration curve & pK values, Buffers & Stability of their pH , numerical problems.

**Redox potential** :Oxidation –Reduction , Equivalence of electrical & chemical energy, Electrochemical cell, contact potentials, galvanic cell, potential of half cell, redox potentials & its calculations by Nernst equation, standard electrode potentials & its determination , its relationship with emf, Types of electrodes, pH electrodes, ion selective electrodes, oxygen electrodes.

**Unit 2 : Molecular alphabets of life –Nucleic acids & Proteins**

**Nucleic acid**: Purine & pyrimidine bases, nucleosides & nucleotides , double helical structure of DNA , conformational parameters of nucleic acids & their constituents, nucleic acids geometrics, glycosidic bond rotational isomers and those puckering backbone rotational isomers and ribose puckering forces stabilizing ordered forms, base pairing, base stacking, Chargaff's rule, DNA polymorphism , DNA supercoiling , hyperchromicity, circular DNA, Types & structure of RNA, m RNA, tRNA, rRNA & modified nucleotides, tertiary structure of nucleic acids.

**Proteins**: Structure, classification & properties of amino acids , titration of amino acids, Principles of ionization equilibria ,ionization of side chains; equilibria in proteins. Predicting properties from amino acid composition. Unusual amino acids , peptides, polypeptides , structural levels of proteins & stabilizing forces , conformational properties of polypeptides, Ramchandran plot, Helical parameters & conformation , organization & interaction angles, Prediction of proteins structure ,conformational structures of alpha keratin , silk fibrin, collagen, actin , myosin , conformation of globular proteins, hemoglobin , myoglobin, lysozyme, cytochromes etc. Classification & role of  $\beta$  bends & bulges, super secondary structures, Domain & motifs, protein sequencing.

Conformational Analysis-Forces that determine protein and nucleic acid structure, basic problems, polypeptide chains geometrics, potential energy calculations, observed values

for rotation angles, hydrogen bonding, hydrophobic interactions and water structures ionic interactions, disulphide bonds. The random walk, helix coil transitions in proteins, statistical thermodynamics and organizational levels of biomacromolecule structure.

### **Unit 3: Molecular alphabets of life- Other Biomolecules**

Structure of D-glucose & D-fructose; formation of glucosides & the cyclic structure of D-glucose; D-ribose & D-deoxyribose; Structure and conformation of disaccharides and polysaccharides- cellulose, amylose, amylopectin & glycogen, Chitin, carbohydrate conjugates, Lipids :major classes of lipids- Fats & oils; phospholipids , lipoproteins, fatty acids, Structure, classification & role of vitamins & hormones.

**Biophysics of Water** : Molecular structure, Association of water through H- bonding, Nature of hydrophobic interactions, physicochemical properties of water ,State of water in biostructures & its significance,Water as a Liquid and Solvent : Water Structure, Small-Molecule Solutes: Hydrophiles,Small-Molecule Solutes:Hydrophobes,Large Hydrophobic Solutes and Surfaces , The Influence of Ions: Structure-Making and Structure-Breaking, Long-Range Hydrophobic Interactions and the Role of Bubbles, Hydrophilic Surfaces , Aqueous Environment of the Cell

Protein Hydration-Nonspecific Effects,The Hydration Shell,Dynamics, Cooperativity, and the Glass Transition,Protein Hydration- Specific Roles of Water in Structure and Function, Secondary Structure, Protein-Protein Interactions, Mediation of Ligand Binding, Functional Tuning, Allostery Hydrophobic Cavities,Electron Transfer, Involvement of Bound Water in Catalytic Action, Proton Wires Function of Protein Channels, Water and Nucleic Acids.

### **Unit 4 : Thermodynamics and Bioenergetics.**

Laws of thermodynamics , concept of free energy, unavailable energy & Entropy, Negative entropy change in living system, heat content of food , Bomb calorimetry, Energy generation & energy transfer processes in biochemical reactions.

Cellular energetic and metabolic pathway: overview of metabolism: Metabolism pathways, Energy requirements in cell metabolism thermodynamic considerations, and control of metabolic flux, structure & role of mitochondria, High energy compounds in biological system, ATP and phosphoryl group transfers, Metabolism of glucose & formation of ATP, ATP synthesis by rotary catalysis. Couple reactions, Redox potential in biological system, Oxidation-reduction reactions: FAD and NAD<sup>+</sup> . Overview of major metabolic pathways-Glycolysis, Kreb's cycle, oxidative phosphorylation, electron transport chain, Constituents of ETC & their sequence (Complex I-IV) & location, inhibitors of ETC, chemiosmotic theory, ATP synthase complex- structure and function, dicarboxylic acid shuttle, glycerol phosphate shuttle, P:O ratio, regulation of oxidative phosphorylation; amino acid, fatty acid and nucleotide metabolism, and their control and integration, cofactor mechanism.

### **Unit 5 : Macromolecular Interactions**

Ligand interaction at equilibrium, binding of small molecules by polymer, identical and independent sites model , Scatchard plot, multiple classes of independent sites, interaction between binding sites, nearest interaction and statistical weight allostherism , MWC model, sequential model, oxygen-hemoglobin binding, binding of two different ligands , cooperative binding, anti-cooperative binding and excluded site binding ,energetics & dynamics of binding, structures of protein ligand complexes, relationship

between protein conformations & binding, binding of immunoglobulin and DNA binding protein, free radicals in biology & medicine.

### **Paper BPP-1-R: - Practicals based on Molecular Biophysics.**

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.
6. To study the characteristics of UV absorption spectra of Proteins.
7. To study the characteristics of absorption spectra of Nucleic Acids and Nucleotides.
8. To study the mutarotation of simples Sugars using Polarimetry.
9. Spectrophotometric assay of electron transport in intact Mitochondria using Dye Reduction methods.
10. Light induced proton pumping (uptake) in hypotonically swollen Chloroplast from Spinach Leaves.
11. To estimate light driven Chloroplast electron transport by Dye Reduction method.
12. 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..
13. To estimate the inorganic phosphate.
14. To analyze of Oil-Iodine number, saponification value & acid number.
15. Model building using Space filled & Ball and Stick models.
16. To estimate the DNA molecules.
17. To estimate the RNA molecules.
18. Studies the simple molecular structures using DTMM and other basic molecular modeling softwares
19. To prepare the buffers & measurement of pH.
20. To determine the titration curve of amino acids & calculate the pKa values.
21. To determine the titration curve of Proteins & calculate the pKa values.
22. To determine the Tm of DNA.
23. Denaturation & Renaturation of DNA.
24. To isolate the Proteins- Casein from milk, Hb from RBC.
25. Study of UV absorption spectra of Proteins.
26. Study of UV absorption spectra of Nucleic acids.
27. To study the macromolecular interactions using ultrasonic interferometer.
28. To study the effect of temperature, concentration, macromolecular size, shape on ultrasonic velocity
29. To isolate the Phospholipids from Egg Yolk.
30. To study the interactions of Acridine orange with DNA.
31. To estimate quantitatively the Amino acids using the ninhydrin reaction.
32. To estimate proteins by Biuret assay.
33. To estimate the Protein by Folin's-Lowry method.



34. To prepare the Cytochrome C & its characterization.
35. To identify the C-terminal Amino acids of a protein.
36. To identify the N-terminal Amino acids of a protein.
37. To study the protein structure by using DTMM (Desk top molecular modeling)
38. To analyze the major types of vertebrate collagen by SDS PAGE.

Recommended books: - Refer annexure for detail book titles. 1,2,4,5,6,7,10,11, 12,14,15,18,19,20,21,23,24,26,27,29,30,31,32,58,60,61,65,69,70,72,73,74,82,86, 87,105, 106,114,115,118,155...

## **Paper BPT-II-R: Cellular Biophysics.**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

### **Unit I: Cell Organization**

Cell as the basic structural unit, Origin & organization of Prokaryotic and Eukaryotic cell, Cell size & shape, Fine structure of Prokaryotic & Eukaryotic cell organization (Bacteria, Cyanobacteria, plant & Animal cell), Internal architecture of cells, cell organelles, compartment & assemblies membrane system, Ribosome, Polysomes, Lysosomes & Peroxisomes, Connection between cell & its environment, Glycocalyx, Extracellular Matrix.

### **Unit II: Tools in Cell Biology**

Light microscope, Resolving Power, Phase contrast microscope, Detection of small differences in refractive indices, Interference microscopy, Dark field microscopy, Light scattering at cell boundaries, Polarization microscopy, Fluorescence microscopy, Cytophotometry methods, Flowcytometry & cell sorting, Electron microscopy, electron optics, electrostatic focusing, magnetic focusing, electron lens, specimen preparation, shadow casting, Negative & Positive staining, High Voltage Electron Microscopy, Scanning Electron Microscopy (SEM), Scanning Transmission Electron Microscopy (STEM), Image reconstruction from electron micrographs, resolution of image, applications, Autoradiography-General principles, Types & constitutions of photographic emulsion sensitivity specks, Auto radiographic technique, Image quality, Resolution, Evaluation of autoradiogram.

### **Unit III: Cell Growth & Division**

Kinetics of cell growth, The Cell Cycle, Interphase-G<sub>1</sub>,S,G<sub>2</sub>,M molecular events at different cell cycle phases, A cytoplasmic clock times, cell cycle in early embryogenesis, Polypeptide Growth Factors & Control of cell proliferation, Mitosis & Cell division-Molecular mechanism, Events in mitosis, Role of mitotic apparatus, Meiosis & Sexual reproduction, Molecular mechanism of meiosis, DNA metabolism during meiosis, Dividing & Non-dividing cells, Synchronization of cell cycles, Cell transformation & Malignancy, Cell aging & death-Apoptosis, Cell Cycle Control, Role of MPF, Cd2 Proteins & G-1\* Cyclins.

### **Unit IV: Cell-Cell Interaction**

Connection between the cell and its environment, Glycocalyx, Extracellular Matrix, collagen, Elastin, Fibronectin, Lamin, Proteoglycans, Integrins, Cell Junctions,

Desmosomes, Gap junction, Tight Junctions, Plasmodesmata, Synapse and synaptic vesicles\*, Cell Signaling, General principle of cell signaling, Paracrine, Autocrine, Endocrine & synaptic signaling, Heat Shock Proteins, G-Protein structure and role in signaling, Intracellular Cyclic AMP, Role  $Ca^{++}$  in cell signaling, CAM Kinases, (Calmodulin/ $Ca^{++}$  dependent protein kinases), Interaction between cyclic AMP &  $Ca^{++}$ . Role of Methylation in adaptation & bacterial chemotaxis.

Cell differentiation, General characteristics of cell differentiation, Localization of cytoplasmic determinants, Molecular mechanism of cell differentiation, Morphological movements & the shaping of body plans\* Cell memory, Concept of positional values, maintenance of differentiated state, Tissue with permanent cells, neuronal networks & centre of the lens of adult eye.

### **Unit V: Cell & Tissue Culture**

Plant & Animal Cell Culture: Callus Culture, Suspension culture, Estimation of growth, Cell viability Test, Totipotency in culture, Importance of totipotency, Cyto-differentiation in cultured cells, rnanogenesis, Somaclonal variations, Somatic embryogenesis, Artificial seeds, Embryo Culture, Protoplast Fusion & Somatic hybridization, Cryopreservation & its application in cell & tissue culture. Applications of cell & Tissue culture.

Culturing techniques for bacteria and virus

### **Paper BPP-2-R: - Practicals based on Cellular Biophysics.**

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 identified 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-R: Biostatistics, Biomathematics & Computers**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

## **Unit 1: Basic Concepts & Descriptive Statistics**

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.

Measures of central tendency [Mean(Arithmetic, Harmonic and Geometric), Median, Mode] Measures of dispersion (Range, quartile deviation, mean deviation, standard deviation, coefficient of variation), Comparison of two CVs; Skewness; Kurtosis  
**Elements of probability theory:-** axiomatic definition; Addition theorem; Conditional probability; Bayes theorem; Random variable; Mathematical expectation probability distribution - binomial, Poisson and normal distribution; Sampling- parameter, statistic and standard error; Census - sampling methods; Probability and non-probability sampling; Purposive sampling; Simple random sampling; Stratified sampling

**Correlation and regression,** Positive and Negative correlation and calculation of Karl-Pearsons Co-efficient of correlation, Spearman's rank correlation, Partial and multiple correlation, regression analysis; Sample linear and non linear regression; multiple regression, regression equation, Calculation of an unknown variable using regression equation, Probit and logit analysis, Types of estimation, Confidence interval level of confidence. Confidence interval estimate of mean and of proportion.

## **Unit 2: Errors in measurements & Statistical Analysis.**

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

Basic idea of significance test –Hypothesis testing. , Null and alternative hypothesis;

Large sample tests(z-test); Test of significance of single and two sample means; Testing of single and two proportions - Small sample tests: F-test — testing of single mean; Testing of two sample means using independent t test, paired t test; ANOVA and Chi-Square Tests: One-way and two-way ANOVA – Latin Square tests for association and goodness of fit; testing linkage; segregation ratio.

## **Unit 3: Biomathematics I**

Sets & symbolic logic: Finite set, infinite set, null or void set, subset, Intervals; closed and open, universal set, operations of set. Relations and functions; Power functions & Polynomials, limits and continuity, Arithmetic and Geometric Series, Binomial Theorem. Permutation and combinations; Determinants: Definition, properties associated with determinants, Cramer rule condition of consistency, evaluations of 3 x 3 determinants, simultaneous equations and inversion. Interpolation and polynomial fitting.

Matrices: Definitions and types of matrices, properties of matrices, addition, subtraction of matrices, matrix multiplication, elementary transformation, Adjoint matrix, inverse of matrices; matrices manipulations Special square matrices, Determinant of a square matrix, Inverse of a matrix, rank of a matrix, Eigen vectors and eigen values, diagonalization; Logarithmic and exponential functions, domain and range.

2D Coordinate Geometry: Equation of a line, circle, ellipse, parabola, and hyperbola. 3D geometry: Equation of sphere, cone; Graphical representations: Linear scales, nonlinear scales, Semi logarithmic, triangular, nomography, pictorial presentations

#### **Unit 4: Biomathematics II**

**Differential Calculus:** Function, Limit, Continuity and Differentiability, Derivative and its physical significance, basic rules for differentiation (without derivation), Differentiation of standard functions, Method of Differentiation, Derivative of simple algebraic and trigonometric functions, Maxima and Minima. exact and inexact differentiation with specific emphasis on thermodynamic properties, partial differentiation. Curve sketching

**Integral Calculus:** Basic rules for integration (without derivations), definite and indefinite integrals, geometric meaning of integration, applications in the biology and chemistry. Solutions to quadratic and cubic equations. Integration of some standard functions. Integration by substitution, by parts, by partial fraction. Applications of Integral calculus in biology. Definite integral. Ordinary differential equations (first order) - example from biology.

**Vectors:** Vector algebra, coordinate systems, Basic vectors and components, Scalar and vector multiplications, Reciprocal vectors, coordinate transformations. Vector differential calculus: curves, arc length, tangent, curvature, velocity & acceleration, directional derivative, transformation of coordinate systems and vector components, divergence and curl of vector field. Relations & Functions: Linear, periodic, logarithmic, exponential, Quadratic functions. Mapping & Cartesian product. periodic functions and conversion of different co-ordinate system; Their application in Biology.

Partial differential equations: Introduction to partial derivatives & Ordinary Differential Equation of the first order. Fourier transform and inverse Fourier transform

#### **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, MODEM, Fibre Optics Network) 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 webs) Internet connectivity, search engines. Interactive communication on Internet, Programming concepts in c++, Introduction to Bioperl, Biojava, Bioxml.

## **Paper BPP-3-R:-Practical based on Biostatistics, Biomathematics & Computers**

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.
10. Five Mathematical assignment based on unit-3
11. Five Mathematical assignment based on unit-4

Recommended books: - Refer annexure for detail book titles.

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

## **Paper BPT-IV-R: Molecular Enzymology**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

### **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, Michaelies equation, steady state kinetics, transient phases of enzyme reactions, Lineweaver-Burk, Eddie-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, Abezymes, Ribozymes, Enzyme therapy, Extremozymes, Solventogenic and non-aqueous enzymes.

## **PAPER BPP-4-R: -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

*Dr. Babasaheb Ambedkar Marathawada University,  
Aurangabad*

*M.Sc. [Biophysics] Semester 2 Syllabus*

## **Paper BPT-V-R:-Membrane & Ion Channel Biophysics**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

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

Various membrane models, Carbohydrate, Lipids & Proteins, Components of cell membrane, Composition of biological membranes- lipid molecules, proteins, glycoproteins, membrane skeletons, forms of lipids and proteins, electrical properties of lipids and proteins, Principles of membrane organization & stability, Biogenesis of cell membrane, Self-organisation of lipids and proteins- linear aggregates of membranous components, aggregation of lipid molecules in mycelia and lipid double layers, biologically important non-lamellar lipid phases, formation of flexible membranous nanodomains, lateral phase separation of membranous components, aggregation of nanodomains, formation and stability of membranous nanotubes, Elastic properties of membranes: deformations in levels of a membrane, flexible energy, influence of forms of membrane components and direct interactions between membranous components in elastic properties of membranes, lateral distribution of membranous components and elastic properties of membranes, elastic properties of membranes and forms of cells and organelles, influence of cytoskeleton on forms of cells, Molecular motion in membrane & membrane fluidity, Protein lipid interactions, Phase properties of biological membranes.

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

Nature & magnitude of cell surface charge, Electric properties of membranes: electric double layer, Poisson-Boltzmann theory of electric double layer, Gouy-Chapman model of electric double layer, free energy of electric double layer, influence of final size of molecule and distribution of charge within individual molecules on the properties of an electrical double layer, influence of size and distribution of electrical charge of a membrane on transport of electrified molecules through a membrane, bonds and adhesion of electrified molecules on the surface of a membrane, 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.**

Electrostatic interaction between membrane surfaces: influence of components of solvents on the interaction between membranes, influence of electrical properties of molecules in solvents on the interaction between membranes, adhesion of membranes, 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, Ion channel structure and gating function, Ion channel types and characterization, 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, Transport and communication between cells and organelles: mechanisms of micro- and nano-vesiculation, influence of electrical properties of membranes and solvents on the vesiculation of membranes, endocytosis, exocytosis, fusion of vesicles, encapsulation of nano-particles and DNA, influence of detergents and nano-particles on vesiculation and forms of membrane, mechanisms of stability and formations of membrane nanotubes and their role in the transport of substances between cells and between cell organelles. Microvesiculation of membranes and its role in spreading tumours and creation of blood clots. Mechanisms of creation and stability of membrane pores.

#### **Unit 5: Membrane Energetics.**

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

### **PAPER BPP-5-R:- Practicals based on Membrane & Ion Channel 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-VI-R:-Molecular Genetics & Molecular Biology**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

### **Unit I: Mendelian Genetics & Structural Organization**

Mendelian principles-Dominance, Segregation, Independent Assortment, Deviation from Mendelian inheritance. Codominance, Incomplete dominance, Gene interactions, Pleiotropy, Genomic Imprinting, penetrance & Expressivity phenocopy, Linkage & Crossing Over, Sex Linkage, Sex Limited & Sex Influenced Characters.

Extra chromosomal Inheritance- Mitochondrial, chloroplast & maternal inheritance. Polygenic inheritance, heritability & its measurements, QTL mapping.

Nucleic acids as a genetic material, Topology of nucleic acid & role of topoisomerases, concept of gene, Chromosomal organization in prokaryotes, eukaryotes & Viral systems, Spatial arrangement & role of histone, chromatin subunit, Nucleosomes, Solenoid model, loops, domains & scaffolds in chromatin, Laws of DNA constancy & C-value paradox, Concept of Repetitive DNA, Selfish DNA, Split genes, Pseudogenes, cryptic genes, Promiscuous DNA, Multigene families, DNA replication in prokaryotes and eukaryotes-mechanism, enzyme involved.

### **Unit II: Gene Expression.**

Central dogma of molecular biology, Genetic code, silent features of genetic code, protein synthesis-mechanism of transcription in prokaryotes and eukaryotes, m-RNA synthesis and processing (capping, splicing, RNA editing, poly adenylation) role of ribozymes, ribosomes structure and function of different components, shine-dallgrno sequence, TATA box, termination of transcription. Mechanism of translation, formation of aminoacyl t-RNA initiation, elongation, termination of polypeptide synthesis, translation in chloroplast and mitochondria, post translational modifications.

### **Unit III: Regulation of Gene Expression.**

Regulation of gene expression in prokaryotes, concept of inducer and repressor, operons and transcriptional regulation (lac operon, tryptophan operon, leucine responsive protein (LRP)), sigma ( $\sigma$ ) factor and transcriptional control. Post transcriptional regulation, Leader sequences and attenuators, alternative splicing, role of antisense RNA-regulation in bacteriophages Cro gene and  $\lambda$  repression proteins. Gene expression control in eukaryotes-role of specific DNA sequences, modifications in DNA transcripts and histone proteins. Regulation at translational level, phosphorylation of translational machinery, masking of m-RNA, regulation by gene rearrangement, W-D repeat proteins.

### **Unit IV: Mutation and Repair.**

Molecular basis of Mutation, types of mutations, spontaneous mutations, base analogues (5-Bromo Uracil, 2-amino purine) tautomeric shift and frame shift mutations. chemical mutagens, intercalating substances, mutator genes, site specific mutagenesis and mutational hot spots, methods for isolation of mutants. Physical mutagen, biochemical mechanism of repair, photo reactivation, excision repair, SOS repair etc.

## **Unit V: Genetic Recombination.**

Genetic recombination between homologous DNA sequences, Holliday model, Role of RecA proteins, meiotic recombination (linkage and crossing over). Transformation, transforming principle, competence, uptake and fate of DNA, conjugation- mechanism of conjugation, Role of F plasmid, Hfr. transduction-lytic and lysogenic cycles, generalized and specialized transduction. Transposition- transposable elements, insertion sequences, bacterial transposons, transposable elements in eukaryotes.

## **PAPER BPP-6-R: -Practicals based on Molecular Genetics & Advanced Molecular Biology.**

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.

## **Paper BPT-VII-R:- Research methodology & Communication**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

### **Unit 1. Introduction to Research: General**

Definition, need, process. Research objectives, Research approaches, Significance of research & importance of knowing how research is done-Criteria of good research; Types of Research: Pure, Applied and Action Research, Kinds of Research: Diagnostic, Descriptive, Exploratory, Explanatory, Research Ethics – Animal ethics; Human ethics; Bio-safety in research: microorganisms studies Scientific methods, components of scientific methods, Research process, Problem encountered by researchers in India; Personal attributes- Research and scholarship; difference between undergraduate and research education: skills habits and attitudes for research; status of research in India; Psychological phases of PhD process; stress point; aims of supervisors; mismatches and problems; Managing self; empathy; managing relations with your supervisor, colleagues, and supporting staff, listening; assertiveness; teamwork; sense of humor; Duration and stages of a PhD Process; long term and short goals; time tabling and dead lines;

Profession; integrity, objectivity, fairness and consistency; loyalty; plagiarism and research ethics; safely. Problem finding and literature survey

## **Unit 2. Literature survey, Proposal writing & Research Design**

Types of Literature search – use of library, books & journals – Medlines, internet, getting patents and article reprints as a source of literature survey; Review of Literature– Formulation of Hypothesis, Identification and selection of research problems, preparation of research proposal, synopsis. Need for research design, Important concepts relating to design, Features of good design; Research designs ; Basic principles of experimental design - Pre-experimental, CRD and Quasi-Experimental designs; Types of research design: Historical design, Descriptive design, case control, cohort, cross sectional, longitudinal; Experimental and modeling skills-Introduction, selection of variables, design matrix, 2-level factorial design, 3-level factorial design, fractional factorial design, analysis of variance, Taguchi methods – orthogonal arrays, signal to noise ratio; Response Surface Methodology, Latest trends in experimental designs.

## **Unit 3. Data Collection Techniques and Interpretation**

Collection of Data : Primary Data, Meaning of Secondary data, Meaning ,Relevances, limitations and cautions. Data Collection methods: Interview; Observation; Questionnaire Scope of survey based research, Types of surveys – specific, periodic and transaction driven, Identification of research problem, analysis of research problem, customer identification, categorization and sampling, planning a survey project– resources, budget and schedule, preparation of questionnaire – elements of questionnaire, sequencing questions, question formats; methods of conducting survey, data collection, analysis, and compilation of survey report, Developing tools – Validity (internal & external), Reliability of the tools. Meaning of Interpretations; Techniques of Interpretation, Precautions in Interpretations, Data Processing ; Coding, tabulations, classifications.

## **UNIT-4 PROBLEM SOLVING AND CREATIVITY**

Thinking processes problem solving and creativity Level and styles of thinking; common-sense and scientific thinking; examples. Problem solving strategies- reformulation or rephrasing. Techniques of representation, Logical thinking, division into sub-problems, verbalization. awareness of scale; importance of graphical representation; Creativity - Some definitions, illustrations from day to day life; gift or skill; creative process; requirement of creativity- role of motivation and open v/s closed minds; multiple approaches to a problem analytical vs analogical reasoning, puzzle solving; example; prepared mind, Creative problem solving using Triz Prescriptions for developing creativity and problem solving; Communication Skills: Reading Skill :Reading tactics and strategies, Reading purpose and meaning, Reading outcomes, structure of meaning; Writing Skill: Guidelines for effective writing, Writing styles for application with personal resume, Business letter and memo including requests, complains, Technical report writing, Development of paragraph, Development of story. Listening Skill: Barriers to listening, Effective listening skills, Attending telephone calls, Note-taking; Speaking and discussion Skill: Component of effective talk / presentation, Effective speaking skills, Discussion skills

## **Unit 5. Research Reporting Scientific Writing:**

Definition and kinds of scientific documents – research paper, review paper, book reviews, thesis, conference and project reports (for the scientific community and for funding agencies). Publication – role of author, guide, co-authors. Components of a

research paper – the IMRAD system, title, authors and addresses, abstract, acknowledgements, references, tables and illustrations. Structure, style and contents; Style manuals (Chicago, Harvard, Vancouver, APA, MLA); Citation styles: Footnotes, references; Evaluation of research, Dealing with publishers – submission of manuscript, ordering reprints. Current trends in scientific research (Advanced countries, Less-Advanced countries and Global); Report writing- Significance of Report writing; Different steps in Report writing; Mechanics and precautions of writing research reports; Layout of the Research project; Types of reports and Oral presentation, Oral and poster presentation of research papers in conferences/symposia; Preparation of abstracts. Preparation and submission of research project proposals to funding agencies. Structure of Thesis and Content – Preparing Abstracts; Collaborators & Funding - Classification of Institutes, Collaborations and collaborators, Funding for research, Computers in research

#### **Recommended Books:**

1. How to Write and Publish a Scientific Paper ?; Robert A. Day, Barbara Gastel ; 6<sup>th</sup> edition; Cambridge : Cambridge University ; 2006.
2. Research Methodology Methods and Techniques ; C.R.Kothari; 2nd edition; New Age International; 1990 (e-published in 2009).
3. Research Methodology Methods and Statistical Techniques ; Santosh Gupta; New Delhi: Deep & Deep Publications ; 2000.
4. Research Methodology ; Indrayan
5. E.M. Phillips and D.S. Pugh, " How to get a Ph.D-a handbook for Ph.D students and their supervisors", Viva books Pvt. Ltd for all scholars irrespective of their disciplines.
6. Hand book of Science Communication, compiled by Antony Wilson. Jane Gregory, Steve Miller, Shirely Earl. Overseas Press India Pvt. Ltd, New Delhi. First edition 2005
7. G.L Squires, " Practical physics", Cambridge University Press, for all scholars except those from Humanities and management Sciences.
8. Peter b Medewar, " Advice to a Young Scientist", Pan Books. LONDON. 1979.
9. D C Montgomery, Design and Analysis of Experiments

### **PAPER BPP-7-R: Practicals based on Research methodology & Communication**

1. Five assignments on Literature survey of the previous works and search for articles in the library
2. Five assignments on Review of an article in the relevant field and preparation of a short report
3. Five assignments on research design
4. Five assignments on data collection & interpretation
5. Five assignments on case studies revealing problem solving & creativity
6. Five assignments on Proposal writing
7. Five assignments each on review paper & book reviews conference, workshop, Symposium reports and proposal for funding
8. Five Presentations involving Group discussion, paper & poster presentation
9. Five assignments on general informative articles in science & technology

# Paper BPT-VIII-R: Biophysical Techniques & Bioinstrumentation

[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]

## Unit 1: Spectroscopic Techniques I.

Spectroscopy- Basic principles, nature of electromagnetic radiation, Interaction of light with matter, Absorption and emission of radiation; Atomic & Molecular Energy levels, Electronic, vibrational and Rotational spectroscopy of molecules, transition and selection rules; Atomic & Molecular spectra ,

Principle, Instrument Design, Principle, Instrument Design, Methods & Applications of **UV-Visible spectroscopy**: UV-Visible range, energy-wavelength-color relationships., Interaction of UV-VIS radiation with matter and its effects, chromophores and their interaction with E.M.R. Absorption spectra of organic compounds and complexes illustrating the phenomenon and its utilization in qualitative and quantitative studies of drugs & other compounds, shifts and their interpretations (including solvent effects);

**IR & Raman spectroscopy** - Nature of I.R. radiation, interaction of I.R. radiation with organic molecules and effects on bonds, molecular or infra-red spectra, brief outline of classical I.R. instrumentation and interpretation of spectra including sample preparation for spectroscopy, qualitative interpretation of I.R. spectra, quantitative methods; FT-IR, Attenuated Total Reflectance (ATR), Near infra red Spectroscopy (NIR) -theory and applications.

**Fluorescence spectroscopy**- Principle, Instrument Design, Principle, Instrument Design, Methods & Applications- Fluorescent probes, modification in methionine, histidine, tryptophan, amine and carboxylic groups, fluorescence life-time and quenching studies; & applications in proteins & membrane studies. Energy transfer for distance measurement in proteins & membranes. Use of fluorescence polarization and anisotropy, measurement of anisotropy decay. Comparative study of rigid proteins i.e.; lysozyme and lactalbumin. Internal flexibility of multidomain proteins, i.e. myosin, fractin, fibrinogen. Fluorescence dye-Nucleic acid complexes.

**Atomic Absorption spectroscopy**- Principle, Instrument Design, Principle, Instrument Design, Methods & Applications

**Inductively coupled plasma atomic emission spectrophotometry**: Plasma emission sources, inductively coupled argon plasma, direct current argon plasma

## Unit 2: Spectroscopic Techniques II.

**NMR spectroscopy**- Fundamental principles of NMR (magnetic properties of nuclei: applied field and precession: absorption and transition frequency Nuclear magnetic moments, spin quantum number, restricted orientation of magnetic nuclei in applied field.), chemical shifts concept, factors affecting chemical shift, isotopic nuclei, reference standards; Proton magnetic spectra, their characteristics, presentation, terms used in describing spectra and their interpretation (number position and intensity of signal), brief outline of instrumental arrangements and some practical details, signal multiplicity

phenomenon in high resolution PMR; Spin-spin coupling, application of signal splitting and coupling constant data to interpretation of spectra, proton exchange reactions, decoupling and shift reagent methods. Brief outline of principles of FT-NMR with reference to  $^{13}\text{C}$ -NMR: Spin-spin and spin-lattice relaxation phenomenon, free induction decay (FID), proton noise decoupling, signal averaging time domain and frequency domain signals, nuclear overhauser enhancement;  $^{13}\text{C}$ -NMR spectra; their presentation, characteristics, interpretation, examples and applications. Brief indication of application of magnetic resonance spectral data of other nuclei by modern NMR instruments, introduction to 2-D NMR techniques- Basic 2D spectroscopy, benefits of 2D NMR, practical details for the general 2D experiments (COSY, NOESY). Assignment problem in biopolymers, Ligand binding to macromolecules, chemical exchange, P-NMR spectroscopy, monitoring of cellular pH, metabolism (detail), compartmentation, pH gradient in tumor cells etc. Fluidity gradient in lipids, chemical shift anisotropy of P resonance in membranes

**Nuclear quadrupole resonance spectroscopy:** Consequence of nuclear spin greater than  $1/2$ . Prolate and oblate nuclear quadrupole charge distributions, the NQR isotopes, electric field gradients. Nuclear quadrupole coupling constants. Measurement techniques (SRO detection and pulse NQR). Application to purine and pyrimidine nucleic bases.

**ESR Spectroscopy-** Magnetic moment of unpaired electrons and paramagnetic resonance, Principle of operation and working of electron spin resonance, E.S.R. spectrometer, Hyperfine ESR spectroscopy, representation of ESR spectrum, E.S.R. spectra of organic radicals in solution--isotropic hyperfine splitting, ESR spectra of organic radicals in solids-anisotropic hyperfine splitting, ESR spectra of inorganic radicals-g-value anisotropy. ESR of organic molecules in triplet states-Electron spin-spin interactions. Relaxation processes and line shapes, 'g' -value, spectra of simple organic free radicals, hyperfine coupling, prediction of expected number of lines and intensities. Spectra of transition metal complexes, Zero-field splitting, utility for identification of radical; spin labeled probes, spin-labelling: A reporter group technique, requirement of such a group, Nitroxide spin label probes and their molecular structures, Anisotropy of the value order parameters, information obtained from ESR motion, polarity, biochemical data, orientation Intra-molecular distances etc. Applications of these concepts to (i) studying the structure and function of enzyme, i.e. lysozyme etc. (ii) conformational change of molecular artifact in try spin, spin labelled ligands as probe for rigidity of binding sites, lipid spin labels in the biological membranes etc. applications in biology, pharmacy.

**Mass Spectroscopy-** Basic principles and brief outline of instrumentation, ion formation and types; molecular ions, meta stable ions, fragmentation processes, fragmentation patterns and fragment characteristics in relation to parent structure and functional groups, relative abundances of isotopes and their contribution to characteristic peaks, mass spectrum; its characteristics, presentation and interpretation, chemical ionization mass spectrometry, GC-MS including recent advances in MS, Fast atom bombardment mass spectroscopy; analysis of drugs in biological samples by combined GC- MS. Chemical ionization mass spectroscopy (CIMS), Field Ionization Mass Spectrometry (FIMS), Fast Atom Bombardment MS (FAB MS), Matrix Assisted laser desorption / ionization MS (MALDI-MS), interpretation of spectra and applications in biology, Pharmacy etc

**Photoacoustic Spectroscopy**-Basic principles, Techniques & Instrumentation involved, applications

### **Unit 3: Hydrodynamic Techniques.**

**Centrifugation & Ultracentrifugation**-Basic principles, Forces involved, RCF Centrifugation, techniques- principles, types and applications. Centrifuges & Ultracentrifuges-types, optical methods used and applications of preparative [Differential, Density Gradient] and analytical [sedimentation velocity, sedimentation equilibrium] ultracentrifugation.

**Viscometry**- General features of fluid flow (streamlined and turbulent) nature of viscous drag for streamlined motion. Definition of viscosity coefficient. Origin of viscosity of gases and liquids, expression for viscosity coefficient of gases (with derivation), temperature dependence of viscosity coefficient of gases and liquids. Stoke's law and terminal velocity. Determination of viscosity coefficient of liquids, diffusion of gases and solute in solution, Fick's law, viscometric measurement, Viscometers- Ostwald capillary, Ubbelohde capillary, Conette and the Zimm-Crothers floating rotor viscometers with the Cartesian diver modification. Relation between intrinsic viscosity and molecular weight, Measurement of Viscoelasticity,

**Surface tension**- Definition, angle of contact, interfacial tension, capillary rise, determination of surface tension, temperature effect,

**Osmosis and Diffusion as experimental techniques**

### **Unit 4: Physicochemical Fractionation & Electro-analytical Techniques.**

**Chromatography**-Basic Concepts of Adsorption & Partition Chromatography, Principle Experimental set-up, Methodology & Applications of all types of Adsorption & Partition Chromatography methods-chromatography using paper, thin layer, HPTLC column (gel filtration, ion exchange, affinity), gas (GC, GLC) and HPLC: types of HPLC, Mobile phase elution, normal phase and reverse-phase HPLC, column packing material, efficiency of column, types of HPLC – principles of methodologies; HPLC pumps -efficiency and suitability, Different injectors and Detectors; Ion Chromatography

**Electrophoresis**- Principle, Electrophoretic mobility (EPM) estimation, factors affecting EPM, Instrument design & set-up, Methodology & Applications of Free & Zone (Paper, Cellulose acetate, Agarose & Starch gel gel, Pulsed-field, PAGE, SDS-PAGE, Capillary) Electrophoresis techniques, Principle, Experimental set-up, Methodology & Applications isoelectric focusing, 2D electrophoresis

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

Principle, Instrument Design, Methods & Applications of Polarimetry, Light scattering, Refractometry, Atomic Force Microscopy, Circular Dichroism and optical rotatory dispersion: Plain, circular and elliptical polarization of light, Absorption by oriented molecules, Dichroic ratio of proteins and nucleic acids. Circular dichroism (CD), optical rotatory dispersion (ORD), Relation between CD and ORD, application of ORD in conformation and interactions of biomolecules, Determination of structural correlations in biomolecules using absorption spectroscopy. Relationship between molar ellipticity of CD, comparison of CD and absorption spectra. Conformational dependence of CD helical structure, coupling between chromophore etc. Secondary and tertiary structures of

peptides and proteins, effect of pH, temperature, organic solvents and neutral salts. Conformational information-aromatic and disulphide side chains. CD spectra of di, oligo and polypeptides, structure of supramolecular structure i.e. membranes and ordered aggregates of chromophore.

Crystals, Molecular crystal symmetry, Miller indices, reciprocal Lattice, Ewalds Construction, X ray diffraction by crystals, Bragg's Law & Bragg's diffraction equation, laue powder and rotation methods & Laue's equations, diffraction methods-Laue's method, Weissenberg diffraction camera and powder method, Calculating electron density and Patterson maps (Fourier transform and Structure factors, convolutions), phases, model building & evaluation, Interpretation of results, geometrical structure factor. Phase problem in interpretation of results. Crystallization of proteins, preparation of heavy metal derivatives, Patterson synthesis, isomorphous replacement methods, structure factors of centro-symmetric and non-centrosymmetric crystals. General remarks on Protein-structure determination from X-ray diffraction data Neutron diffraction, Electron diffraction, Synchrotron diffraction, Application in Biomolecular structural studies

### **PAPER BPP-8-R:-Practicals based on Biophysical Techniques and Bioinstrumentation.**

1. To familiarize in the use of pH meter and Colorimeter.
2. One-dimensional Ascending & Descending Paper chromatography of Amino acids & sugars
3. Two-dimensional Ascending & Descending Paper chromatography of Amino acids.
4. One-dimensional Ascending & Descending TLC of Amino acids & sugars
5. Two-dimensional Ascending & Descending TLC of Amino acids & sugars.
6. HPTLC of Amino acids & sugars
7. Fractionation of Sugars from fruit juice using TLC/HPTLC
8. Column Chromatography for Proteins, Pigments, amino acids.
9. Paper Electrophoresis of Amino acids.
10. Cellulose acetate strip Electrophoresis of Amino acids.
11. Paper Electrophoresis of Proteins.
12. Cellulose acetate strip Electrophoresis of Proteins
13. Agar Gel Electrophoresis of Proteins
14. Polyacrylamide Gel Electrophoresis (PAGE).
15. SDS- Polyacrylamide Gel Electrophoresis (PAGE).
16. To study the structure based visco-elastic properties of proteins, nucleic acids, sugars, lipids using Ostwald's Viscometer.
17. To perform image analysis using CCD camera of Microscopic dynamic Images.
18. To determine the sugar and protein concentration using Refractometry.
19. To obtain relation between concentration and Refractive Index (RI) using Refractometry.
20. To study the renal stone using Infra-Red (IR) Spectroscopy.
21. To determine the oil content of oil seeds using Nondestructive IR Spectrophotometry.
22. To perform the separation of Proteins using Capillary Electrophoresis.



23. To perform the separation of Proteins using HPLC
24. To study the co-relation between Concentration, Size, Shape of the molecules and Viscosity characteristics using digital viscometer.
25. To perform the structural analysis of amino acids, small peptides using NMR spectrometer
26. To perform the Free radical spectral analysis using ESR spectrometer
27. To perform the conformational analysis of amino acids, small peptides, large proteins using CD spectrometer and spectropolarimeter
28. To determine the molecular weight of biomolecules using ultracentrifuge

Recommended books: - Refer annexure for detail book titles.

1,5,7,8,9,14,15,17,19,21,26,28,29,60,69,98,101,140,155.

***Dr. Babasaheb Ambedkar Marathawada University,  
Aurangabad***

*M.Sc. [Biophysics] Semester 3 Syllabus*

**Paper BPT-IX-R: -Physiological Biophysics**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

**Unit 1: Brain & Neurophysiology.**

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-9-R: - Practicals based on Physiological Biophysics.**

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.)
15. Assignments on various aspects using signal acquisition systems. ADInstruments-LAB Tutor and other protocols

Recommended books: - Refer Annexure for detail book titles.

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

## **Paper BPT-X-R: -Photobiophysics.**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

### **Unit 1: - Non-Ionizing Radiation physics**

Different sources of Non Ionizing radiation-their physical; properties, Various types of optical radiations-UV, visible & IR sources, Lasers-Theory and mechanism, Measurement of fluence from optical sources, Optical properties of tissues, theory and experimental techniques, interaction of laser radiation with tissues, photo thermal,photochemical,photo ablation electromechanical effect,Radiofrequency & Microwave radiation, Production and properties,interaction mechanism of RF and microwaves with biological systems, Thermal and non-thermal effects on whole body, lens and cardiovascular systems,tissue characterization and Hyperthermia and other applications.Biomagnetism,Effects,applications.Electrical Impedance and Biological Impedance, Principle and theory of thermography, applications in biology & medicine

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

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, Phophysical processes, fluorescence, Photophosphorescence, Internal conversion, Intersystem

crossing, Photophysical spectra, Action spectra, Optical activity, Photophysical kinetics of bimolecular processes.

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 Extra retinal 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: - Photo-medicine.**

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. Mediphotonics: Lasers in dermatology, oncology and cell biology, Laser Surgical Systems, Application of ultra fast pulsed lasers in medicine and biology, Lasers in blood flow measurement, Fiber optics in medicine, microscopy in medicine, birefringence, Fluorescence microscope, confocal microscope, Hazards of lasers and their safety measures.

## **PAPER BPP-10-R: -Practicals based on Radiation Fundamentals & Photobiophysics**

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.
5. To study the Photo Inactivation of Enzymes.
6. To study the survival of E. Coli. as a function of fluence of UV radiation (254 nm) at different temperature.
7. To study the photomorphogenesis using seedlings.
8. To isolate chloroplast from spinach leaves.

9. To study bioluminescence of live fire flies by correlating light intensity with time.
10. To study chemiluminescence in a chemical transformation.
11. To isolate and characterize photosynthetic pigments by Chromatography and Spectrophotometry.
12. To study the spectrophotometric assay of Hill reaction and estimation of chlorophyll.
13. To demonstrate Hill reaction using Oxygen Electrode.
14. To study the effect of Inhibitors and Light Intensity on Hill reaction.
15. Effect of Lasers on Biomolecules and Cellular Systems.
16. To study the characteristics of Fluorescence spectra of Auto fluorescent and induced fluorescent substances.

Recommended books: - Refer Annexure for detail book titles.  
5,19,22,29,41,45,48,49,53,90,91,97,148.

**Paper BPT-XI-R : - First Elective [A-I] [One from the Following]**

**Paper BPT-XII-R : - Second Elective[A-II] [One from the Following]**

### **Elective 1. Immunology and Immunotechniques.**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

#### **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, ABEZYME technique.

#### **Elective1:- Practicals based on Immunology and Immuno-techniques.**

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 CH<sub>50</sub> 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

#### **Elective 2 -Radiation Biophysics.**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

##### **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,

## **Elective 2 : -Practicals based on Radiation Biophysics.**

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 LD<sub>50</sub>.
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  
158,159,163,167.



## **Elective 3 : Protein Engineering**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

### **Unit-I Protein Architecture**

Amino Acids And Their Characteristics: Amino acids (the students should be thorough with three and single letter codes) and their molecular properties (size, solubility, charge, pKa), Primary, secondary, tertiary, quaternary structure, Bonds And Energies In Protein Makeup: Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Primary structure: peptide mapping, peptide sequencing - automated Edman method & massspec. High-throughput protein sequencing setup Secondary structure: Alpha, beta and loop structures and methods to determine Super-secondary structure: Alpha-turn-alpha, beta-turn-beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds, prediction of substrate binding sites Tertiary structure: Domains, folding, overview of methods to determine 3D structures, Quaternary structure: Modular nature, formation of complexes. Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups) and peptide synthesis. Protein folding, molten globule structure, characterization of folding pathways; Post translation modification; Sequence and 3D structure analysis: Data mining, Ramachandran map, Mechanism of stabilization of proteins from psychrophiles and thermophiles vis-à-vis those from mesophiles; Protein design.

### **Unit-II Characterization of proteins**

Protein raw materials: cereals, legume, oil seeds and pseudo cereals. Muscle protein, Milk protein, Egg protein, Hemoglobin, Collagen, Keratin. Nutritive role of food proteins; Methods to determine structure of proteins- Protein structure determination, X-Ray analysis of protein, NMR and mass Spectroscopy, Absorption and Fluorescence, Circular Dichroism, FT Raman, FT-IR, MALDITOF. Protein characterization, 2 D Gel Electrophoresis; Structure and function prediction- Protein Bimolecular interaction, Drug protein interaction Thermal properties of proteins and application of DSC. Protein denaturation, aggregation and gelation. Flow properties of proteins and sensory properties of pertinacious foods..

### **Unit-III Proteins Stability, Interactions & Modifications**

Interaction with electromagnetic radiation (radio, micro, infrared, ultraviolet, X-ray) and elucidation of protein structure. denaturation and renaturation, Protein stability and Methods of measuring the stability of a protein: Spectroscopic methods to study physicochemical properties of proteins: far-UV and near-UVCD; Fluorescence; UV absorbance; methods to alter primary structure of protein-Random mutation Site directed mutation, Catalytic activity; Protein modification- thermal, enzymatic, physical, pressure, solvents, interactions; Hydrodynamic properties-viscosity, hydrogen-deuterium exchange; Brief introduction to NMR spectroscopy – emphasis on parameters that can be measured/obtained from NMR and their interpretation

## **UNIT IV Structure-Function Relationship**

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers, Membrane proteins: General characteristics, Trans-membrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center, Immunoglobulins: IgG Light chain and heavy chain architecture, abzymes and Enzymes: Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate assisted catalysis other commercial applications.

## **UNIT V Protein Engineering**

Protein engineering: definition, application; Features or characteristics of proteins that can be engineered (definition and Electives methods of study)–affinity and specificity Spectroscopic properties; Stability to changes in parameters as pH, temperature and amino acid sequence, aggregation propensities, etc Advantages and purpose, overview of methods, underlying principles with specific examples: thermal stability T4-lysozyme, recombinant insulin to reduce aggregation and inactivation, de-novo protein design.

### **Elective 5: -Practicals based on Protein Engineering**

#### **PART I: QUANTITATION OF PROTEINS[5 Assignments]**

- 1 Protein Determination by UV Absorption
- 2 The Lowry Method for Protein Quantitation
- 3 The Bicinchoninic Acid (BCA) Assay for Protein Quantitation
- 4 The Bradford Method for Protein Quantitation
- 5 Ultrafast Protein Determinations Using Microwave Enhancement
- 6 The Nitric Acid Method for Protein Estimation in Biological Samples
- 7 Quantitation of Tryptophan in Proteins
- 8 Flow Cytometric Quantitation of Cellular Proteins
- 9 Kinetic Silver Staining of Proteins

#### **PART II: ELECTROPHORESIS OF PROTEINS AND PEPTIDES AND DETECTION IN GELS [10 Assignments]**

- 10 Nondenaturing Polyacrylamide Gel Electrophoresis of Proteins
- 11 SDS Polyacrylamide Gel Electrophoresis of Proteins
- 12 Gradient SDS Polyacrylamide Gel Electrophoresis of Proteins
- 13 SDS-Polyacrylamide Gel Electrophoresis of Peptides
- 14 Identification of Nucleic Acid Binding Proteins Using Nondenaturing Sodium Decyl Sulfate Polyacrylamide Gel Electrophoresis (SDecS-Page)
- 15 Cetyltrimethylammonium Bromide Discontinuous Gel Electrophoresis of Proteins: Mr-Based Separation of Proteins with Retained Native Activity
- 16 Acetic-Acid-Urea Polyacrylamide Gel Electrophoresis of Basic Proteins
- 17 Acid-Urea-Triton Polyacrylamide Gel Electrophoresis of Histones
- 18 Isoelectric Focusing of Proteins in Ultra-Thin Polyacrylamide Gels
- 19 Protein Solubility in Two-Dimensional Electrophoresis: Basic Principles and Issues
- 20 Preparation of Protein Samples from Mouse and Human Tissues for 2-D Electrophoresis
- 21 Radiolabeling of Eukaryotic Cells and Subsequent Preparation for 2-D Electrophoresis
- 22 Two-Dimensional Polyacrylamide Gel Electrophoresis Using Carrier Ampholyte pH Gradients in the First Dimension

- 23 Casting Immobilized pH Gradients (IPGs)
- 24 Nonequilibrium pH Gel Electrophoresis (NEPHGE)
- 25 Difference Gel Electrophoresis
- 26 Comparing 2-D Electrophoretic Gels Across Internet Databases
- 27 Immunoblotting of 2-D Electrophoresis Separated Proteins
- 28 Quantification of Radiolabeled Proteins in Polyacrylamide Gels
- 29 Quantification of Proteins on Polyacrylamide Gels
- 30 Rapid and Sensitive Staining of Unfixed Proteins in Polyacrylamide Gels with Nile Red
- 31 Zinc-Reverse Staining Technique
- 32 Protein Staining with Calconcarboxylic Acid in Polyacrylamide Gels
- 33 Detection of Proteins in Polyacrylamide Gels by Silver Staining
- 34 Background-Free Protein Detection in Polyacrylamide Gels and on Electroblots Using Transition Metal Chelate Stains
- 35 Detection of Proteins in Polyacrylamide Gels by Fluorescent Staining
  
- 36 Detection of Proteins and Sialoglycoproteins in Polyacrylamide Gels Using Eosin Y Stain
- 37 Electroelution of Proteins from Polyacrylamide Gels
- 38 Autoradiography and Fluorography of Acrylamide Gels

**PART III: BLOTTING AND DETECTION METHODS[5 Assignments]**

- 39 Protein Blotting by Electroblotting
- 40 Protein Blotting by the Semidry Method
- 41 Protein Blotting by the Capillary Method
- 42 Protein Blotting of Basic Proteins Resolved on Acid-Urea-Trinton-Polyacrylamide Gels
- 43 Alkaline Phosphatase Labeling of IgG Antibody
- 44  $\alpha$ -Galactosidase Labeling of IgG Antibody
- 45 Horseradish Peroxidase Labeling of IgG Antibody
- 46 Digoxigenin (DIG) Labeling of IgG Antibody
- 47 Conjugation of Fluorochromes to Antibodies
- 48 Coupling of Antibodies with Biotin
- 49 Preparation of Avidin Conjugates
- 50 MDPF Staining of Proteins on Western Blots
- 51 Copper Iodide Staining of Proteins and Its Silver Enhancement
- 52 Detection of Proteins on Blots Using Direct Blue 71
- 53 Protein Staining and Immunodetection Using Immunogold
- 54 Detection of Polypeptides on Immunoblots Using Enzyme-Conjugated or Radiolabeled Secondary Ligands
- 55 Utilization of Avidin- or Streptavidin-Biotin as a Highly Sensitive Method to Stain Total Proteins on Membranes
- 56 Detection of Protein on Western Blots Using Chemifluorescence
- 57 Quantification of Proteins on Western Blots using ECL
- 58 Reutilization of Western Blots After Chemiluminescent Detection or Autoradiography

**PART IV: CHEMICAL MODIFICATION OF PROTEINS AND PEPTIDE PRODUCTION AND PURIFICATION [10Assignments]**

- 59 Carboxymethylation of Cysteine Using Iodoacetamide/Iodoacetic Acid
- 60 Performic Acid Oxidation
- 61 Succinylation of Proteins
- 62 Pyridylethylation of Cysteine Residues
- 63 Side Chain Selective Chemical Modifications of Proteins
- 64 Nitration of Tyrosines
- 65 Ethoxyformylation of Histidine
- 66 Modification of Arginine Side Chains with p-Hydroxyphenylglyoxal
- 67 Amidation of Carboxyl Groups
- 68 Amidination of Lysine Side Chains
- 69 Modification of Tryptophan with 2-Hydroxy-5-Nitrobenzylbromide
- 70 Modification of Sulfhydryl Groups with DTNB
- 71 Chemical Cleavage of Proteins at Methionyl-X Peptide Bonds
- 72 Chemical Cleavage of Proteins at Tryptophanyl-X Peptide Bonds
- 73 Chemical Cleavage of Proteins at Aspartyl-X Peptide Bonds
- 74 Chemical Cleavage of Proteins at Cysteinyl-X Peptide Bonds
- 75 Chemical Cleavage of Proteins at Asparaginyl-Glycyl Peptide Bonds
- 76 Enzymatic Digestion of Proteins in Solution and in SDS Polyacrylamide Gels
- 77 Enzymatic Digestion of Membrane-Bound Proteins for Peptide Mapping and Internal Sequence Analysis
- 78 Reverse Phase HPLC Separation of Enzymatic Digests of Proteins

**PART V: PROTEIN/PEPTIDE CHARACTERIZATION[10Assignments]**

- 79 Peptide Mapping by Two-Dimensional Thin-Layer Electrophoresis–Thin-Layer Chromatography
- 80 Peptide Mapping by Sodium Dodecyl Sulfate-Polyacrylamide Gel Electrophoresis
- 81 Peptide Mapping by High-Performance Liquid Chromatography
- 82 Production of Protein Hydrolysates Using Enzymes
- 83 Amino Acid Analysis by Precolumn Derivatization with 1-Fluoro-2,4-Dinitrophenyl-L-Alanine Amide (Marfey's Reagent)
- 84 Molecular Weight Estimation for Native Proteins Using High-Performance Size-Exclusion Chromatography
- 85 Detection of Disulfide-Linked Peptides by HPLC
- 86 Detection of Disulfide-Linked Peptides by Mass Spectrometry
- 87 Diagonal Electrophoresis for Detecting Disulfide Bridges
- 88 Estimation of Disulfide Bonds Using Ellman's Reagent
- 89 Quantitation of Cysteine Residues and Disulfide Bonds by Electrophoresis
- 90 Analyzing Protein Phosphorylation
- 91 Mass Spectrometric Analysis of Protein Phosphorylation
- 92 Identification of Proteins Modified by Protein (D-Aspartyl/L-Isoaspartyl) Carboxyl Methyltransferase
- 93 Analysis of Protein Palmitoylation
- 94 Incorporation of Radiolabeled Prenyl Alcohols and Their Analogs into Mammalian Cell Proteins: A Useful Tool for Studying Protein Prenylation

- 95 The Metabolic Labeling and Analysis of Isoprenylated Proteins
- 96 2-D Phosphopeptide Mapping
- 97 Detection and Characterization of Protein Mutations by Mass Spectrometry
- 98 Peptide Sequencing by Nanoelectrospray Tandem Mass Spectrometry
- 99 Matrix-Assisted Laser Desorption/Ionization Mass Spectrometry for Protein Identification Using Peptide and Fragmentation Masses
- 100 Protein Ladder Sequencing
- 101 Sequence Analysis with WinGene/WinPep
- 102 Isolation of Proteins Cross-linked to DNA by Cisplatin
- 103 Isolation of Proteins Cross-linked to DNA by Formaldehyde

**PART VI : GLYCOPROTEINS [5 Assignments]**

- 104 Detection of Glycoproteins in Gels and Blots
- 105 Staining of Glycoproteins/Proteoglycans in SDS-Gels
- 106 Identification of Glycoproteins on Nitrocellulose Membranes Using Lectin Blotting
- 107 A Lectin-Binding Assay for the Rapid Characterization of the Glycosylation of Purified Glycoproteins
- 108 Chemical Methods of Analysis of Glycoproteins
- 109 Monosaccharide Analysis by HPAEC
- 110 Monosaccharide Analysis by Gas Chromatography (GC)
- 111 Determination of Monosaccharide Linkage and Substitution Patterns by GC-MS Methylation Analysis
- 112 Sialic Acid Analysis by HPAEC-PAD
- 113 Chemical Release of O-Linked Oligosaccharide Chains
- 114 O-Linked Oligosaccharide Profiling by HPLC
- 115 O-Linked Oligosaccharide Profiling by HPAEC-PAD
- 116 Release of N-Linked Oligosaccharide Chains by Hydrazinolysis
- 117 Enzymatic Release of O- and N-Linked Oligosaccharide Chains
- 118 N-Linked Oligosaccharide Profiling by HPLC on Porous Graphitized Carbon (PGC)
- 119 N-Linked Oligosaccharide Profiling by HPAEC-PAD
- 120 HPAEC-PAD Analysis of Monosaccharides Released by Exoglycosidase Digestion Using the CarboPac MA1 Column
- 121 Microassay Analyses of Protein Glycosylation
- 122 Polyacrylamide Gel Electrophoresis of Fluorophore-Labeled Carbohydrates from Glycoproteins
- 123 HPLC Analysis of Fluorescently Labeled Glycans
- 124 Glycoprofiling Purified Glycoproteins Using Surface Plasmon Resonance
- 125 Sequencing Heparan Sulfate Saccharides
- 126 Analysis of Glycoprotein Heterogeneity by Capillary Electrophoresis and Mass Spectrometry
- 127 Affinity Chromatography of Oligosaccharides and Glycopeptides with Immobilized Lectins

**PART VII : ANTIBODY TECHNIQUES[10Assignments]**

- 128 Antibody Production
- 129 Production of Antibodies Using Proteins in Gel Bands
- 130 Raising Highly Specific Polyclonal Antibodies Using Biocompatible

## Support-Bound Antigens

- 131 Production of Antisera Using Peptide Conjugates
- 132 The Chloramine T Method for Radiolabeling Protein
- 133 The Lactoperoxidase Method for Radiolabeling Protein
- 134 The Bolton and Hunter Method for Radiolabeling Protein
- 135 Preparation of <sup>125</sup>I Labeled Peptides and Proteins with High Specific Activity Using IODO-GEN
- 136 Purification and Assessment of Quality of Radioiodinated Protein
- 137 Purification of IgG by Precipitation with Sodium Sulfate or Ammonium Sulfate
- 138 Purification of IgG Using Caprylic Acid
- 139 Purification of IgG Using DEAE-Sepharose Chromatography
- 140 Purification of IgG Using Ion-Exchange HPLC
- 141 Purification of IgG by Precipitation with Polyethylene Glycol (PEG)
- 142 Purification of IgG Using Protein A or Protein G
- 143 Analysis and Purification of IgG Using Size-Exclusion High Performance Liquid Chromatography (SE-HPLC)
- 144 Purification of IgG Using Affinity Chromatography on Antigen-Ligand Columns
- 145 Purification of IgG Using Thiophilic Chromatography
- 146 Analysis of IgG Fractions by Electrophoresis
- 147 Purification of Immunoglobulin Y (IgY) from Chicken Eggs
- 148 Affinity Purification of Immunoglobulins Using Protein A Mimetic (PAM)
- 149 Detection of Serological Cross-Reactions by Western Cross-Blotting
- 150 Bacterial Expression, Purification, and Characterization of Single-Chain Antibodies
- 151 Enzymatic Digestion of Monoclonal Antibodies
- 152 How to Make Bispecific Antibodies
- 153 Phage Display: Biopanning on Purified Proteins and Proteins Expressed in Whole Cell Membranes
- 154 Screening of Phage Displayed Antibody Libraries
- 155 Antigen Measurements Using ELISA
- 156 Enhanced Chemiluminescence Immunoassay
- 157 Immunoprecipitation

## **PART VIII: MONOCLONAL ANTIBODIES[10Assignments]**

- 158 Immunogen Preparation and Immunization Procedures for Rats and Mice
- 159 Hybridoma Production
- 160 Screening Hybridoma Culture Supernatants Using Solid-Phase Radiobinding Assay
- 161 Screening Hybridoma Culture Supernatants Using ELISA
- 162 Growth and Purification of Murine Monoclonal Antibodies
- 163 Affinity Purification Techniques for Monoclonal Antibodies
- 164 A Rapid Method for Generating Large Numbers of High-Affinity Monoclonal Antibodies from a Single Mouse.

## **Elective 4: Electrophysiology**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

### **Unit I: Overview of Electrophysiology**

different electrical signals in human body. Potential of nerve – resting membrane potential–ionic basis. Nernst equation. Hodgkin-Huxley model. Goldman equation. Action potential- ionic basis, gating kinetics and physio-pharmacology of different ion channels. Voltage clamp studies, biphasic and compound action potential. Receptor potential- general transduction mechanism, stimulus–receptor relationship, adaptation of receptors.

### **Unit II: Electrophysiology of Heart, Brain & Muscle**

Electrocardiogram (ECG), source of ECG voltage – dipole theory, vector analysis of ECG, changes of ECG potential in different cardiac abnormalities myocardial ischemia and infraction, hypertrophy, different types of arrhythmias; Brain Potentials, Electroencephalogram (EEG), source and mechanism of formation of rhythmic pattern of EEG, characteristics of EEG waves. EEG pattern changes in sleep. abnormalities of EEG. Event related potential (evoked potential)- types, characteristics and significance; Electromyogram (EMG) – Motor unit potential, physiological significance and analysis of EMG.

### **Unit III: Electrophysiology of Visual & Auditory Sensory system**

Ultrastructure of retina. Photoreceptor potential – genesis of potential in light and dark phase, recording of potential. Molecular mechanism of phototransduction process. Electroretinogram (ERG) – characteristics, physiological and clinical significance. The visual system: Retinal neural circuitry, visual pathway, primary visual cortex – topographic map, organization of infruts. Effect of striate cortex lesions in primated spatio temporal organization of retinal and other visual neurons. Chromatic properties of retinal, LGB and striatal cortical neurons. Binocular and stereoscopic perception

Ultrastructure of cochlea. Resting and stimulus related potentials – endocochlear potential, cochlear microphone potential, summing potential, auditory nerve potential. The Auditory system: Sound transmission in auditory system. Organ of corti. Central auditory pathway. Descending auditory pathway. The primary and secondary auditory cortical areas. Functions of auditory system – frequency analysis of sound by cochlea and central auditory pathway. Intensity coding of auditory system. Perception of sound in space. Cochlear potentials.

### **Unit III: Electrophysiology of Olfactory & taste Sensory system**

Structure of olfactory receptor. Olfactory receptor potential – characteristics and molecular mechanism of transduction. Olfactory system: Organization of receptors in olfactory epithelium. Olfactory receptor potential. Olfactory pathways – olfactory bulb, central olfactory connections. Codibng of olfactory informations. Anosmia and dysosmia. Ultrastructure taste receptors – taste receptor potential – molecular mechanism of transduction. Taste system: Receptor organs – distribution, ultramicroscopic structure and innervations. Taste qualities. Receptor potential. Taste pathway. Sensory processing,. Abnormalities of taste.

### **Unit III: Electrophysiology of Sensory systems**

The Sensory system: Sensation and perception. Sensory receptor, coding of sensory modality, intensity, localization of sensation, central processing of somatic sensation – spinal cord, thalamus cerebral cortex. Somatosensory areas of cerebral cortex-topographic organization, columnar organization, effect of lesion of primary somatosensory area. Pain – CNS in modulation of pain.

### **Elective 5: -Practicals based on Electrophysiology**

#### **1. Amphibian based experiments**

1. Study of apparatus used for amphibian experiments.
2. Gastrocnemius muscle and Sciatic nerve preparation of frog.
3. Recording of simple muscle twitch (SMT).
4. To study the effect of temperature on SMT.
5. To determine conduction velocity of nerve impulse.
6. To study effect of load on SMT.
7. Effect of increase in strength of stimulus on skeletal muscle contraction.
8. Effect of two successive stimuli on SMT.
9. Effect of increasing frequency of stimulus on SMT.
10. Genesis of fatigue.
11. Recording of normal cardiogram.
12. To study the effect of temperature on normal cardiogram.
13. To study properties of Heart muscle—Autorhythmicity and Conductivity.
14. To study the properties – Refractory Period and Extra Systole (ES) of Heart Muscle.
15. To study All or None law and Staircase phenomenon.
16. Effect of Vagosympathetic Trunk and White Crescentic Line on heart muscle.
17. Effect of Vagal stimulation showing Vagal Escape.
18. To study the effect of drugs – Adrenaline and Acetylcholine.
19. To study the effect of drugs – Nicotine and Atropine.
20. Study of reflexes in Spinal and Decerebrate frog.
21. Capillary circulation in frog (Frog Web).
22. Perfusion of isolated heart of frog.
23. To demonstrate the phenomenon of reciprocal innervation in frog.
24. Oocyte Biophysics based electrophysiological experiments

#### **2. Human Experiments**

1. Phenomenon of human fatigue by Mosso's Ergograph and Hand Grip
2. Dynamometer.
3. Clinical examination and recording of Arterial Pulse.
4. Recording of Systemic Arterial BP and effect of posture and exercise.
5. Recording of 12 lead ECG
6. Plethysmography (Measurement of Blood Flow).
7. Stethography.
8. Vitalography.
9. Spirometry.



10. Measurement of BMR.
11. Cardiac Efficiency Tests.
12. Perimetry.
13. Auditory Function tests.
14. Clinical examination of abdomen
15. Clinical examination of respiratory system.
16. Clinical examination of CVS.
17. Clinical examination of Nervous System.
18. Examination of Higher Functions
19. Examination of Cranial Nerves.
20. Examination of Motor System.
21. Examination of Sensory System.
22. Reaction time (VRT & ART).
23. Electroencephalogram (EEG).
24. Autonomic Function Tests.
25. Neuro – electrodiagnostic tests.
26. Sensory and motor nerve conduction.
27. Visual Evoked Potential (VEP).
28. Auditory Evoked Potential (AEP).
29. Critical Fusion Frequency (CFF).
30. Cold Pressor Test (CPT).
31. Galvanic Skin Resistance.

### **3. Mammalian Experiments**

1. Record of movements of isolated Rabbit Intestine and effects of drugs and ions.
2. Perfusion of mammalian heart by Langendorff's Method and effect of drugs and ions.
3. Acquisition of data for various physiological parameters using various computational data acquisition system
4. Electrophysiological recording setup (EEG, ECG, EMG, EOG, Heart rate, respiration, pulse rate, heart sound, etc.)

## **Elective 5 : Cellular & Molecular Neurophysiology**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

### **Unit I Neurons**

Introduction to neurons; The Neuron Doctrine; Components of neurons; Classification of neurons; The Nissl and Golgi stains; Types of neurons; Cytology of neurons; Dendrites structure and function; Axons structure and functional aspects; Ultrastructure; Myelination and synapses. impregnation method; Structure and function of glial cells; Different types of glial cells: astrocytes, oligo dendrocytes and Schwann cells; Types of astrocytes – type I & II astrocytes, fibrous and protoplasmic astrocytes; Function of other glial cells: oligodendrocyte and microglial cells; Overview of glial and neuronal relationship in the CNS; Importance of astrocytes in glutamate metabolism and blood brain barrier; Microglial phenotypes; Glial –neuronal interplay in the CNS; Principles of fixation and staining of nervous tissue; Methods of tissue processing for microtomy, cryotomy and vibratotomy;

## **Unit II Biophysical basis of Neurophysiology**

Electrical properties of excitable membranes: Basic electricity and electric circuits; Neurons as conductors of electricity; Equivalent circuit representation; Electrical properties of excitable membranes: Membrane conductance, linear and nonlinear membrane, ionic conductance, current-voltage relations; Ion movement in excitable cells: Physical laws, Nernst-Planck Equation, active transport of ions, movement of ions across biological membranes; Membrane potential and role of sodium and potassium pumps

## **Unit III Neural Signals**

Neural Signals, Overview of Neurons, Synapses and Networks; Stimulus to Sensory Perception to Motor Action / Higher Brain Function; Chemical and Electrical Signaling Within a Circuit; Methods to Record Electrical Activity of a Neuron.

Action potential; Non-gated ion channels and generation of action potential; Electrical properties of neurons, quantitative models of simulations; Hodgkin & Huxley's analysis of squid giant axon: Voltage-clamp experiments; Voltage gated channels; Biophysical, biochemical and molecular properties of voltage gated channels.

## **Unit IV Synaptic transmission & Neurotransmission**

Synaptic vesicles; Principles of synaptic transmission: Electrical and chemical synapses; Calcium hypothesis: Control of transmitter release; Synthesis and trafficking of neuronal proteins. Synaptic transmission at nerve-muscle synapses; Synaptic transmission at central synapses; Ligand gated channels; Second messengers and synaptic transmission. Transmission of nerve impulse – resting and action potentials – Polarization, depolarization and repolarisation . Sodium/ potassium pump – Role of calcium. Chemical transmission

## **Unit V: Neurotransmitters & Neuromuscular Coordination**

neurotransmitters – types, synthesis and secretion of neurotransmitters, Receptors – adrenergic receptors and cholinergic receptors. Regulation of transmission. Enzymatic inactivation of neurotransmitters. Ach. Esterase – inhibitors – neuro toxins. Forces involved in ligand – receptor interaction; Neuromuscular transmission, reflex action and reflex arc. Regulation of body temperature. Interaction between sense organs and neurons.

### **Texts/References**

1. Squire, Fundamental Neuroscience, 3rd Edition, Elsevier, 2008.
2. Kendel, Principles of Neural Science, 4th Edition, McGraw Hill, 2000.
3. Mishra, Clinical Neurophysiology, 2nd Edition, Elsevier, 2006.
4. Duchene E. Haines, Fundamental Neuroscience for Basic & Clinical Applications, 3rd Edition, Churchill Livingstone, 2006.
5. Bear, Neuroscience-Exploring the Brain, Lippincott, 2007.

## **Elective 5: -Practicals based on Cellular & Molecular Neurophysiology**

### **Part A**

1. Study of the nerve cell: staining of neurons by cresyl violet and Nissl fast violet stain in the paraffin section of the spinal cord and cerebellum.
2. Study of central nervous system architecture by hematoxylin van Giessen method and Mallory's phosphotungstic acid hematoxylin method.
3. Experimental neuroanatomical studies:
  - a) Nauta – Laidlaw method / Marchi's method
  - b) Fink –heimer procedure.
  - c) Cupric silver method.
  - d) Rapid Golgi cox method / Bulchawosky method.
4. Tracing nerve tract horseradish peroxidase techniques.
5. Vital staining of nerve fibre by Methylene blue method.
6. Measurement of neurotransmitters:
  - a) Spectrofluometric method for measuring acetylcholine, epinephrine, norepinephrine, dopamine, serotonin in micro dissected brain regions of rats.
  - b) HPLC method for measuring neurotransmitter.
7. Electrocardiographic study in humans in resting and stress condition.
8. Electromyographic study in humans in different stages of sleep and awakefulness.
9. Electroencephalographic study in humans: Recording of EEG in humans in different stages of sleep and awakefulness.
10. Evoked potentials study in humans: Brainstem evoked potential and auditory evoked potential in humans.

### **Part B Neurochemistry**

1. Neurotoxicological studies using animal models
2. Study of developing rat nervous system
3. Normative and under exposure to toxic agents
4. Study of pathological tissue from different pathological conditions
5. Study of permanent slides
6. Visits to neurology and neurosurgery clinics
7. Histopathological methods for analysis of pathological tissues
8. Study of neurodegenerative models, e.g., nerve crush models

### **Part C**

1. Acquisition of data for various physiological parameters using various computational data acquisition system
2. Electrophysiological recording setup (EEG, ECG, EMG, EOG, Heart rate, respiration, pulse rate, heart sound, etc.)
3. To determine pain sensitivity in rat/mice using Tail-Flick Analgesia meter
4. To learn the use of Stereotaxic instrument for neuroscience research
5. Demonstration of basal metabolic rate
6. Effect of various neurotransmitters on fish melanophores
7. Pharmacological experiments on melanophores
8. Study of Physiology models related to neurophysiology

## Part D

1. Studies of blood pressure in humans:
  - a) Effect of posture changes on blood pressure and heart rate.
  - b) Effect of vestibular stimulation on blood pressure and heart rate
  - c) Valsalva maneuver.
2. Perimetry: visual field determination with different colours in perimeter in resting and stressful condition.
3. Audiometry: study of frequency threshold curve in humans.
4. Biofeedback: EMG biofeedback studies.
5. Study of galvanic skin response (GSR): Measurement of GSR in resting and different stressful condition.
6. Experimental of Chronobiology:
  - a. Recording of 24 hrs. body temperature of study circadian rhythm of body temperature.
  - b. Recording of heart rate to study circadian rhythm of resting heart rate.
7. Neuroimmunological studies: PMN assay, cytotoxic assay, PLN assay, phagocytotic assay in experimental animals in resting condition and after stress.
8. Training programme / Laboratory Visit: Students will submit a report on the basis of their visit /training in some advanced national laboratories such as NBRC. New Delhi: NIMHANS & NCBS Bangalore, AIIMS, New Delhi etc. as a part of their practical syllabus.

## Elective 6 : Clinical Biochemistry

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

### Unit I: Specimen Collection & Processing and Medical Lab management

**Collection of blood** vein puncture, collection with syringe, collection with evacuated tube, skin puncture, arterial puncture and anticoagulants.

**Collection of urine**:-Timed urine specimens, urine preservatives. Test for urinary compounds. Clinical significance of urinary components with reference to sugars, proteins, ketone bodies, bilirubin and porphyrins. **CSF**:- Composition and collection, chemical examination and infections, spinal cord infections. **Amniotic fluid**:- Origin, collection, composition and analysis of amniotic fluid.

Laboratory management and planning, Knowledge of maintenance and use of the following :Microscope, Automatic tissue processor, vacuum embedding bath, mictotomes (various types with working of each), hot plates, refrigerators, cryostat. Blood Bank refrigerators, Walking coolers, refrigerated centrifuge, incubators, ovens, autoclaves

### Unit II: Serology & Hematology and Histopathology

C- reactive protein test, immunological test for pregnancy. Rhumatoid arthritis (RA) test. ESR., Coagulation test, prothrombin test. **Hemoglobin**: Different methods of estimation of hemoglobin. Salient features and investigations for iron deficiency anemia megaloblastic anaemia and haemolytic anaemia. Peripheral blood smears. Leukaemias, Haemostasis, Haemorrhagic disorders. Normal and abnormal Hb, Separation of hemoglobin. Thalasemia, Hemoglobinopathies. Erythrocyte metabolic pathways, Disorder

of erythrocyte metabolic pathways, erythrocyte enzyme disorders. Porphyrins and porphyrias.

**Tissue processing** —details of paraffin embedding, vacuum embedding. Decalcification. Section cutting and different types of microtomes. Frozen section — uses and techniques. Staining procedures in Histopathology and haematology.

### **Unit III: Blood bank management & Clinical Enzymology**

Blood bank management and planning the receiving and recording of blood samples, indexing, Inheritance and nomenclature of ABO and Rh blood group systems, other blood group systems, Transfusion reactions—recognition and investigations. Criteria used while selecting a blood donor

*Principles of Diagnostic Enzymology, Factors affecting enzyme levels in blood. Principle, assay, and clinical significance of transaminases, creatine kinase, lactate Dehydrogenase, phosphatases, isocitrate dehydrogenase, 5' nucleotidase, gamma – glutamyl transferase, amylase, lipase, trypsin, chymotrypsin, choline esterase, glutamate dehydrogenase, glucose -6-phosphate dehydrogenase and ceruloplasmin.*

**Enzyme pattern in diseases:-** Myocardial infarction, hepatobiliary diseases. Enzymes in inborn errors of metabolism – Phenyl ketonuria, alkaptonuria, throsinosis, albinism, Hartnups disease, Galactosemia, Taysacch's disease, Niemann Pick's disease, Hunters syndrome, Lesh Nyham syndrome.

### **Unit IV: Organs Associated with Disease Diagnosis**

**Liver function test and related disorders:-** Jaundice, cirrhosis, hepatitis, fatty liver and gall stones. **Renal function test and related disorder:-** Acute renal failure. Glomerular disease, tubular diseases, urinary tract obstruction, analysis of urinary calculi. **Gastric and pancreatic function test:-** Hyper and hypo lipoproteinemias and diagnostic test for lipoprotein disorders.

### **Unit V: Cancer Biology**

**Oncology:-** Cancer markers for oral cancer. Prostate cancer, Colorectal cancer, breast cancer and gastrointestinal tract cancer. Alpha fetoproteins, carcino embryonic antigens, leukemia. Radioisotopes & their clinical applications.

**Free radicals in diseases:-** Introduction , Types of free radicals. Free radical induced lipid peroxidation and antioxidant enzymes – SOD, Catalase, GPX and GSHs.

#### **Text Books:**

1. Fundamentals of clinical chemistry – Teitz, W.B. Saunders company, 1994
2. Practical clinical biochemistry, volume I and II, 5th edition – Varley et al., CBS Publishers, 1980.
3. Clinical chemistry in diagnosis and treatment 6th edition – Mayne, ELBS Publications, 1994
4. Teitz text book of clinical biochemistry 3rd edition – Burtis et al., William Heinmann medical books, Ltd., 1999
5. Clinical biochemistry – Metabolic and clinical aspects, Pearson Professional Ltd. 1995
6. Clinical chemistry 5th edition – Mosby, Marshall, 2004
7. Clinical chemistry – principles, procedures and correlations, Bishop, Lippincott, 2000

### **Elective 5: -Practicals based on Clinical Biochemistry**

**I Estimation of the following in urine and serum**

1. Urea 2. Uric acid 3. Creatinine 4. Glucose 5. Calcium 6. Phosphorus 7. Chloride

**II Estimation of the following in serum**

1. Total protein 2. Albumin 3. Bilirubin 4. Total and free cholesterol 5. Total lipids  
6. Triglycerides 7. Phospholipids

**III Determination of the following enzymes in serum**

1. Acid phosphatase 2. Alkaline phosphatase 3. Aspartate amino transferase  
4. Alanine amino transferase 5. Lactate dehydrogenase

**IV Estimation of antioxidants in rat or goat liver**

1. Superoxide dismutase 2. Catalase 3. Vitamin E 4. Lipid peroxides

*Dr. Babasaheb Ambedkar Marathwada University,  
Aurangabad*

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

**Paper BPT-XIII-R: -Bioinformatics & Computational Biology.**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

**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 –EMB 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-13-R: Practicals based on Bioinformatics & Computational Biology.**

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.

### **Elective 3: Recombinant DNA Technology & Genetic Engineering**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

#### **Unit 1: Gene Cloning & Vectors**

Concept of gene cloning, Recombinant (Chimeric DNA) DNA, Steps in gene cloning. Restriction Endonucleases and generation of DNA fragments for cloning, Vector, properties of good vector, Plasmids, pBR322, pUC18119, pGEM32, Bacteriophage vectors:  $\lambda$  phage vectors, Phagmid vectors, Phasmid vectors, Artificial Chromosome Vectors, BAC, Fosmid vectors, Shuttle vectors, YAC vfectors, Vectors for animals & plant[PET expression system]

#### **Unit 2: DNA Sequencing & Genome Mapping**

Concept of Gene Library, C-DNA library, Methods for DNA sequencing, Genetic maps- Linkage maps, Cytogenetics map & Physical map. Concept & Application of Genetic Markers- Naked eye polymorphism (NEP), Protein based markers, DNA markers, Application of molecular markers. Linkage mapping of DNA markers- Restriction Fragment Length polymorphism (RFLP), Random Amplified Polymorphic DNAs (RAPDs), Amplified Fragment Length Polymorphism (AFLP), Sequence Tagged Sites (STSs), Linkage Mapping of RFLP markers, Map Based Cloning. VNTRS (Variable Numbers of Tandem Repeats), minisatellite & microsatellite, Simple Sequence Repeats & ribosomal DNA.

#### **Unit 3: Techniques in Recombinant DNA Technology**

Agarose gel electrophoresis & purification of DNA fragments, Chemical synthesis of gene, Enzymatic synthesis of DNA. PCR: Denaturation, PCR primers, annealing, primer extension, Types of PCR, RT-PCR, site directed mutagenesis using PCR, Overlap

extension PCR, Asymmetric PCR, Thermal Cycle Sequencing PCR, Nested PCR. Analysis of PCR products, Advantage & Limitations of PCR. Concept of blotting, blotting membranes, preparation & labeling of probes, Different types of blotting, Nucleic Acid blotting, Colony Hybridization, Dot-blot technique, Southern blotting, Northern blotting, Western blotting, Oligonucleotide Microarrays & DNA chips.

#### **Unit 4: Transgenics**

Transfection, Gene transfer methods in plant, Target cells for transformation, Vector based TI & Ri plasmid of Agrobacterium. Agrobacterium mediated transformation Physical delivery methods, DNA mediated gene transfer (DMGT) Chemically Stimulated DNA uptake by protoplast, microinjection, macro injection, microprojectile & electroporation. Chemical methods of DNA transfer, use of polyethylene glycol, Calcium phosphate, DEAE Dextrose, Use of polycation DMSO etc.

#### **Unit 5: Application of Genetic Engineering**

In Agriculture- Agrobacterium mediated transformation, Transgenic Plants (disease resistance, protein production, herbicide resistance) animal as bioreactor. In Medicine- Stem Cell Therapy, gene therapy in cystic fibrosis DMD, SCID, RNAi as a tool of gene therapy in Industry- Production of recombinant therapeutic proteins, eg: -insulin, erythropoietin factor VIII & IX Hepatitis & surface antigen, recombinant vaccine.

### **Elective 3: -Practicals based on Recombinant DNA Technology & Genetic Engineering**

- 1 Isolation and estimation of DNA, RNA and protein  
Isolation and purification of plasmid DNA- i. Mini preparation, ii. Purification by LMP agarose, iii. Purification using DE81 cellulose.
- 2 Preparation and transformation of competent E.coli, Restriction enzyme analysis- restriction mapping
- 3 Agarose gel electrophoresis and PAGE of DNA and RNA – Southern blotting – RFLP analysis
- 4 Gene cloning- cloning a DNA fragment in Blue script vector. Blue White selection of transformed colonies
- 5 Characterization of transformants:  
i. Complementation, ii. Insertional inactivation, iii. Screening by hybridization.
- 6 Isolation of DNA from bacteriophage  
Isolation, estimation and restriction analysis of phage DNA., Preparation of helper phage and its titration., UV survival curve, Dark repair of UV mutation.
- 7 Extraction, Purification and analysis of RNA  
i Isolation of total RNA, ii. Isolation of cytoplasmic RNA, iii. Electrophoresis of RNA on denaturing gels
- 8 DNA sequencing, mutagenesis and engineering genes PCR and RAPD



**Paper BPT-XV-R: - Third Elective [B-I] [One from the Following]**

**Paper BPT-XVI-R: -Fourth Elective[B-II] [One from the Following]**

**Elective 1 : -Medical Biophysics.**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

**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 imaging, Ultrasonography.

**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), Radio pharmaceuticals & their Diagnostic applications.

**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, Paliative & 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.

### **Elective 1: -Practicals based on Medical Biophysics.**

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.
  - a) Beam collimation and alignment.
  - b) Electron contamination of beam.
  - c) Electron build up in the wall of Dosimeter.
  - d)
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).
17. Assignments on various aspects using signal acquisition systems. AD Instruments-LAB Tutor and other protocols

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.

## **Elective 2:- Environmental Biophysics.**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

### **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 background 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.

## **Elective 2: -Practicals based on Environmental Biophysics.**

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.

## **Elective 4 :- Bioelectronics and Medical Instrumentation.**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

### **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 Resistors, 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.

### **Elective 4: -Practicals based on Bioelectronics and Medical Instrumentation.**

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.

### **Elective 4: Neurobiophysics**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

#### **Unit I-Neuroanatomy:**

Central nervous system – components; Peripheral nervous system – Autonomous nervous system– Sympathetic and parasympathetic. Morphology of the brain and spinal cord. Development and growth of nervous system. Principles of cellular organization in the nervous system and population of cells. Structure and function of the nervous tissue. Types of neurons Functional groups of neurons, neuron circuits and neuroglia cells. CSF.

Synaptic cleft and neuromuscular junction. Spinal cord, internal structures, spinal nerves, cytoarchitectural lamination, dorsal root afferents, spinal tracts, Brain and its gross anatomy: cerebral hemispheres, basal ganglia, brain stem. Pons. Thalamus, hypothalamus, cerebellum, medulla, corpus striatum and related nuclei, hippocampal formation, mygdala and olfactory pathways, cerebral, cerebellar and cerebrospinal tracts, meninges.

### **Unit II-Electrophysiology:**

Origin of membrane potential, Role of Na/K pump and leak channel, recording of membrane potential, Nerve action potential: initiation and propagation. Role of Voltage gated channels in conductance of ion during action potential, Synapses, physiology of chemical, Synapses, neurotransmitters, excitatory and inhibitory postsynaptic potentials, synaptic summation and facilitation. Electrical characteristic of skeletal muscles electromyography and electroencephalography ;Somatic Sensation- Sensory receptors and their basic mechanism of action. Tactile and position sensation pathway for transmission to CNS. Somatic sensory cortex. Characteristics of transmission, pain, Headache and Thermal sensation. Special Senses: Photochemistry of vision, colour vision, neurophysiology of vision. The sense of hearing.

### **Unit III- Motor Mechanisms:**

Cortical and Brain Stem Control of Motor function, control of posture and movement, reticular formation and support of the body against gravity, vestibular system and maintenance of equilibrium structure and function basal nuclei. Concept of pyramidal and extrapyramidal system, motor functions of cerebellum, Sensory control of motor functions. Basal ganlia and its function.

### **Unit IV- Cerebral Cortex and Intellectual Functions of Brain**

Functional organization of the cerebral cortex, functions of specific cortical areas, learning conditioned reflexes, thoughts, consciousness and memory, consolidation of memory, intercortical transfer of learning, drugs that facilitate learning functions of neocortex, aphasia and allied disorders, cerebral dominance, frontal and temporal lobe in higher functions.

### **Unit V-Neurophysiologic basis of behavior & Neural Centers regulation**

Neurophysiologic basis of behavior: Limbic system and hypothalamus, regulation of biologic rhythms, sexual behavior, fear and range, motivation, mechanism of sleep, Wakefulness and self stimulation.

Tools in electrophysiological studies of the brain in animals; Animal activity monitoring; Different types of mazes and their application in studies on behavior, learning and memory and cognitive aspects of animals; Rotarod; Grip strength meter; Pain sensitivity testing with the help of tail-flick instrument and paw test..

Neural Centers regulating visceral functions: Medulla oblongata in control of respiration heart rate and blood pressure, medullar, autonomic reflexes, hypothalamus and its relation to autonomic functions, Autonomic nervous system, basic characteristics of sympathetic and parasympathetic function, Chemical transmission of autonomic nerve

endings, the autonomic reflexes.

**Reference Books:**

1. Core Text Book of Neuroanatomy by Carpenter, MB
2. Test Book of Medical Physiology by AF Guyton
3. The Human Nervous System- Basic Principles of Neurobiology by Charles R. Noback and Robert J. Demarest.
4. Physiology by Ganong.
5. Principle of neuro science by Kandel, Shwartz
6. John A. Kiernan, Barr's the Human Nervous System, 7th Edition, Lippincott-Raven, 1998.
7. Richard S. Snell, Clinical Neuroanatomy for the Medical Students, 5th Edition, Lippincott-Williams & Wilkins, 2001.
8. Susan Standring (Editor-in-Chief), Gray's Neuroanatomy: The Anatomical Basis of Clinical Practice, 39th Edition, Elsevier, 2005.
9. M.J.T. Fitzgerald, Clinical Neuroanatomy & Related Neuroscience, 4th Edition, CRC Press, 2000.
10. Water, J. Hendelman, Atlas of Functional Neuroanatomy, 2nd Edition, CRC Press, 2006.
11. Sanes, Development of the Nervous System, 2nd Edition, Academic Press, 2006.
12. Squire, Fundamental Neuroscience, 3rd Edition, Elsevier, 2008.
13. Kandel, Principles of Neural Science, 4th Edition, McGraw Hill, 2000.
14. Gilbert, Developmental Biology, 7th Edition, Sinaur Publication, 2006.
15. Siegel et al., Basic Neurochemistry, 6th Edition, Lippincott -Williams-Wilkins, 1999
16. Kandel et al., Principles of Neural science, 4 Edition, McGraw-Hill Medical, 2000.
17. Zegmond, Fundamentals of Neuroscience, 1st Edition, Academic Press, 1999
18. Bear: Neuroscience: Exploring the Brain, 2nd edition, Lippincott Williams & Wilkins, 2001

**Elective 4: -Practicals based on Neurobiophysics**

**Part A**

1. Experimental electrical stimulation in animals (rat/cat): Study of electrical stimulation of different portion of brain, by electrical stimulation and observation of changes in muscle tone, behaviour, heart. rate, respiration, blood pressure. Evaluation of electrolytic lesion.
2. Experimental chemical stimulation of brain: Microinjection of acetyl choline, epinephrine, nor-epinephrine, serotonin, histamine, kainic acid in different regions of brain and cerebral ventricles and study of changes in physiological parameters.
3. EEG and ECoG in experimental animals: Recording of spontaneous electrical activity of surface and deeper parts of brain of experimental animals in acute and chronic condition. Effect of stimulant and depressive drugs on ECoG.
4. Evoked potential study in experimental animals Recording of auditory and visual evoked potential in rats.
5. Study of experimental epilepsy rat.
6. Behavioural study in experimental animals:

- a) Exploratory behaviour in open field
  - b) Exploratory behaviour in hole board
  - c) Light dark transition test.
  - d) Active social interaction test.
  - e) pento barbital sleeping time
  - f) Maze tests
7. Locomotor movements in rats: Recording of locomotor movements in rats by Kymograph at rest and after injection of stimulant drug.
8. Study of neuroendocrine functions:
- a) Effect of stress on estrous cycle, ovary, adrenal, thyroid, pineal.
  - b) Effect of lesion of different neural structure of endocrine function.
9. Studies of blood pressure and heart rate in experimental animals:
- a) Effect of bilateral carotid occlusion on blood pressure and heart rate in cats.
  - b) Effect of stimulation of medullary pressure area on heart rate and blood Pressure

**Part B**

1. Steriotaxic technique lesioning of a specific brain area.
2. EEG recording of normal human subject in different states by multichannel recorder (BIOPAC).
3. Assessment of autonomic status by orthostatic tests and 15:30 ratio and E:I ratio.
4. Determination of Vo<sub>2</sub> max by Queen's college test.
5. Determination of hearing threshold by audiometer.
6. Estimation of physiological active substance by HPLC.
7. ECG recording and interpretation
8. Determination of percentage of body fat and desired body weight
9. Estimation of Acid phosphates from rat testis.
10. Measurement of hormone by ELISA techniques

**Part B Behaviour Biology**

1. Automated exploratory behaviour recording using activity monitor
2. Assessment of neuromuscular function/performance using Grip Strength Meter
3. Studies on locomotory behaviour in rats
4. Studies on learning behaviour using T-maze
5. Studies on locomotory development like: pivoting, traversing, homing, etc.
6. Exploratory behavior of young and old rats
7. Maternal behaviour in rats and mice
8. Chemoreception in butterflies and houseflies
9. Avoidance behaviour in cockroach
10. Behaviour patterns in honeybee
11. Geotropism and phototropism
12. Nesting behaviour in birds
13. Study of museum specimens for adaptations



## **Elective 5: Molecular Modeling & drug Designing**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

### **Unit I Quantum mechanics and concepts in molecular modeling:**

Concepts of Molecular Modeling, Coordinate System: Cartesian and Internal, Surfaces, Potential Energy Surfaces, introduction to quantum mechanics, postulates, Schrodinger wave equation, hydrogen molecule, Born-Oppenheimer approximation, Molecular Graphics and Structure visualization, Applications of Molecular Graphics in Molecular Modeling.

### **UNIT II: Force Fields, Molecular mechanics & Energy Minimization**

Force Fields. Molecular mechanics and Quantum mechanics, Empirical force field models, thermodynamics properties using a force field, Features of Molecular mechanics force fields. Bond Stretching. Angle Bending. Torsion terms, Introduction to Non-bonded Interactions. Electrostatic Interactions. Van der Waals Interactions. and Local and Global energy minima. Hydrogen Bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water.

Energy Minimization and Related Methods for Exploring the Energy Surface, Energy minimization by Systematic search, derived and non derived energy minimization method, 1st and 2nd order minimization methods, simplex – sequential univariate method, steepest descent method, conjugate gradient method, Newton-Raphson method, Applications of energy minimization,

### **Unit IV Molecular Dynamics & Monte Carlo Simulation**

Introduction, Using single Model, time steps, Multiple steps, Setting up MD, energy conservation in MD Simulation Examples – Monte Carlo – Random number generation. Molecular Dynamics Simulation Methods. Molecular Dynamics Using Simple Models. Molecular Dynamics with Continuous Potentials. Molecular Dynamics at Constant Temperature and Pressure. Metropolis Method, Methods and simulations, Monte Carlo Simulation of Molecules, Models Used in Monte Carlo Simulations of Polymers. Molecular Modeling software: BIOSUITE, Conformational Search Computer Simulation Methods. Simple Thermodynamic Properties and Phase Space. Boundaries. Analyzing the Results of a Simulation and Estimating Errors. GROMACS and CNS. Difference between Molecular dynamics and Monte Carlo method

### **UNIT V: Structure Prediction and Drug Design**

Sequence Alignment. Constructing and Evaluating a Comparative Model, Introduction to Comparative Modeling. Homology modeling: Comparative modeling of proteins, comparison of 3D structure, Homology- steps in homology modeling, tools, databases, side chain modeling, loop modeling. Protein Structure Prediction, Predicting Protein Structures by 'Threading', Modeling Drug – Receptor Interaction-Molecular Recognition by Receptor and Ligand Design, Ligand-Receptor Interaction, Binding site properties, Ligand Binding Prediction, The pharmacophore concept, Binding Energy, Aqueous and Nonaqueous Solvent models.

Drug design: General approach to discovery of new drugs, lead discovery, lead modification, physicochemical principles of drug action, drug stereo chemistry, drug action, Structure based De Novo Ligand design, Chemo informatics – QSAR, 3D database

search, computer aided drug design, molecular modeling in drug design – Molecular Docking, AUTODOCK and HEX., structure based drug design, pharmacophores, QSAR

## **Elective 5: -Practicals based on Molecular Modeling & Drug Designing**

1. Model building of Biomolecules using CHEM SHETCH
2. Structural Analysis of Protein/Nucleic Acids
3. Conformational parameters for oligosaccharides/ polypeptides
4. Homology modeling using SWISS-PDB
5. Energy minimization for protein/ carbohydrates – Schrödinger software
6. Molecular Dynamics for Protein/carbohydrates - Schrödinger software  
QSAR/STRUCTURE BASED DRUG DESIGN
7. Docking and binding site analysis - Schrodinger software
8. Combinatorial Screening of small molecules database – GOLD, ZINC
9. CORINA and SMILES for target molecule
10. Quantitative structure activity relationship and QSAR equation - Schrödinger software
11. Hydrogen bond interaction for Protein-Lead complex - Schrödinger software
12. Structure based inhibitor design - Molecular mechanics and Molecular dynamics calculation for Protein ligand (inhibitor) complex - Schrödinger software
13. Molecular Modeling and drug designing practical assignments using conventional latest softwares/freewares

### **Reference Books:**

1. A.R. Leach, Molecular Modelling Principles and Application, Longman, 2001.
2. J.M. Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
3. Satya Prakash Gupta, QSAR and Molecular Modeling, Springer-Anamaya Publishers, 2008.
4. Allan Hinchcliffe, Molecular Modeling for Beginners, Wiley Publisher, 2003
5. N. Claude Cohen, Guidebook on Molecular Modeling in Drug Design, Academic Press, 2006
6. R.K. Prasad, Quantum chemistry, Halsted Press, 2002.

## **Elective 6 : Genomics & Proteomics**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

### **Unit I Overview**

Research areas and related journals in genomics and proteomics - Concepts of central dogma – Structure and organization of prokaryotic & eukaryotic genome – Changes and regulation of genome activity in prokaryote and eukaryote - Brief outlook of various genome projects and their outcomes - Human genome project

## **Unit II Genome mapping and sequencing**

Mapping techniques – Genetic markers – RFLP, SSLP, STRs, VNTRs – Physical markers – EST, STS, FISH, SNP - Radiation hybrids – Mapping resources - Sequencing methods: chemical and enzymatic method - High throughput method –Automated sequencing methods – Whole genome shotgun sequencing method

## **Unit III Sequence assembly and annotation**

Assembly of contiguous DNA sequence - shotgun, directed shotgun and clone contig approach - Genomic DNA library – cDNA library – Primer walking, Chromosome walking, Chromosome jumping – Tools for sequence assembly - Structural and functional genomics - Transcriptome and Microarray approach — Comparative genomics - Population genomics – Pharmacogenomics

## **Unit IV Proteomics**

Introduction to proteome – Proteome and technology – Information and the proteome – Importance of 2D Electrophoresis in proteomics - Protein identification in proteome projects - Primary and secondary attributes for protein identification –Cross species protein identification – Detection and analysis of co- and post-translational modification

## **Unit V Proteome databases**

Protein sequence databases - SWISS-PROT and TrEMBL – Pattern and profile databases – PROSITE and BLOCKS - 2D PAGE databases – Structure databases - PDB- Metabolic databases – post translational modification databases – Application of proteomics to medicine, proteomics, toxicology and pharmaceuticals

### **Text Books:**

1. T.A. Brown, Genomes, 2nd edition, BIOS Scientific Publishers Ltd, 2002.
2. Marc R. Wilkins, Keith L. Williams, Ron D. Appel and Denis F. Hochstrasser  
Proteome Research: New Frontiers in Functional Genomics, Springer, 1997.

### **Reference books:**

1. Greg Gibson, Spencer V. Muse, A primer of genome science, Sinauer associates Inc.Publishers, 2002.
2. David W. Mount, Bioinformatics: sequence and genome analysis, 2nd edition, CBS publishers, 2004.
3. Pennington, Proteomics from protein sequence to function, 2nd edition, Viva Books Ltd, 2002.

## **Elective 6: -Practicals based on Genomics & Proteomics**

1. Approximately 45 Practical assignments designed/downloaded from Internet elucidating skills of computational methods in genome, transcriptome and proteome analysis the area of genomics and proteomics to be useful in research are to be performed. A through proficiency in gene, genome, transcriptome and proteome analysis through computational methods to be acquired
2. Approximately 15 Practical assignments designed/downloaded from Internet to know well about the genome features of prokaryote and eukaryote and develop sequence analysis tools based on any genome and proteome feature.

## **Elective 7 :Microarrays & Data Analysis**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

### **Unit I**

Introduction to Microarrays-making microarrays-Spotted microarray - insitu microarray- Microarray technologies - Affymetrix technology – mask less photodeprotection technology, Using microarray – Steps needed to measure gene expression in a sample.

### **Unit II**

Oligonucleotide probes – filtering of low complexity sequence – prediction of cross hybridization to related genes – thermodynamics of nucleic acid duplexes – Prediction of melting temperatures.

### **Unit III**

Image feature extraction – Identifying the positions of the features - Identifying the background pixel Normalization – Data cleaning and transformation – Within array normalization – Linear and non linear regression of log ratio against average density.

### **Unit IV**

Calibration experiments – Classical parametric statistics – T tests – Non-classic parametric test -One way annova

### **Unit V**

Microarray standard and databases: LIMS – Local data warehousing - MGED - MAGE – Minimal information about a microarray experiment - Microarray sequence databases – primary and secondary databases

**Text Book:** Dov Stekel “Microarray Bioinformatics” Cambridge university press, 2005

## **Elective 7: -Practicals based on Microarrays & Data Analysis**

1. Approximately 45 Practical assignments designed/downloaded from Internet elucidating how microarray technology works, including the various types, and analyze data sets that are produced by microarrays, including the following steps: image processing, normalization, differential expression analysis and gene clustering to be preformed.
2. Approximately 15 Practical assignments designed/downloaded from Internet to be revealed and analyzed to understand the primary literature on gene expression networks (genetic networks) and will be able to analyze data sets and design simple gene regulatory networks for a few genes and assess its performance.

## **Elective 8: IPR, Biosafety & Bioethics**

*[Total Marks: 50] [Exam Duration: 3 hrs] [Total Workload: 60 hrs]*

### **Unit I : Introduction to Intellectual Property**

Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies

## **Unit II :Agreements and Treaties**

History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments

## **Unit III : Basics of Patents and Concept of Prior Art**

Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees Invention in context of “prior art”; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, esp@cenet(EPO), PATENT Scope(WIPO), IPO, etc.)

## **Unit IV : Patent filing procedures**

National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting—disclosure/non-disclosure; Financial assistance for patenting-introduction to existing schemes, Patent licensing and agreement Patent infringement- meaning, scope, litigation, case studies

## **Unit V :Biosafety**

Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines- Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including; Cartagena Protocol. Bioethics- Ethical implications of biotechnological products and techniques. Social and ethical implications of biological weapons.

### **Texts/References:**

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007

### **Important Links:**

<http://www.w3.org/IPR/>

<http://www.wipo.int/portal/index.html.en>

[http://www.ipr.co.uk/IP\\_conventions/patent\\_cooperation\\_treaty.html](http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html)

[www.patentoffice.nic.in](http://www.patentoffice.nic.in)

[www.iprlawindia.org/](http://www.iprlawindia.org/) - 31k - Cached - Similar page

<http://www.cbd.int/biosafety/background.shtml>

<http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm>

<http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html>

## **Elective 6: -Practicals based on IPR, Biosafety & Bioethics**

1. About 25-30 Case studies to be revealed and analyzed emphasizing the procedural aspects of IPR, biosafety & bioethics.
2. About 15-20 practicing mock exercises to be performed

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

1. Ackerman E.A. Ellis, L.E.E. & Williams L.E. (1979), Biophysical Science, Prentice-Hall Inc.
2. Barrow. C. (1974), Physical Chemistry For Life Sciences, McGraw-Hill.
3. Berns M.W. (1982), Cells, Holt Sounders International Editors.
4. Bloomfield V.A. and Harrington R.E. (1975), Biophysical chemistry, W.A.Freeman and CO.
5. Bulter I.A.V. And Noble D.Eds. (1976), Progress in Biophysics and Molecular Biology (all volumes) pergamon, Oxford.
6. Cantor C.R. and Schimmel P.R. (1980), Biophysical chemistry, W.A.Fremman and Co.
7. Casey E.J. (1967), Biophysics, concepts and mechanisms. Affiliated East west press.
8. Chang R. (1971), Basic principles of spectroscopy, McGraw-Hill.
9. Crabbe P. (1972), ORD and CD in chemistry and biochemistry, Academic Press.
10. De Robertis E.D.P. and De Robertis E.M.P. (1981), Essentials of cell and molecular Biology, Holt sounders International Editions.
11. Dickerson R.E.& Geis I. (1972), Proteins: structure, function and evaluation, Benjamin.
12. Dugas H. and Penney C. (1981), Bioorganic chemistry, Springer-Verlag.
13. Fleischer S. Hatefi Y. McLennan D.H. and Tzagoloff A. (1977), The molecular biology of Membranes, Plenum press.
14. Haschemyer R.N. and Haschemyer A.E.B.V. (1973), Proteins, John willey and sons.
15. Hughes W. (1979), Aspects of Biophysics, John willey and sons.
16. Jain M.K. and Wanger R.C. (1980), Introduction to Biological Membranes, John willey and sons.
17. James T.L. (1975), Nuclear Magnetic Resonance in Biochemistry, Academic press.
18. Lehninger A. (1981), Biochemistry, Butter Worth Publication.
19. Pesce A.J., Rosen C.G and Pasty T.L., Fluorescence Spectroscopy: An introduction for Biology and Medicine, Marcel Dekkar.
20. Pullman B. (1978), Molecular Association in Biology, Academic Press.
21. Quagliokiello E., Palmieri F. and singer, T.P. (1977), Horizons in Biochemistry and Biophysics (all volumes) Addison Wesley Publishing Company.
22. Quinn P.J. (1984), The Molecular biology of cell Membranes, Macmillan.
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.
25. Segel F.H. (1975), Enzyme Kinetics, John willey and sons.
26. Setlow R.B. and pollard E.L. (1962), Molecular Biophysics, Pergamon Press.
27. Sheelk P. and Birch D.E. (1983), Cell Biology Structure, Biochemistry and function, John willey and sons.
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.
30. Stryer L. (1981), Biochemistry, W.A. Freeman and Co.
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, Addison-Wesley.
35. Cameron J. R. and skofronick J.G. (1978), Medical Physics, John willey and sons.
36. Casarett A.P. (1968), Radiation Biology, Prentice-hall Inc.
37. Castellan A. and Querela I.F. (1979), Synchrotron Radiation, Applied to Biophysical and Biochemical Research, Plenum Press.
38. Clause W.D. (1958), Radiation Biology and Medicine, Addison-Wesley.
39. Eisen H.N. (1980), Immunology, Harper and Row publishers.
40. Geides A. (1979), Electrodes and Measurements of Bioelectric events, John Willey and sons.
41. Grosch D.S. (1979), Biological effects of Radiation, Academic Press.
42. Guyton A.C. (1981), Textbook of Medical Physiology, Saunders co.
43. Horrocks D.L. (1971), Organic and liquid scintillation counting, Academic Press.
44. Howard L. A. (1974), Radiation Biophysics, Prentice Hall Inc.
45. Knoll G.E.(1979), Radiation detection and measurement, John willey and sons.
46. Martin A. & Harbisan S.A. (1982), An introduction to Radiation Protection, Chapman and hall Publication.
47. Moorse B.M., Panker R.P. and Pullman B.R. (1981), Physical aspects of medical imaging, John willey and sons.
48. Banks S.M. (1983), Photosynthetic system: structure function and symmetry, John willey and sons.
49. Rahatgee K.K. (1978), Fundamentals of photochemistry, John willey and sons.
50. Roit I.M. (1977), Essential immunology, Blackwell scientific Publication, Oxford.
51. Ruch J. and Patton H.D. (1973), Physiology and Biophysics (all volumes), W.B. sounders co.
52. Dhurnburn C.C. (1972), Isotopes and Radiation in Biology, Butter worth and Co.
53. Vince-Paupe D. (1975), Photoperodism in plants, McGraw Hill
54. Wilkum C.B. (1966), Fundamentals of immunology, Interscience publishers.
55. Old R.W., Primriose S.B. (1980), Principles of gene manipulation (An introduction to genetic Engineering), Blackwell sciences.
56. H.Gutfreund (1972), Enzymes-Physical principles, John willey and sons.
57. David M.Gates (1981), Biophysical Ecology, Springer-verlag.

58. Geoffrey L. Zubay, William W. Parson, Dennis E. Vance. (1995), Principles of Biochemistry, Wm.c.Brown Publishers.
59. Sambrook and Russell (2001), Molecular cloning (A laboratory Manual) cold spring Harbor Laboratory Press.
60. Henry B. Bull (1971), An Introduction to physical biochemistry, F.A.Devis Co.
61. Gerald Karp (1996), Cell and Molecular biology concepts and experiments, John willey and sons, Inc.
62. Beniamin Lewin (2000), Gene-VII. Oxford Uni. Press.
63. Beniamin Lewin (1994), Gene-V. Oxford Uni. Press.
64. Loewy Sickevitz, Menninger, Gallant (1991), Cell structure and function, Sounders college pub.
65. Laszlo, Patthy (1991), Protein Evolution, Blackwell science.
66. Christopher H. Wharton, Robert Elsenthal A.B. (1981), Molecular Enzymology Thomson Litho ltd.
67. Nicholas C. Price, Lewis Stevens (1999), Fundamentals of Enzymology (The cell and Molecular Biology of catalytic proteins), Oxford University.
68. Jean Brachet (1985), Molecular cytology, Academic press.
69. Hans Netter (1969), Theoretical Biochemistry, Oliver and Boyd, Springer-verlag Press.
70. Carl Branden and John Tooze (1991), Introduction to protein structure, Garland publishing, Inc.
71. Myron L. Bender, Raymond J.Bergeron, Makoto Komlyama (1984), The Bioorganic chemistry of Enzymatic catalysis, John willey and sons.
72. David Freifelder (1987), Molecular Biology, Narosa Publishing house.
73. Thomas E. Creighton (1994), Proteins: Structure and Molecular properties, W. A. Freeman and co.
74. M. Satake, Y.Hayashi, M.S. Sethi & S.A.Iqbal (1997), Biophysical chemistry, Discovery publishing house.
75. N. B. Strazhevskaya (1972), Molecular Radiobiology, John willey and sons.
76. Rogor L.Miesfeld (1999), Applied molecular genetics, John willey and sons.
77. C.Edward Gasque (1992), A manual of lab. Experience in Cell biology, Universal stall.
78. F. Heinmets (1970), Quantitative Cellular Biology, Marcal Dekker, Inc.
79. Ernst L. Winnacker (1987), from gene to clones. Introduction to gene. Technology.
80. Daniel L. Hartl (1995), Essential genetics, Jones and Barlett Publishers.
81. Bernard R. Glick and Jack J. Pastermak: (1994), Molecular Biotechnology Principles and Applications of Recombinant DNA.
82. C. Kalidas (1996), Chemical Kinetics Method (Principle of Relaxation Techniques and applications).
83. Malcolm Dixon, Edwin C. Webb & C.J.R Thorne K.F. (1964), Enzyme, Academic press.
84. B.I.Kurganov, Trans.by R.F.Brookes, Ed. By V.A. Yakoves (1982), Allosteric enzymes, John willey and sons.
85. G. Rickey Welch (1996), The Fluctuating Enzyme, John willey and sons.



86. Clearance H. Suelter (1985), A practical guide to enzymology, John Willey and sons.
87. Robert K. Scopes (1994), Protein Purification Principles and practice, Narosa Pub. House.
88. Stanley R. Maloy (1983), Experimental techniques in bacterial genetics, John and Bartlett pub.
89. Victor Arena, Ionizing Radiation and life.
90. B.L. Diffey (1989), Radiation Measurement in photobiology, Academic press.
91. T. Kobayashi (1987), Primary Processes in photobiology, Springer-verlag.
92. D. M. Weir (1967), Immunochemistry, Handbook of Experimental immunology vol-I, Blackwell Scientific publishing house.
93. K.G. Zimmer, Trans by H. D. Griffith (1961), Studies on Radiation Biology, Oliver and Boyd.
94. V. A. Bernstam (1997), V.YA. Alexandrov: Cells, Molecule and temperature, Springer-verlag.
95. M. M. Rehani (2000), Advances in Medical physics, Jaypee Brothers.
96. B.R. BAIRI, B.Singh, N.C.Rathod, P.V. Narurkar (1994), Handbook of nuclear medicine instrumentation. Tata McGraw Hill.
97. J. Roberts and D.G Whitehouse (1976), Practical plant physiology, Longman.
98. H. H. Perkampus (1992), UV-VIS Spectroscopy and Its applications, Springer-Verlag.
99. Felix Franks (1985), Biophysics and Biochemistry at low temperature, Cambridge University Press.
100. Alan Johnston and Robin Thorpe (1982), Immunochemistry in practical, Blackwell science.
101. Garry D. Christian, James E.O'reilvy (1986), Instrumentation analysis, Alien and Bacon, Inc.
102. Ryo Sato, Yasuo Kagawa (1982), Transport and Bioenergetics in Biomembrane, Japan Scientific Societies Press.
103. Clarsson I., M. Moller (1990), The plant Plasma Membrane (Structure, function and molecular biology), Springer-verlag.
104. Jürgen Kiefer (1990), Biological Radiation Effects, Springer-verlag.
105. Bernard Pullman (1978), Proteins in physicochemical Biology, Academic Press.
106. A.Kotyck, K. Janacek and J. Koryta (1988), Biophysical chemistry of membranes functions, John Wiley and sons.
107. E. Edward Bittar (1980), Membrane structure and function, John Wiley and sons.
108. N. Lakshminarayanan (1984), Membrane Structure and function, John Wiley and sons.
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