

**PERIYAR E.V.R. COLLEGE,(AUTONOMOUS)**

**TIRUCHIRAPPALLI-620023**



**P.G. AND RESEARCH DEPARTMENT OF ZOOLOGY**

**M.Sc., ZOOLOGY**

**SYLLABUS**

**2018-2021**

**PERIYAR E.V.R.COLLEGE (AUTONOMOUS), TRICHIRAPPALLI-620 023.**

**MCBCS- COURSE PATTERN FOR M.Sc., ZOOLOGY – 2018-2019 Onwards**

Sl. No	PART/ CODE	COURSE	COURSE TITLE	Hrs	Credits	Int. Exam	Ext. Exam	Total
<b>I-SEMESTER</b>								
1	18PZO1C1	CORE-I	Animal Biodiversity and Conservation	6	5	25	75	100
2	18PZO1C2	CORE-II	CellBiology	6	5	25	75	100
3	18PZO1C3	CORE-III	Microbiology	6	4	25	75	100
4	18PZO1C4	CORE-IV	Molecular Genetics	6	4	25	75	100
5	18PZO1P5	CORE-V-P	Practical-I-(Core-I,II,III,IV)	6	4	40	60	100
<b>TOTAL</b>				<b>30</b>	<b>22</b>	<b>140</b>	<b>360</b>	<b>500</b>
<b>II-SEMESTER</b>								
6	18PZO2C6	CORE-VI	Animal Physiology	6	5	25	75	100
7	18PZO2C7	CORE-VII	Developmental Biology	6	5	25	75	100
8	18PZO2C8	CORE-VIII	Gene Technology	6	5	25	75	100
9	18PZO2C9	CORE-IX	Biostatistics and Bio-Informatics	6	4	25	75	100
10	18PZO2P10	CORE-X-P	Practical-II-(Core-VI,VII,VIII,IX)	6	4	40	60	100
<b>TOTAL</b>				<b>30</b>	<b>23</b>	<b>140</b>	<b>360</b>	<b>500</b>
<b>III-SEMESTER</b>								
11	18PZO3C11	CORE-XI	Biophysics and Biochemistry	6	5	25	75	100
12	18PZO3C12	CORE-XII	Immunology and Immunotechnology	6	5	25	75	100
13	18PZO3C13	CORE-XIII-P	Practical-III-(Core-XI,XII & CBE-I,II)	6	5	40	60	100
14	18PZO3E1	CBE-I	Aquaculture	6	4	25	75	100
15	18PZO3E2	CBE-II	General and Applied Entomology	6	4	25	75	100
<b>TOTAL</b>				<b>30</b>	<b>23</b>	<b>140</b>	<b>360</b>	<b>500</b>
<b>IV-SEMESTER</b>								
16	18PZO4C14	CORE-XIV	Environmental Biology & Management	6	5	25	75	100
17	18PZO4P15	CORE-XV-P	Practical-IV-(Core-XIV & SBE-III,IV)	6	5	40	60	100
18	18PZO4E3	CBE-III	Applied Biotechnology	6	4	25	75	100
19	18PZO4E4	CBE-IV	Research Methodology	6	4	25	75	100
20		PROJECT	Project Work	6	4	25	75	100
<b>TOTAL</b>				<b>30</b>	<b>22</b>	<b>140</b>	<b>360</b>	<b>500</b>
<b>GRAND TOTAL</b>				<b>120</b>	<b>90</b>	<b>560</b>	<b>1440</b>	<b>2000</b>

**Semester 1**  
**Core Course I**

**Hours: 6**  
**Credits:5**

## **ANIMAL BIODIVERSITY AND CONSERVATION**

### **UNIT I**

Basic concept of Biodiversity –Elements of Biodiversity – Ecosystem Diversity, Genetic Diversity, Species Abundance & Diversity, Patterns of Species Diversity, Alpha, beta and Gamma biodiversity. Global patterns of Biodiversity – measuring , cataloging and discovering Species, Geographical Patterns of Species Richness, Biogeography, Importance of Distribution Patterns (Local Endemics, Sparsely Distributed Species, Migratory Species).

### **UNIT II**

Biodiversity & Conservation – Overexploitation and Common patterns of Overexploitation. Threatening of living species, Loss of biodiversity - causes and consequences, Hot spots in India and World.Mega diversitycenters.Need for conservation. Methods of conservation –In situ and Ex situ methods. Cryopreservation and germplasm conservation.

### **UNIT III**

Exotic Species of Invertebrates – phylum Porifera, Coelenterate, Annelida, Arthropoda, Mollusca and Echinodermata.Exotic Species of Vertebrates - Fishes, Amphibians, Reptiles, Birds and Mammals. Detrimental effects of Exotic Species. Biosphere reserves, National parks, wild life sanctuaries in India and Tamilnadu. Conservation of Biosphere reserves.

### **UNIT IV**

Rare and endangered species. Endemic species- Extinct species - causes of extinction. Conservation of endangered Species – The Endangered species act. Role of ESA in Habitat Protection-Critical Habitat-Problems with the endangered species act andhabitat conservation Plans. Animals threatened by International trade, Free Trade & Conservation.

### **UNIT V**

Ethics of Conservation – Values of Biodiversity, Biopiracy, GM crops (benefits & criticism), Economic Value of Biodiversity.Legal, Ethical and Conservation issues related to biodiversity and Global Conservation Issues.Organizations of biodiversity research in India and World. Role of CITIES and ICUN – Red Data book categories.

### **TextBook:**

- 1.Kumar, U. and M.J Asija.2006. Biodiversity, Principle and Conservation.Student Edition, Jodhpur.
- 2.Environmental Science & Engineering, T. Meenambal. [2009],MJP Publishers, Chennai.

### **Reference Books:**

1. Environmental Science-Ahluwalia.V.K. &Sunitha Malhotra-Ane Books India-2008.
- 2 Environmental Studies-From Crisis To Cure-Rajagopalan.R.-Oxford University Press,New Delhi.2005.
3. An advanced book on Biodiversity – Principles and Practice by K.V.Krishnamurthy, 2003 – Oxford SIBH publishing Co, Pvt. Ltd., New Delhi.

**Semester I**  
**Core Course II**

**Hours 6**  
**Credits 5**

## **CELL BIOLOGY**

### **UNIT I**

Introduction - Cell Theory - Ultra structure of prokaryotic and eukaryotic cell. Plasma Membrane: ultra structure and molecular organization – Membrane lipids, proteins and carbohydrates. models of membrane structure. Properties. Intracellular junctions - tight junctions, gap junctions, plasmodesmata, desmosomes and hemidesmosomes. Cell Cycle: Chromosomal events during mitosis and meiosis.

### **UNIT II**

Protoplasm – chemical and molecular organization and properties. Microtubules and microfilaments- dynamics, regulation and functions. Endoplasmic Reticulum: structure and composition. Intracellular compartments - transport and vesicular traffic. Trans-Golgi Network (TGN) and protein sorting. Golgi Complex: ultra structure and composition. Protein synthesis and secretion in pancreatic cell.

### **UNIT III**

Mitochondria: Molecular organization of mitochondria and Energy Transduction. Ribosomes: Ultra Structure and composition and functions in Prokaryotic and eukaryotic cells. Assembly during protein synthesis and its functions. Lysosome: ultrastructure, composition -enzymatic content, and functions.

### **UNIT IV**

Nucleus: General structure of interphase nucleus - Chromonema cycle. Nuclear envelope – pore complex - functions. Nuclear matrix and nuclear proteins, Nucleosome ultra structure and functions. Nucleolus - structure and its role in RNA processing. Metaphase Chromosomes- ultra structure, types and functions. Giant chromosomes - Polytene and Lampbrush chromosomes.

### **UNIT V**

Cancer Biology: Genetic rearrangements in progenitor cells, Characteristics of Cancer Cells, types of tumours. Therapeutic intervention of uncontrolled cell growth. Apoptosis and its relevance in cancer biology. Cytology of Aging: Factors for ageing and cellular changes. Role of free radicals in ageing.

#### **Text Books:**

1. Gupta, P.K. [2005].Cell and Molecular Biology, Rastogi Publications, India.
2. Verma P.S. and V.K. Agarwall. [2005].Cell Biology, Himalaya Publishing House, Bombay.

#### **References:**

1. De Roberties, E.D.P and E.M.F. De Roberties. 1998. Cell and Molecular Biology. 8<sup>th</sup> Edn. Hong Kong.
2. Gerald Karp, 1996. Cell and Molecular Biology, John Wiley and sons, USA.
3. Powar, C.B. 1997. Cell Biology. Himalaya Publishing House, Bombay.
4. Ajoy Paul, 1960. Cell and Molecular Biology, India.
5. Kuttikan, A.M. 1987. Cell Biology. Fourth Edition. JAC Publications, Kanyakumari.

**Semester I**  
**Core Course III**

**Hours 6**  
**Credits 4**

## **MICROBIOLOGY**

### **Unit I**

History and Scope of microbiology- Classification based on cellularity- Structure of *E.coli*  
Bacterial respiration and reproduction – Bacteriophage - multiplication and life cycle; Fungi-  
Distinguishing characteristics of *Penicillium*.

### **Unit II**

Bacterial nutrition and Growth- Nutritional types of bacteria-Growth factors- culture media-  
Isolation of pure culture –Colony morphology and growth- Growth curve and Growth  
kinetics.

### **Unit III**

Microbial ecology-Fresh water environment- water purifications- Microbiological analysis of  
water purity- Marine environment – Microorganism and formation of different soils-Soil  
microorganisms, interactions with the atmosphere- Extreme environments – Thermophiles  
and Halophiles.

### **Unit IV**

Food Microbiology - Food borne infections and intoxications: Bacterial with example of  
infective and toxic types- Clostridium, Salmonella, and Staphylococcus –micro toxins in food  
with reference to Aspergillus species- Quality assurance- microbiological quality standards of  
food, government regulatory practices and policies- FDA, EPA.

### **Unit V**

Medical Microbiology - Morphological characteristics, Pathogenesis, laboratory diagnosis  
and treatment – Pathogenic bacteria - *Streptococcus pneumoniae*, *Shigella dysenteriae*.  
Pathogenic fungi - *Candida albicans*, Microsporium, Pathogenic Virus – Rabies, AIDS-  
Parasitic Protozoans- *Leishmania donovani*, *Entamoeba histolytica*, *Plasmodium vivox*.

### **Text Books**

1. A Text book of microbiology. R.C. Dubey, D.U. Maheshwari, [2005]. S.Chand and company Ltd.
2. Sharma, P.D. 1998: Microbiology, Rastogi Publ. Meerut, India
3. Vijaya Ramesh, 2005: Environmental Microbiology, MJP.Publ., Chennai, India

### **References**

1. Microbiology an Introduction- fifth edition, Gevaral .J, Tortora, Berdell R. Funne  
Christine L. Cara, 1994
2. Medical Microbiology, Rajan,S. 2007, MJP.Publ. Chennai, India.
3. Pelczer, M.J., Reid, R.D. and Chan, E.C.S. (1996), Microbiology, V Ed., Tata  
McGraw Hill Publishing Company Ltd., New Delhi.
4. Ananthanarayanan, T and Jayaram Paniker, C.K. (2000), Text Book of Microbiology,  
VI Ed., Orient Longman Ltd., Madras.
5. Talaro, Park.,Kathelee, N and Talaro,Arthur. 2002, Foundations of Microbiology.  
McGraw Hill Higher Education, NY.

**Semester 1**  
**Core Course IV**

**Hours 6**  
**Credits 4**

## **MOLECULAR GENETICS**

### **Unit I**

The birth of Molecular genetics. Nucleic acids: Structure and chemical nature of DNA and RNA, types and properties. Denaturation and renaturation of double helix. The Gene – cistron. Gene – protein relations - Globin gene. Constitutive Genes and Inducible Genes, Interrupted genes and gene families. Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids. Prokaryotic and Eukaryotic genome- human genome.

### **Unit II**

DNA replication, repair and recombination: Watson and Cricks's model for DNA Replication, The Meselson and Stahl experiment- replication units, replication origin and replication fork, fidelity of replication, extra-chromosomal replicons and Enzymatic DNA synthesis. Models of DNA Replication, Termination of Replication. DNA damage and repair mechanisms. Mechanism of DNA Replication in Prokaryotes and in Eukaryotes.

### **Unit III**

RNA synthesis and processing in prokaryotes: Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation. RNA synthesis and processing in Eukaryotes: Enzymatic Synthesis of RNA. Binding of RNA Polymerase to Promoter, Initiation, Elongation and Termination phase, Anti-termination and attenuation. Initiation of transcription in eukaryotes,

### **Unit IV**

Protein synthesis and processing and Regulation: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination. Characteristics of genetic code and Wobble Hypothesis. Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post- translational modification of proteins.

### **Unit V**

Control of gene expression at transcription and translation level: Regulation of prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression and gene silencing. Hormonal control of gene expression. Regulation of gene action in prokaryotes: Transcriptional Control mechanisms, Translational Control mechanisms -The operon model (lac, tra operons).

### **Text book**

1. Gupta. P.K.2003. Genetics. Rastogi Publishers. Meerut.
2. G.S. Stent and Richard Calendar., Molecular Genetics (Second edition) CBS. 1986.

### **References:**

1. Gardner, E J. 1984. Principles of Genetics. Jhon Wiley and Sons Ltd. New York.
2. Levin B, Gene IX. 2014. Jones and Bartlett Publishers
3. Tom Strachan and Andrew P Read. Human Molecular genetics 4th Edition, Tailor and Francis Group, New York;2010
4. Singh BD.2006. Fundamentals of genetics. Kalyani Publishers. Lucknow.

Semester: I  
Core Course-V-P

PRACTICAL -I

Hours: 6  
Credit: 4

**ANIMAL DIVERSITY AND CONSERVATION, CELL BIOLOGY,  
MICROBIOLOGY AND MOLECULAR GENETICS**

**Animal Diversity**

1. Using world and Indian map mark biodiversitically important regions, countries and centres.
2. Measuring Biodiversity – Quadrature method using various indices and calculate dominance and evenness.
3. Collection of endemic animals photos with information by using websites, Journals, Newspapers etc.

**Spotters :** Two animals from each phylum from invertebrates and vertebrates.

**Cell Biology**

**Cytological techniques**

1. Micrometry – Measuring the diameter of microorganisms using ocular and stage micrometers.
2. Micro techniques – Tissue fixation – processing – sectioning – spreading – staining.
3. Study of different types of cells: Blood cells – Differential count in man.

**Spotters:** Epithelial, connective, blood, muscle, bone, nerve and germ cells.

**Microbiology**

1. Staining and identification of Bacteria and Fungi
2. Demonstration of isolation of single bacterial colony: Streak plate method
3. Enumeration of bacteria in a sample – Viable plate count – Spread plate and Pour plate methods
4. Hanging drop preparation of Lactic acid bacteria.
5. Preparation of bacterial growth curve.

**Spotters:**Microorganisms relevant to theory syllabus: *Clostridium- Staphylococcus- Streptococcus pneumonia, Shigella dysenteriae, Candida albicans.*

**Molecular Genetics**

Human karyotype- Normal male and female and syndromes.- Sickle cell anemia and DNA and RNA types.

**Record to be submitted for the Practical Examination**

Semester II  
Core Course VI

Hours 6  
Credits 5

## ANIMAL PHYSIOLOGY

### Unit I

Digestive system-Digestion, Absorption and Assimilation in man - Digestive Enzymes -Digestion and Absorption of Carbohydrates, Lipids and Proteins – Defecation- Gastrointestinal hormones. Intermediary metabolism. Respiration; External respiration - Internal respiration –Mechanism of respiration. Respiratory pigments - Structure and functions of Haemoglobin - Lung-tissue gaseous exchange – Respiration in animals - Gill and cutaneous respiration.

### Unit II

Circulation – Heart structure and function; Cardiac cycle - Cardiac rate - cardiac rhythm, ECG - Conduction and regulation of heart beat - heart block. Cardiac output -Venous return - blood pressure – normal, hypo and hyper tension. Composition of blood - Properties and function of corpuscles and plasma -Erythropoiesis and haemopoiesis. Blood groups. Structure of Kidney, Nephron - Formation of urine - Glomerular filtration and maintenance of acid-base balance.

### Unit III

Muscles- Types - Structure of skeletal- chemistry of muscle proteins -mechanism of muscle contraction - theories of contraction. Structural organization of Brain and spinal cord- functions, Reflex action- conditional reflex, Autonomous nervous system - Cerebrospinal fluid. Neurons - structure and types - neuro transmitters- conduction and transmission of nerve impulse and synaptic transmission.

### Unit IV

Sensory Receptors- Vision: Visual system structural organization - structure of retina-Biophysical phenomenon- chemistry of vision-colour vision- common defects of vision. Hearing and balance: Ear - structural organization - Auditory pathways - ear ossicles, structure of Cochlea, Organ of corti- Physiology of hearing and common cause of hearing impairment-membranous labyrinth- cristae and maculae - maintenance of equilibrium, sense organ of olfaction, touch and taste.

### Unit V

Reproductive physiology: Structural organization of male and female reproductive organ, sperm-structure, maturation, motility, semen secretion and composition. Growth and maturation of graffian follicles- hormonal control- Ovulation- Corpus luteum- phases of menstrual cycle- synchrony of ovarian and menstrual cycle-menarche menopause. Structure of egg, fertilization, pregnancy, parturition and Lactation. Endocrine Physiology: Hormones and its functions - pituitary, thyroid, parathyroid, pancreatic islets and adrenals.

### Text Book

Verma, P.S and V.K Agarwal, 1992. Animal Physiology, S. Chand and Co, New Delhi.

### References:

1. Mariakuttikan and N Arumugam, 2002. Animal Physiology, Saras publications, Nagercoil
2. Rastogi, S.L., 1997. Essential of Animal Physiology, New Age International Publisher, New Delhi.
3. Parameswaran, R., Ananthakrishnan T.N., 1999 Outlines of Animal Physiology. Viswanathan pvt. Ltd,  
4. Chennai.
5. William .S. Hoar. 1995. General and comparative physiology, 3<sup>rd</sup> Edition, Prentice Hall of India Pvt. Ltd, New Delhi.



**Semester II**  
**Course VII**

**Hours 6 Core**  
**Credits 5**

## **DEVELOPMENTAL BIOLOGY**

### **UNIT-I**

Gametogenesis, Structure of gametes- sperm maturation, motility, semen secretion and composition. Egg-membranes-types-maturation- ovulation.Fertilization:Physical and chemical factors- Recognition of egg and sperm, gamete fusion, activation of egg metabolism, rearrangement of egg cytoplasm.Physiological changes during fertilization-Pathinogenesis types and significance.

### **UNIT-II**

Polarity and gradient: dorsal and ventral polarity – homeobox concept. Cleavage: Patterns and types of embryonic cleavage, mechanism and control of cleavage. Reorganising the embryonic cells: amphibian blastulation and gastrulation; totipotency and pluripotency. Morphogentic movements. – Fate map in frog.

### **UNIT-III**

Organiser-Differentiation: Cellular differentiation- morphological and physiological - Chemodifferentiation and cytodifferentiation. Organogenesis- ectoderm- formation of central nervous system- neurulation- neural tube, neural crest and development of brain-development of eye. Mesoderm - development of heart and kidney: Endoderm- development of digestive systems in frog.

### **UNIT-IV**

Regeneration:- Stimulus and suppression of regeneration. Types of regeneration- Planeria – amphistoma regeneration. Metamorphosis- types- amphibian metamorphosis; events and hormonal control of metamorphosis. Insect metamorphosis: moulting, growth and hormonal control.

### **UNIT-V**

Formation of extra embryonic membranes in Chick. Placentation in Mammals. Teratogenesis- Contributions of teratology to developmental biology. Stem cells and its applications.

### **Text Book**

Verma , P.S. Agarwal, V.K. and Tyagi, B.S. 1980. Chordate Embryology, S.Chand and Company Ltd. New Delhi.

### **References:**

1. Developmental biology- Scott F. Gilbert, 11<sup>th</sup> Edition.,2016. Oxford University Press,London
- 2 .Principles of Animal Developmental Biology-Suresh C.Goel, HPH Rastogi, V.B. and Jayaraj, M.S. 2002.
3. Berill N.J, 1992. Developmental biology, Tata McGraw Hill Publishingcompany ltd. New Delhi.
4. Twymann, R.M.2003. Developmental biology, Viva Books Private ltd. New Delhi.
5. Arora, M.P. 1992. Embryology, Himalaya Publishing House , New Delhi.
6. Berry, A.K.2013. An introduction to Embryology, EMKAY Publications, New Delhi.

**Semester II**  
**Core Course VIII**

**Hours 6**  
**Credits 5**

## **GENE TECHNOLOGY**

### **Unit-I**

rDNA Technology: Introduction to Gene Technology. Scope. Overview of recombinant DNA technology. Deoxyribonucleic acid- molecular structure. Chemical synthesis of DNA. Applications of Gene technology with reference to personalized medicine.

### **Unit-II**

Tools for DNA technology: Enzymes - Restriction endonuclease, ligases, SI nucleases, DNA polymerases, Ribonucleases, Deoxyribonuclease, Reverse transcriptase. Vectors: plasmid vectors – pBR 322, Ti plasmids– cosmid, phagemids viral vectors, transposons. Specialized vectors, Expression vectors, Binary and shuttle vectors. Klenow fragment, linkers, adaptors and homopolymers.

### **Unit –III**

Steps involved in Genetic Engineering: Methods of plasmid and DNA isolation. Insertion of desired DNA fragment into vector - Cutting and joining of DNA strands - Construction of rDNA - Examples for chimeric DNA - creating and screening of DNA library - DNA hybridization. Methods of introducing DNA into bacteria-Ca mediated transfection, particle bombardment, microinjection, electroporation, Sperm mediated transfer and lipofection.

### **Unit –IV**

Gene cloning in prokaryotes - identification and selection of recombinants by- insertional inactivation, colony hybridization and plaque hybridization. Chromosome walking, chromosome jumping. Cloning. DNA synthesis that encodes eukaryotic proteins. Genetic transformation and Recombinant gene expression in prokaryotes and eukaryotes.

### **Unit-V**

Gene amplification-PCR different schemes and applications. Molecular Markers: Restriction Fragment Length Polymorphism(RFLP)-Random Amplified Polymorphic DNA(RAPD)-application of RAPD. Minisatellite or Variable Number of Tandem Repeats (VNTRs). Microsatellite or Simple Sequence Repeats (SSRs). Reporter, marker and promoter genes. DNA chip technology, micro arrays-production and application on DNA chips.

### **Text book:**

Dubey, R.C. 2007. A Text book of Biotechnology. S. Chand and Company Ltd, New Delhi.

### **References :**

1. Ignacimuthu, S.J. 2002. Basic Biotechnology. Tata Mc Graw- Hill Publishing Company, Ltd., New Delhi.
  2. Arora, P.M.2003. Biotechnology. First Edition. Himalaya Publishing House, Mumbai. Gupta, P.K.2001. Elements of Biotechnology and Genomics (I edition) Rastogi Publication, Meerut.
  3. Gupta, P.K. 2004. Biotechnology and genomics (I edition) Rastogi Publication, Meerut.
- Trevan, M.D., Boffey, Goulding, K.H. and Standbury, P. 1987. Biotechnology: The Biological Principals. Tata Mc Graw – Hill Publishing Company Ltd., New Delhi

**Semester: II**  
**Course Core IX**

**Hours: 6**  
**Credit: 4**

## **BIOSTATISTICS AND BIOINFORMATICS**

### **UNIT – I**

**Probability theory:** Basic concepts: Sample, Space, Exhaustive cases, Mutually exhaustive events, Likely events, Independent events, Dependent events; **Theoretical distribution:** Characteristic features and functions of Binomial Poisson and Normal distribution; **Skewness:** Karl Pearsons Co-efficient of Skewness and Bowleys co-efficient of skewness.

### **UNIT – II (problem question to be asked)**

**Hypothesis testing – Student t test** (Paired Two independent samples, Population Vs Sample mean); tests of significance, 95 % confidence in interval. **Chi square test** and Goodness of fit: characteristics of Chi square test; Degree of freedom, Uses of Chi square test; **Analysis of Variance:** Assumptions, Techniques of analysis of variance: One way classification and Two way classification.

### **UNIT – III**

**Multivariate analysis:** Solving simultaneous equation for more than three variables (Gauss – DOO Little method); Application of multivariate analysis in Biological Sciences; **Cluster analysis** – Dendrogram, Principal Component Analysis; **Application of SPSS** in biological sciences.

### **UNIT – IV**

**Genomics:** DNA sequencing techniques – Sanger method, **DNA microarrays** – applications, Gene chips, Levels of gene expression; **Proteomics** – Protein sequencing – Determination of structure of protein – NMR and X-ray crystallography; Isoelectric focusing; **Structural databases** – SCOP, CATH. **Mechanogenomics:** Definition.

### **UNIT – V**

**Sequence alignment:** PSA and MSA; Local and global sequence alignment – FASTA, BLAST, CLUSTALW; **Phylogenetic Tree** – Phenetic and Cladistic approach, Clade, Taxon, Mode, Dendrogram, Cladogram, Phylogram. Monophyletic, Paraphyletic and Polyphyletic; Root and unrooted trees.

### **Textbooks**

1. Guramani, N. 2004. An Introduction to Biostatistics. MJP Publishers, Chennai.
2. Rajathi, A. 2011 .An Introduction to SPSS. MJP Publishers, Chennai.
3. Ignacimuthu, S. J. 2013. Basic Bioinformtatics, Narosa Publishing House, New Delhi.
4. Attwood, T. K and Parry – Smith, D. J. 2004. Introduction to Bioinformatics. Pearson Education

### **References**

1. Sokal, R. R and Rohlf, F. J, 1981. Introduction to Biostatistics, WH Freeman and co, USA.
2. Veer bala Rosrogi. 2007. Fundamental of Biostatistics. Ane Books India, Chennai.
3. Ramakrishnan, P. 1995. Biostatistics. Saras Publications, kanyakumari.
4. Prasad, S. 2001. Elements of Biostatistics. Rastogi Publication, Meerut.
5. Bliss G I. 1970. Statistics in Biology. Mc Graw Hill Book Company, Vol I an II
6. Zoe Lacroix and Terence Critchlow. 2003. Bioinformatics. Morgan Kaufmann Publishers, San Francisco.

Semester II  
Core Paper X - P

PRACTICAL II

Hours 6  
Credits 4

**ANIMAL PHYSIOLOGY, DEVELOPMENTAL BIOLOGY, GENE TECHNOLOGY,  
BIOSTATISTICS AND BIOINFORMATICS**

**Animal physiology:**

1. Estimation of RQ in fish with reference to light and temperature.
2. O<sub>2</sub> consumption in aquatic animal (fish).
3. Salt loss and salt gain in fish.
4. Separation of amino acids in the tissues (liver/muscle) of fish obtained from the market (Paper Chromatography).
5. Estimation of blood glucose level (GOD kit).
6. Estimation of blood urea (DAM method) using commercially available kits.
7. Principles and applications of the following instruments: Kymograph, Spectrophotometer/Colorimeter, Sphygmomanometer, Chromatographic assembly, ECG and Retinogram.

**Slides :** T.S of Thyroid, T.S of Pancreas, T.S of Ovary, T.S of Testes, Muscles (striated, non-striated and cardiac).

**Developmental Biology:**

1. Chick blastoderm mounting
2. Pregnancy test using kit.

**Spotters:** Frog egg, cleavage, blastula, gastrula, Yolk plug stage. Chick developmental stages 24, 48, 72 and 96 hours.

**Gene Technology:**

1. Separation of protein by SDS-poly acrylamide gel electrophoresis (SDS-PAGE).
2. Quantitative estimation of DNA
3. Quantitative estimation of RNA
4. Isolation of DNA from human saliva
5. Restriction digestion of lambda DNA ( Demo)
6. Demonstration of PCR, Western Blot.

**Gene Technology**

1. Vector pBR 322, electroporation, microinjection, Sanger's Dideoxy sequencing, Automated gene sequencer

**Bio Statistics and statistical packages:**

1. Collection classification and presentation data relating to continuous and discrete variables – obtaining descriptive measures for the collected data – frequency distribution – graphical representation.
2. Descriptive measures such as mean, standard deviation, standard error and coefficient of variation.
3. Problems related to test of significance (chi square test and t test).
4. Problems relation to correlation and regression
5. Statistical packages – problem solving with SPSS.

**Bioinformatics**

**Spotters:** Gen Bank EMBL, DDBJ, SWISS PROT, PIR, BLAST, FASTA, PHYLIP, Gen Bank and Dendrogram

*Practical record to be submitted to the Practical Examinations*

**Semester III**  
**Core Course XI**

**Hours 6**  
**Credits 5**

## **BIOPHYSICS AND BIOCHEMISTRY**

### **UNIT- I**

Scope of biophysics: Colloids – Description, types and properties – Electro-kinetic properties, Donnan equilibrium, Tyndall effect, Surface tension, Brownian movement, Filtration, Osmosis, Dialysis, Adsorption, Components of light: Beer Lambert's law of absorption of light – colorimetry and spectrophotometry- Xray diffraction – Bioluminescence- types –mechanisms- LASER.

### **UNIT-II**

Laws of thermodynamics- Concept of free energy, Entropy and Enthalpy; Exergonic and Endergonic reaction-high energy phosphate (ATP) - Radioactivity – Types, measurement of radioactivity – Geiger – Muller counter. Microscopy – Principles and application of light and electron microscopes (SEM and TEM), Phase contrast and fluorescent microscopes. Centrifugation –Differential and Density gradient centrifuges: Principles, types and application.

### **Unit –III**

Basic concepts of Biochemistry-Structure of atoms, molecules and chemical bond: Covalent bond, hydrogen bond, disulphide bond, peptide bond, Vander walls bond, Electrostatic bond, hydrophobic and hydrophilic interactions. Water: Electrolytic dissociation-acid-base balance; Chemical equilibrium- Buffer-Biological importance; pH-Acidosis-alkalosis.

### **Unit-IV**

Biomolecules; Structure, Classification, Properties and Functional Significance of: Carbohydrates(Mono, Di and Polysaccharides)–Lipids (Fatty acids, Triglycerides and Steroids, Prostaglandins) – Proteins ( Amino acid classification). Vitamins: Types, Occurrence, Classification, Structure and Deficiency symptoms.

### **Unit-V**

Enzymes – Classification – Properties and functions. Mechanism of enzyme actions; Application of Michaelis - Menten equation. Factors affecting enzyme action- Enzyme inhibitors – Co-Enzymes and their action. Animal hormones: Classification, Salient features, Biochemical Properties and Functions- Mechanism of hormone action and their cell signaling -signal transductions -Second messengers- cAMP & GPCR.

### **Text Book:**

1. Thiraviaraj, S., 1998, Biophysics, . Saras Publications, Nagercoil.
2. Nelson, D.L., Leninger, A.L. and Cox, M.M., 2008, Principles of Biochemistry, W.H. Freeman Co.,
3. Ambika Shanmugam, 2003, Fundamentals of Biochemistry for Medical Students.

### **Reference Books:**

1. Subramanian M.A. 2008, Biophysics Principles and Techniques, MJP Publishers.
2. Upadhyay, A., Upadhyay, K., and Nath, N., 2004, Biophysical Chemistry, Himalayas Publishing House, Mumbai.
3. Stryer, L., 1988, Biochemistry, W.H. Freeman & Co. New York.
4. Cooper, T.G., 1977, the Tools of Biochemistry, Wiley Interscience Publications, John Wiley & Sons, New York.
5. Murray, R.K., Granner, D.k., Mayes, P.A., Rodwell, V.W., 1988, Harper's Biochemistry, 21 ed., Appleton & Lange, Medical publications, California.

**Semester III**  
**Core Course XII**

**Hours 6**  
**Credits 5**

## **IMMUNOLOGY AND IMMUNOTECHNOLOGY**

### **UNIT I**

Introduction to immune system. Innate and Adaptive immunity – Lymphoid system: Primary and secondary lymphoid organs, tissues. Cells of immune system: lymphoid lineage, myeloid lineage. Molecules- complements, acute phase proteins, interferon, lymphokines and cytokines.

### **UNIT II**

Antigens: Types of antigens – factors of antigenicity. T cell and B cell epitopes, haptens, adjuvants and carriers. Antibodies: Ultra structure of immunoglobulin, types, paratopes, characteristics and functions. Generation of Ab diversity- Ab engineering. Monoclonal and polyclonal antibodies. Antibody receptors- T cell receptors (TCR), Genes for TCR, TCR diversity. Immune response- Humoral and cell mediated immune response – cell mediated effectors functions. Primary and secondary immune modulation.

### **UNIT III**

Hypersensitivity: Definition and classification; Types- I,II,III,IV and V. Major Histocompatibility Complex (MHC): Genomic organization, MHC molecules, peptide binding- Ag presentation & binding. TLRs. Transplantation immunology: Types of grafts- Allograft rejection- Prevention of graft rejection.

### **UNIT IV**

Vaccination: Principle, antigen as vaccines, subunit vaccines, recombinant vaccines, anti idiotypic antibodies as vaccines, Vaccination schedule. Immune response against bacterial (TB), parasite (Malaria) Viral (HIV) infections. Tumour immunology: Tumour antigens- Immune response to tumours- Immunotherapy to tumours- Tumour vaccines. Autoimmune diseases. Immunodeficiency- inherited and acquired.

### **UNIT V**

**IMMUNOTECHNOLOGY:** Clinical methods for detection of antigens and antibodies: Immunodiffusion: Ouchterlony analysis (Single radial diffusion), Double immunodiffusion. Immunoelectrophoresis: Electro immunodiffusion. Immunocontraception. Binder- Ligand assays: RIA, ELISA, EMIT. Histocompatibility testing: HLA typing- RFLP method, PCR method. Autoimmune disease detection: Rheumatoid arthritis, Hepatitis – B virus test. Immune complex detection: Rosette Forming Array, Plaque Forming Array.

#### **Text books:**

1. Rao, C.V. 2006. Immunology. Narosa Publishing House, New Delhi.
2. Kannan, I. 2007 Immunology, MJP Publishers, Chennai.
3. Arumugam, N. *et al.*, 2005. Immunology and Microbiology, Saras Publications, Kanyakumari.

#### **References:**

1. Janis Kuby. 1997. Immunology. W.H. Freeman & company, New York.
2. Ivan M. Roitt *et al.*, Essential Immunology. XII Edition, Wiley- Blackwell Publishers. UK.
3. Shetty, N. 2006. Immunology. New Age International (P) Limited, Publishers. New Delhi.

Semester III  
Core Course XIII - P

**PRACTICAL III**

Hours 6  
Credits 5

**BIOPHYSICS AND BIOCHEMISTRY, IMMUNOLOGY AND  
IMMUNOTECHNOLOGY AQUACULTURE, AND APPLIED ENTOMOLOGY**

**Biophysics and Biochemistry:**

Determination of pH using pH meter.  
Salivary amylase activity in relation to pH.  
Quantitative analysis of Protein, Glucose and Lipid.

**Spotters:** ATP model, Hb model, Colloids (ice cream, gum, smoke), Viscometer, pH meter, Plasma membrane, ECG, Stethoscope, Sphygmomanometer.

**.Immunology and Immunotechnology;**

WIDAL test for typhoid detection  
Mancini's Single Radial immunodiffusion  
Ouchterlony's Double immunodiffusion  
Demonstration of Ig G by precipitation ring test  
Demonstration for haemagglutination

**Spottres: Immunology and Immunotechnology**

Lymph node, Lymphocytes, Vaccine, ELISA, RIA. Immunoglobulin Model.

**Aquaculture:**

Morphometric measurements of any five available fishes.

**Aquaculture: Spotters**

Catla, Rohu, Mirigal, *Penaeus monodon*, *Macrobrachium rosenbergii*, Transgenic fishes, MPEDA

**Applied entomology**

Collection and Identification of insects in college campus/ insect box submission  
Identification of Insect vectors and Pests  
Mosquito egg collection, egg hatching

**Spotters: Mouthparts :-** Mosquito, Honeybee, Cockroach, Butterfly, Housefly.

**Practical record to be submitted to the Practical Examination**

**Field visit/Tour Report : Related to Entomology and Aquaculture**

**AQUACULTURE**

**UNIT I**

Aquatic Biomes-Brief introduction of the aquatic biomes; Freshwater ecosystem (lakes, and rivers),Estuaries, intertidal zones,oceanic pelagic zone, marine benthic zone,-Physicochemical Characteristics of fresh water bodies and Sea water.

**UNIT II**

Fresh water aquaculture - Culture of Indian Major carps-pond construction-pond preparation-stocking- fish feeds - natural feeds - plankton; artificial feed-pellets - encapsulated feed - live feed - Artemia, Rotifer. -water quality management in fish pond –types of aerators- Fungal ( Cooton wool ),and Bacterial (Tail fin and mouth rot ) and viral (EUS) diseases of fish and prawns and its prophylaxis.

**UNIT III**

Fish breeding techniques: Fish seed from natural sources- Bundh breeding-induced breeding - hypophysation - hybridization - hatchery techniques -transport of fish seed -. Monoculture and Polyculture.- sewage fed fish culture - Ornamental fish culture.

**.UNIT IV**

Shrimp farming- *Macrobrachium malcomsonii*, - *Penaeus monodon* - pond construction - seed collection - nursery management - feeding – Economic importance of Coastal aquaculture-Crab culture : Culture of *Scylla serrata*,- culture of Seaweeds and its economic importance- Culture of edible Oysters, pearl oysters and mussels.

**UNIT V**

Culture of brackish water fishes ;*Lates calcarifer*, *Etroplus suratensis* and *Mugil cephalus*

Integrated fish farming: Paddy cum fish culture; duck cum fish culture; fish cum cattle farming. Crafts and gears used in fish harvest; - preservation and transport of fishes and prawns. Fish by- products,- Organization related fish culture-MPEDA, CMFRI, CIBA and CIFRI and their role in fishery development.

**Text book :**

Aquaculture- Principles and Practices (II Edition). Pillai TVR, Kutty MN.

**References :**

1. Jhingran VG, 1982. Fish and fisheries of India, Hindustan Publishing Corp-
2. Rath RK. Freshwater aquaculture, 1993. Scientific Publishers.
3. Pandey and Shukla, 2007. Fish and fisheries (II Edition), Rastogi Publishers.
4. Santhanam.P, Ramanathan. N and Jegatheesan. G, 1990. Coastal Aquaculture in India.
5. Aquaculture: Dr. N. Arumugam, Saras Publications.



**Semester III**

**Hours 6**

**CBE II**

**Credits 4**

### **GENERAL AND APPLIED ENTOMOLOGY**

#### **UNIT – I INSECT TAXONOMY AND MORPHOLOGY**

**Taxonomy:** Basics of insect classification. Salient features of the insect orders with common south Indian examples.

**Morphology:** Head: segmentation and sutures. Wings: venation – Types of antennae – Types of Legs and modifications – Types of Mouth parts.

#### **UNIT – II INSECT PHYSIOLOGY**

Structure and physiology of Integumentary, digestive, circulatory, excretory, respiratory, nervous, reproductive and endocrine system – Metamorphosis.

#### **UNIT – III AGRICULTURAL ENTOMOLOGY**

Biology, damage caused and control methods of any three major pest of Paddy, Sugarcane, Coconut, Groundnut, Brinjal and Storage pests of Paddy, Black gram and Green gram.

#### **UNIT – IV MEDICAL ENTOMOLOGY**

Insects of public health importance ; mosquitoes, cockroach, housefly, human lice, bed bug, rat flies. Insect pest of live stock; mites and ticks.

#### **UNIT – V INSECT PEST MANAGEMENT**

Natural and artificial control of insect pests – Cultural, Mechanical, Physical and legal methods - Biological control - parasitoids, Predators. Chemical methods - Pesticides - Classification –Types of formulations – Mode of action - Insect Growth Regulators (IGR), Repellents, Antifeedants, Pheromones and Chemosterilants, Applications in pest managements - Biopesticides - Integrated Pest Management (IPM).

#### **Text Books:**

1. Vasantharaj David, B. and Kumaraswami, T., 1982, Elements of Economic Entomology, Popular Book Depo, Chennai.
2. Ambrose Dunston P., 2004, The Insects: Structure, Function and Biodiversity, Kalyani Publishers, Ludhiana.

#### **Reference Books:**

1. Chapman, R.F., 1998, The Insects: Structure and Function, Cambridge University Press.
2. Nayar, K.K., T.N. Ananthkrishnan, and B.V.David, 1986, General and Applied Entomology, Tata McGraw Hill Publishing House, New Delhi.
3. Wigglesworth, V.B., 1979, Principles of Insect Physiology, 9th Ed. Chapman & Hall, London.
4. M.S. Nalinasundari and R.Santhi, 2008. Entomology, MJP Publishers, Chennai-5

**ENVIRONMENTAL BIOLOGY AND MANAGEMENT**

**Unit I**

Environment: Atmosphere (air), Hydrosphere (water), Lithosphere (soil); Abiotic factors: Temperature and light - Biotic factors - Animal association - Symbiosis, Commensalism, Mutualism, Antagonism, Parasitism, Predators and Competition. Ecosystem: Concept, Components - Producer, Consumer, Decomposer, Transformer. Trophic level, Energy flow, Ecological pyramids, Productivity, Food chain, Food web.

**Unit II**

Community Ecology : Types of Communities; Characteristics of Community - Ecotone - Edge effect; Ecological Niche - Ecological succession. Population ecology : Population size and Density, Natality, Mortality, Population Dynamics; Regulation of Population Size- Emigration, Immigration and Migration.

**Unit III**

Hazardous waste -Introduction, characteristics-Classification of hazardous waste ; industrial, hospital, domestic. Solid wastes and disposal techniques - Radioactive wastes. Types, and its control – Sewage, and biomedical wastes and their treatment. Air, water, soil and noise Pollution-sources, impacts and control measures. Occupational hazards and diseases.

**Unit IV**

Environmental monitoring - benefits - types of monitoring - Biological indicators of pollution ;. Bio remediation- approaches and technology of bioremediation,-Role of microorganism in treatment of wastewater.-Role of microbes in soil reclamation.-Principles of Remote Sensing, its Applications in Environmental Monitoring-Recent environmental summits.

**Unit V**

**Geographical Information System(GIS)** and its applications,-Global environmental problems; global warming, climate change. acid rain, ozone layer depletion, green house effect, Environmental disasters management ;earthquakes, landslides, floods, droughts, cyclones, Tsunamis, volcanic eruptions and wild fires, -preventive measures.

**Text Books**

1. Ecology and Environment- by P.D.Sharma, RastogiPublicaitons, X edition, 2009.
2. Fundamentals of Environmental Pollution- by Krishnan Kannan , Chand & Co ., 1997.
3. Concepts of Ecology\_by N. Arumugam. Saras publications. 1983
4. Fundamentals of Ecology - by Eugene P. Odum, III rd Edition, Toppan Company , 1985.

**Semester IV**  
**Core Practical XV-P**

**PRACTICAL IV**

**Hours 6**  
**Credits 5**

**ENVIRONMENTAL BIOLOGY AND MANAGEMENT, APPLIED  
BIOTECHNOLOGY & RESEARCH METHODOLOGY**

**Environmental Biology**

Estimations of Nitrites,  
Estimations of Silicates,  
Estimations of Phosphates  
Estimation of Dissolved oxygen.  
Estimation of Salinity,  
Estimations of Alkalinity,  
Estimations of Calcium in water samples.  
Analysis of industrial effluent for TS, TDS, TSS.

**Spotters : Environmental Biology**

Food Chain, Food Web, Wind Energy, Demography, Pollution (Air, water and soil)

**Applied Biotechnology:**

Monoclonal antibodies, DNA finger printing, DNA chip, Cell line, Knockout mouse  
Biofuels, Probiotics, Bioremediation, SCP, GM Food.

**Research methodology**

Standard graph preparation for DNA and RNA  
Agarose gel electrophoresis of DNA using horizontal submarine gel system.  
Isolation of Carbohydrates by Circular Paper chromatograph  
Isolation of amino acids by Thin layer Chromatography.

**Spotters**

Centrifuge, Spectrophotometer, Autoradiography, Paper chromatography,  
Indexing and abstracting services, Bibliographic databases.

**Practical record to be submitted during Practical Examination**  
**Field Visit /Tour Report to be submitted during Practical Examination.**

## APPLIED BIOTECHNOLOGY

### Unit-I

Medical Biotechnology –Applications of r-DNA technology in human health-Recombinant DNA proteins and their uses: i) Interferon, ii) Interleukin, iii) Factor VIII, iv) Urokinase and v) Tissue plasminogen activator-Recombinant vaccines: Hepatitis-B, Rabies and FMD Vaccine -Commercial production of penicillin-DNA finger printing and its use in Forensic science.

### Unit-II

Hybridoma technology: Production and Application of monoclonal and polyclonal antibodies -Gene Therapy-Cell bank-Animal bioreactor and molecular pharming -Historical background and value of transgenic animals : Transgenic mouse,embryonic stem cell method and pronucleus method, Transgenic fish and sheep - Bioethics in animal genetic engineering.

### Unit-III

Agricultural Biotechnology: Genetically Modified Microorganisms - Biofertilizers:Bacterial, Rhizobial, Azotobacter, Azospirillum inoculants-Nitrogen, Phosphate and Sulphate fixing mechanism, Green manuring-Cyanobacterial inoculants-Mycorrhizal fungi. Benefits of biofertilizers - Biopesticides in pest management.

### Unit-IV

Industrial and Microbial Biotechnology-Fermentation technology:Types of Fermenters, Types of Media, Selection of microbes, Production of Vitamin B12, Amino acids and Proteases -Production of organic compounds by microbial fermentation –Commercial production of antibiotics-Single Cell Protein (SCP) from microorganism-Enzyme Technology : Production of amylase and its applications.

### Unit-V

Environmental Biotechnology-Bioremediation: *In-situ*, and *Ex-situ* -Use of genetically engineered bacterial strains –Bioremediation of dyes-Bioremediation in paper and pulp industry -Bioremediation of xenobiotics. Biofuels - Production of Ethanol and its applications.

### Text book:

Gupta, P.K. Biotechnology and Genomics (Edition, 2009) Rastogi Publication, Meerut, India.

### References:

- 1.Dubey, R.C. A Textbook of Biotechnology (Edition, 2006) S. Chand & Co. Ltd. Ram Nagar, New Delhi, India.
2. Das, H.K.Textbook of Biotechnology (Edition, 2006) Wiley Dream Tech, India Pvt.Ltd. New Delhi, India.
3. Ramawat, K.G and ShilyGoyal. Comprehensive Biotechnology (Edition, 2009), S.Chand & Co. Ltd.Ram Nagar, New Delhi, India.

**Semester: IV**  
**CBE – IV**

**Hours: 6**  
**Credit: 4**

## **RESEARCH METHODOLOGY**

### **UNIT – I**

**Fundamentals of Research:-** Aim, scope and Objectives of research problems; Classification of research; **Research process** – Prioritizing the problem – Selection and analysis. Formulate hypothesis; Formulation of objectives; **Research design** – Execution- Data processing – Data analysis – Interpretation and report writing; Preparation of research paper; Dissertation; Refereed and Non- refereed journals; Impact factor; Citation index; Copyright; Patent. Bibliographic databases.

### **UNIT – II**

**Principles of Microtechniques** – Fixative and Histological stains – Fixation, Tissue processing and staining – freezing Microtomy (Cryostat), Histochemical stains of Carbohydrates, Proteins, Lipids, Enzymes and DNA; **Chromatography** – Paper, Column, Ion-exchange, HPLC, TLC, GLC, GC.

### **UNIT – III**

Principles, Types and application of Electrophoresis – Gel Documentation; 2D Electrophoresis; **Principles and applications** - pH meter, Colorimeter, Spectrophotometer – UV visible, Atomic Absorption Spectrophotometer, NMR, Flame photometer.

### **UNIT – IV**

**Centrifuge: Types-** Analytical centrifuge, Ultra centrifuge, Differential centrifuge – Cell fractionation – Application of centrifugation; **Cell culture techniques:** Tissue culture laboratory –Cell proliferation measurements, Cell viability testing, Culture media preparation and cell harvesting methods.

### **UNIT – V**

**Radioisotope and mass isotope techniques in biology:** Sample preparation for radioactive counting, Autoradiography and Magnetic Resonance Imaging (MRI) – Geiger Muller Counter, Scintillation counter- Carbon dating.**Energy value of biological material:** Wet combustion; Bomb calorimeter – estimation of calorific value.

### **Textbooks**

- 1.Guramani, N. 2009. Research Methodology for Biological Sciences. MJP Publishers, Chennai.
- 2.Kothari, C. R. 2008. Research Methodology- Methods and Techniques. New Age International Publishers, New Delhi – 110002.
- 3.Vijayalakshmi, G., Sivapragasam, C. Research Methods Tips and Techniques. MJP Publishers, Chennai – 600005.

### **References**

- 1.Laboratory Experiments in Microbiology. Case C L and Johnson T R, 1984. The Benjamin Cummings Pub. Co., London.
- 2.Environmental Instrumentation. Fritschen L J and Gay L W, 1979. Springer Verlag, New York.
- 3.Animal Tissue Techniques.IV Edition, Humason G L, 1979, Freeman W H and Co., San Francisco.
- 4.Methods of Protein and Nucleic acid Research. Osterman A, 1984. Springer Verlag, New York.
- 5.An Introduction to Practical Biochemistry. Plumber D T, 1971, Tata Mc Graw Hill Co.
- 6.Introduction to Biophysics. 2008. Pranab Kumar Banerjee, S. Chand