

**Post-Graduate Programme  
in Zoology**

**Courses of study, Schemes of Examinations  
& Syllabi**  
(Choice Based Credit System)



**PG and Research Department of Zoology  
Bishop Heber College (Autonomous)  
(Nationally Reaccredited at the A+ level by NAAC)  
(Reaccredited with 'A' Grade (CGPA – 3.58/4.0) by the NAAC &  
Identified as College of Excellence by the UGC)  
TIRUCHIRAPPALLI – 620017  
TAMIL NADU, INDIA  
2017– 2018**

## Post – Graduate Programme in Zoology

### Structure of the Curriculum

<b>Parts of the Curriculum</b>	<b>No. of courses</b>	<b>Credits</b>
Core Course (Theory)	10	50
Core Course (Practical)	5	15
Elective	4	16
Project	1	5
NMEC	1	2
VLOC	1	2
<b>Total</b>	<b>22</b>	<b>90</b>

**M.Sc., Zoology**  
(For the candidates admitted from the academic year 2016 onwards)

Sem.	Course	Course Code	Course Title	Pre requisites	Hours per week	Credits	Marks		
							CIA	ESA	Total
I	Core I	P15ZY101	Functional Morphology of Invertebrates and Chordates		5	5	25	75	100
	Core II	P15ZY102	Cell Biology		5	5	25	75	100
	Core III	P15ZY103	Molecular Biology and Bioinformatics	P15ZY102	5	5	25	75	100
	Core Prac. I	P15ZY1P1	Core Practical I		5	3	40	60	100
	Core Prac. II	P15ZY1P2	Core Practical II		5	3	40	60	100
	Elective I	P15ZY1:1 / P15ZY1:2	Microbiology/ Parasitology	P15ZY101	5	4	25	75	100
II	Core IV	P15ZY204	Animal Physiology	P15ZY101	5	5	25	75	100
	Core V	P15ZY205	Biochemistry	P15ZY102	5	5	25	75	100
	Core Prac. III	P15ZY2P3	Core Practical III		5	3	40	60	100
	Core Prac. IV	P15ZY2P4	Core Practical IV		5	3	40	60	100
	Elective II	P15ZY2:1 / P15ZY2:2	Immunology/ Endocrinology		4	4	25	75	100
	NMEC		<i>To be selected from the courses offered by the other departments</i>		4	2	25/ 40	75/ 60	100
	VLOC	P17VL2:1 / P17VL2:2	RI / MI		2	2	25	75	100
III	Core VI	P15ZY306	Environmental Biology		5	5	25	75	100
	Core VII	P15ZY307	Developmental Biology	P15ZY101	5	5	25	75	100
	Core VIII	P15ZY308	Genetics		5	5	25	75	100
	Core IX	P15ZY309	Research Methodology		5	5	25	75	100
	Core Prac. V	P15ZY3P5	Core Practical V		5	3	40	60	100
	Elective III	P15ZY3:1 / P15ZY3:2	Animal Biotechnology / Genomics and Proteomics	P15ZY1:1	5	4	25	75	100
IV	Core X	P15ZY410	Evolution and Animal Behaviour		5	5	25	75	100
	Elective IV	P15ZY4:1 / P15ZY4:2	Applied Entomology/ Bioinformatics	P15ZY 101	5	4	25	75	100
	Project	P15ZY4PJ	Project		20	5	--	--	100
<b>Total</b>						<b>90</b>			<b>2200</b>

CIA- Continuous Internal Assessment  
ESA- End Semester Assessment

NMEC- Non Major Elective Course  
VLOC- Value added Life Oriented Course

## CORE – I : FUNCTIONAL MORPHOLOGY OF INVERTEBRATES AND CHORDATES

**Semester:1**  
**Credits : 5**

**Code: P15ZY101**  
**Total Hours: 75**

### **General Objectives:**

1. To know the symmetry and coelom of the invertebrates and their significance.
2. To study the functional aspects of different systems of invertebrates and vertebrates in a comparative basis.

### **Unit I**

Broad classification of Animal kingdom - International code of Zoological nomenclature – Symmetry and its significance in animal organization - Organization of coelom: Acoelomates - Pseudocoelomates – Coelomate groups (schizocoel, enterocoel, and mesenchyme). Locomotion: Amoeboid, flagellar and ciliary movement in Protozoa - Hydrostatic movement in Coelenterata and Echinodermata.

### **Unit II**

Nutrition and Digestion: Patterns of feeding and digestion in lower metazoa, Mollusca and Echinodermata- Filter feeding in Polychaeta. Organs of respiration: Gills, book lungs, and trachea – Mechanism of respiration. Organs of excretion: Coelomoducts, Nephridia and Malpighian tubules – Mechanism of excretion.

### **Unit III**

Nervous system: Primitive nervous system in Coelenterata and Echinodermata- Advanced nervous system in Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda) - Larval forms of Trematoda, Cestoda, Crustacea, Mollusca, Echinodermata and their evolutionary significance.

### **Unit IV**

Classification of chordates – Origin and evolution of elasmobranchs – Adaptive radiation of elasmobranchs and bony fishes – Migration in fishes – Origin and evolution of Amphibia – Adaptive radiation in Amphibia – Terrestrialization

### **Unit V**

Connecting links between reptiles and birds – Mammals: Structural peculiarities of prototheria, metatheria and eutheria. – Structure and functions of integument and its derivatives - Origin and evolution of paired fins and limbs. Evolution of urinogenital system in vertebrates - Comparative anatomy of brain in vertebrates.

## **Text Books**

1. Ruppert E.E., Fox, R.S. and Barnes, R.D. Invertebrate Zoology. 7<sup>th</sup> Ed., Cengage Learning, Singapore, 2004.
2. Jordan E.L. and Verma P.S., Invertebrate Zoology, 12<sup>th</sup> edn. SChand & Co. 1995.
3. Kotpal R.L., Agarwal, R.P.R., Khertarpa, Modern text book of Zoology-I - Rastogi Publications. 1989.
4. Jordan E.L, Verma P.S, Chordate Zoology - S.Chand & Company Ltd. 2008
5. Kotpal R.L.A, Modern text book of Zoology Vertebrates, Rastogi publications, 2009.

## **References**

1. Linzey, D., Vertebrate Biology, McGraw-Hill, Singapore, 2001.
2. Waterman A.J., Chordate Structure and Function, The Macmillan Publishing Co., 1971.
3. Pough H., Heisher J.B. and McFarland W.N., Vertebrate Life. Macmillan Publishing Co., New York, 1990.
4. Hyman L.H., The Invertebrates, Vol. 1 to 7, McGraw Hill Book Co., Inc., New York, 1940.
5. Barrington E.J.W., Invertebrate Structure and Functions, 2<sup>nd</sup> Ed., Thomas Nelson & Sons Ltd., Middlesex, United Kingdom, 1979.
6. Colbert H. E., Evolution of the Vertebrates, New Delhi, New Age International, 2000.
7. Jollie M, Chordate Morphology, Reinholt Publishing Corporation, New York, 1962.
8. Romer A.S., Hyman's Comparative Vertebrate Anatomy, 3<sup>rd</sup> Ed., The University of Chicago Press, London, 1979.
9. Young J.Z., Life of Vertebrates, Clarendon Press, Oxford, 1950.
10. Sinha, Adhikari, Ganguly, Bharati Goswami, Biology of animals Vol.II., New central book agency (p) Ltd., 2004.

## CORE –II CELL BIOLOGY

Semester:I  
Credits : 5

Code: P15ZY102  
Total Hrs. : 75

### General Objectives:

1. To understand the structural and functional aspects of the cell.
2. To understand the molecular mechanism of cell functioning

### Unit – I

Prokaryotic and eukaryotic cells. **Membrane structure:** lipid composition-protein components-principles of Membrane transport-carrier proteins-Ion channels and membrane potential - Cell junctions-Extra cellular matrix. **Intracellular compartments:** Endoplasmic reticulum, Golgi complex and lysosomes- Transport and sorting of proteins-vesicular transport-secretory pathways.

### Unit – II

Structure and functional significance of Mitochondria. Structure of Nucleus - Nuclear pore complexes – Transport of molecules between the nucleus and cytosol. **Cytoskeleton:** Centriole - Dynamic structure of microfilaments, intermediate filaments and microtubules- molecular motors-cytoskeleton and cell behavior.

### Unit – III

**Cell communication:** General principles- G-protein linked receptors –enzyme linked receptors-pathways of intracellular signal transduction. **Cell cycle control and cell death:** overview of cell cycle-control system – apoptosis-extracellular control of cell growth- Tissue maintenance and renewal.

### Unit – IV

**Stem cells:** Types- Molecular Basis of Pluripotency - Stem Cell Niches - Mechanisms of Stem Cell Self-Renewal - Generation of Induced Pluripotent Stem Cells-Characteristics and Characterization of Pluripotent stem Cells- Application of Embryonic stem Cells.

### Unit – V

**Biology of cancer:** Development and causes of cancer-properties of cancer cells- Tumor viruses – Oncogenes - Tumor suppressor genes- Molecular basis of cancer- Cell behavior- Molecular Approaches to Cancer Treatment.

### Text Books

1. Alberts, B., Johnson, A. and Lewis, J. Molecular Biology of the Cell. 4<sup>th</sup> Ed., New York: Garland, 2002.
2. De Robertis, E.D.P. and De Robertis, E.M.F. Cell and Molecular Biology, 8th Ed., Lippincott Williams & Wilkins, A Wolter Kluwer Business, Philadelphia, 2001.

## References

1. Lodish H., Berr, A. and Paul, M. Molecular Cell Biology, New York: W.H. Freeman, 2003.
2. Cooper G.M. and Hausman, R.E., The Cell - A Molecular Approach. 4<sup>th</sup> Ed., Sinauer Associates Inc. USA, 2007.
3. Karp G. Cell and Molecular Biology, G. John Wiley & Sons, 2008.
4. Sheeler P. and Bianchi, D.E., Cell and Molecular Biology, 3<sup>rd</sup> Ed., John Wiley Indian Edition, New Delhi, 2009.
5. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G.P., The World of Cell, 6<sup>th</sup> Ed., Pearson Education, 2007.

## CORE – III: MOLECULAR BIOLOGY AND BIOINFORMATICS

Semester: I  
Credits : 5

Code: P15ZY103  
Total Hrs. : 75

### General Objectives:

1. To understand heredity and variation
2. To understand biologically important predictions from annotated data and transformation of these data for DNA analyses

### Unit – I

Structure of DNA, tRNA, micro-RNA. **Forms of DNA:** A, B and Z DNA - Mitochondrial DNA - structure of eukaryotic chromosome- nucleosome model- heterochromatin and euchromatin - Genome size and C value paradox. Unique and Repetitive nucleotide sequences in eukaryotic genome (LINEs, SINEs). Kinetics of renaturation: Cot curve.

### Unit – II

**DNA replication:** semi conservative, rolling circle, Q, D, Eye – models- Mechanism of replication -DNA damage and its repair mechanisms. **Genetic code:** Properties- Wobble hypothesis. **Transcription in Prokaryotes:** enzymes and proteins involved – mechanism – promoters- enhancers.**Protein synthesis in Prokaryotes:** Ribosomes - factors involved in protein synthesis - process of translation- post translational modifications and signal hypothesis - inhibitors.

### Unit – III

**Transcription in Eukaryotes:** RNA polymerases - promoters- enhancers and silencers - effects of chromatin structure. Post-transcriptional modifications -**Regulation of gene expression:** concepts of enzyme induction and repression- positive and negative control. Regulation of gene expression in Prokaryotes: lac-operon, trp-operon, ara-operon and gal-operon. Catabolite repression. Regulation of gene expression in eukaryotes.

### Unit – IV

Overview of Bioinformatics – Literature, sequence and structure databases – Pattern and motif searches: PROSITE, BLOCKS, PRINTS, PFAM – Structural classification: SCOP, CATH – Metabolic pathway databases: KEGG and Biocyc - Protein structure visualization tools: RasMol, Swiss PDB Viewer Molecular sequence alignment: Pair wise alignment - Local and Global alignment concepts – FASTA and BLAST - Multiple sequence alignment – CLUSTALW and TCOFFEE.

### Unit - V

**Gene and Genome analysis:** Genome projects - Genome Mapping, Sequencing, Assembly and Annotation - comparative genomics. **Protein and proteome analysis:** protein identification tools – protein secondary structure prediction - Chou-Fasman /GOR method. Transcriptomics: Genome expression analysis using microarray techniques - Applications of Microarray-Modern drug discovery – impact of structural bioinformatics in drug discovery.



## Text Books

1. Malacinski G.M., Freifelder's Essential of Molecular Biology, Narosa Publishing House, New Delhi, 2003.
2. Jeyanthi G.P, Molecular Biology, MJP Publishers, Chennai. 2009.
3. Ignacimuthu S, Basic Bioinformatics, Narosa Publishing House, Chennai, 2008

## References

1. Alberts, B., Johnson A and Lewis J, Molecular Biology of the Cell, 4<sup>th</sup> Ed., New York: Garland, 2002.
2. Weaver R, Molecular Biology, 5<sup>th</sup> Ed., McGraw-Hill, NY, 2012.
3. Lodish H, Berr A and Paul M, Molecular Cell Biology, New York, W.H. Freeman, 2003.
4. Epstein R.J, Human Molecular biology, An Introduction to the molecular basis of health and disease, Cambridge University Press, 2003.
5. Colladovides J., Magasanik B and Smith, T.F. Integrative approaches to Molecular Biology. Ane Books, New Delhi. 2004.
6. Lewin B, Genes IX, Jones and Bartlett Publishers, Boston, 2008.
7. Bates A. D. and Maxwell A, DNA Topology, Oxford University Press Inc., New York, Indian Edition, 2005.
8. David H.R., Genetics and Molecular Biology, Tata McGraw, New Delhi, 2009.
9. Lewin B., Krebs J. E., Kilpatrick S.T. and Goldstein, E.S. Lewin's GENES X. John and Barlett Publishers, Sudbury Massachusetts, 2011.
10. Watson J.D., Baker T.A., Bell S.P., Gann A., Levine M. and Losick R, Molecular Biology of the Gene, 5<sup>th</sup> Ed., Pearson Education Inc, 2004.

## ELECTIVE – I: MICROBIOLOGY

Semester: I  
Credits : 4

Code: P15ZY1:1  
Total Hrs. : 75

### General Objectives:

1. To study the structure of microbes, microbial culture and growth.
2. To acquire knowledge about the applications of microbes and its significance in various fields.

### Unit – I

**Microbial diversity:** Whitakers system of classification. **Bacteria:** Structure of *E.coli* -Cytoplasmic membrane – cell wall – gram positive and gram negative bacterial cell surface structures- cell inclusions – gas vesicles- endospores - locomotion - nutrition. **Virus:** Structure and life cycle of Bacteriophage. **Fungi:** Structure and life cycle of *Penicillium*.

### Unit – II

**Microbial culture and growth:**Types of culture – culture media.Cell division - peptidoglycon synthesis- measurement of microbial growth - exponential growth- growth curves –growth kinetics -**Factors affecting growth:** temperature, pH and oxygen.

### Unit – III

**Phototrophy:** photosynthetic pigments **Chemolithotrophy:** inorganic electron donors - hydrogen oxidation- sulfur oxidation- iron oxidation- nitrification. **Anaerobic respiration:** nitrate reduction- sulfur reduction- acetogenesis - methanogenesis - organic electron acceptor.

### Unit – IV

**Industrial Microbiology:** Microbial products -primary and secondary metabolites-characteristics of large-scale fermentations- Antibiotics isolation and characterization-Industrial production of vitamins-steroids - enzymes - alcohol-vinegar-citric acid.

### Unit – V

**Medical microbiology:**Symptoms, prevention and control of **Air borne infections:** diphtheria-whooping cough- tuberculosis- respiratory viral infections - influenza. **Water borne infections:** cholera – typhoid - hepatitis. *Helicobacter pylori* and Gastric ulcer. Sexually Transmitted Diseases: Gonorrhea-Syphilis - AIDS.

### Text Books

1. Pelczar M.J and Reid, Microbiology, Tata Mc Graw Hill, 1996.
2. Prescott L.M., Harley J. P. and Klein D.A., Microbiology, 6<sup>th</sup> Ed., McGraw-Hill, New Delhi, 2005.

## References

1. Pomervill P.C., Alacamo's Fundamentals of Microbiology, 7<sup>th</sup> Ed., Boston: Jones and Bartlett, 2004.
2. Tartora G.J., Case C.L. and Funke B.R., Microbiology - An Introduction, 8<sup>th</sup> Ed., Pearson Benjamin Cummings, New York, 2004.
3. Hogg S, Essential Microbiology, John Wiley & Sons Ltd., England, 2005.
4. Madigan M.T. and Martinko J.M., Brock Biology of Microorganisms, 11<sup>th</sup> Ed., Prentice Hall, USA, 2006.
5. Percival S.L., Chalmers RM, Embrey M., Hunter PR, Sellwood J and Wyn-Jones P, Microbiology of Waterborne Diseases, Elsevier Academic Press, London, 2004.
6. Schaechter M, The Desk Encyclopedia of Microbiology, Elsevier Academic Press, London, 2004.

## ELECTIVE – I: PARASITOLOGY

Semester: I  
Credits : 4

Code: P15ZY1:2  
Total Hrs. : 75

### General Objective:

1. To study the types of parasites, lifecycle and diseases.

### UNIT-I

Parasitism: General consideration- Types of parasites - Type of hosts - Symbiosis and commensalism. Protozoan parasites: Distribution, habit and habitat, structure life cycle and diseases caused by selected pathogenic protozoan parasites of man: Intestinal and urogenital protozoa: *Entamoebahistololytica* (Amoebae) -*Balantidium coli* (Ciliates)- *Giardia lamblia* (Flagellates)- *Trichomonasvaginalis* (Flagellates)- *Cryptosporidium parvum* (Sporozoa)- *Isospora belli* (Sporozoa).

### UNIT- II

Blood and tissue protozoa: Trypanosoma (*T. brucei* and *T. cruzi*)- Leishmania (*L. donovani*, *L. tropica*, *L. braziliensis*, *L. mexicana* and *L. peruviana*)- Plasmodium (*P. falciparum*, *P. ovale*, *P. malariae* and *P. vivax*)- *Toxoplasma gondii*.

### UNIT -III

Helminth parasites - General characters, organization and larval forms of Platyhelminthes and Nematelminthes. Intestinal helminthes:- *Ascarislumbricoides* (Large intestinal roundworm)- *Trichinellaspiralis* (Trichinosis)-*Trichuristrichiura* (Whipworm)- *Enterobiusvermicularis* (Pinworm)- *Strongyloidesstercoralis* (Threadworm)- *Necatoramericanes* and *Ancylostomaduodenale* (Hookworms).

### UNIT- IV

Blood and tissue helminthes: *Dracunculusmedinensis* (Guinea worm)- *Toxocaracanis* and *T. catti* (Visceral larvamigrans)- *Ancylostomabraziliensis*, *Ancylostomacanicum* (Cutaneous larva migrans)- *Wuchereriabancrofti* (Filariasis)- *W. (Brugia) malayi*- *Onchocerca volvulus* (Blinding worm)- *Loa loa* (Eye worm). :Cestodes (Tapeworms): *Teniasolium* (Pork tapeworm)- *T. saginata* (Beef tapeworm) – *Diphyllobothriumlattum*(Fish tapeworm)- *Hymenolepis nana* (Dwarf tapeworm)- *Echinococcusgranulosus* (Dog tapeworm).

### UNIT -V

Trematodes (Flukes; Flatworms):- Blood flukes: *Schistosomamansonii*, *S. japonicum* and *S. hematobium*- Intestinal flukes: *Fasciolopsisbuski*- Liver flukes: *Clonorchissinensis*, *Fasciola hepatica*- Lung flukes: *Paragonimuswestermani*. Vector Biology: Vectors and its importance in transmission of parasites- Major malaria vectors of India. Arthropods and Ectoparasites.

## **Text Book**

1. Chandler A.S. and Read C.P., Introduction to Parasitology, Wiley, 1970.

## **References**

1. Chatterjee K.D., Parasitology, Chatterjee Medical Publishers, 1981.
2. Noble E.R and Noble G.A., Parasitology, Lea and Febiger, 1973.
3. Smyth J.D., Animal Parasitology, Cambridge University Press, 1996.
4. Gillespie Sand Richard D, Principles and Practice of Clinical Parasitology, John Wiley & Sons Ltd., 2001.
5. Chiodini P.L. Moody A.H., Manser, D.W. and Livingstone C, Atlas of Medical Helminthology and Protozoology, 4<sup>th</sup> Ed., 2001.

## CORE PRACTICAL-I: LAB IN CELL BIOLOGY AND MOLECULAR BIOLOGY

Semester: I  
Credits : 3

Code: P15ZY1P1  
Total Hrs. : 75

### General Objectives:

1. To acquire skills in squash preparation, permanent slides and staining.
2. To develop practical skills in the advanced techniques of Molecular Biology

### Cell Biology

1. Squash preparation of onion root tip and observation of mitotic stages.
2. Study of giant chromosomes in chironomous larva and micrometric measurements of Puffs.
3. Differential staining of DNA and RNA in buccal smear.
4. **Histology:** Fixation, dehydration, embedding, sectioning, staining and permanent mounting of tissues - Submission of 5 best slides for Exam evaluation.
5. **Spotters:** Giant chromosome, Mitotic stages of onion root tip, T.S of Heart, T.S of Kidney, T.S of Pancreas, T.S of Liver

### Molecular Biology

1. Isolation of genomic DNA from animal tissue.
2. PAGE - separation and molecular weight determination of proteins.
3. Agarose gel electrophoresis of DNA and calculation of molecular weight.
4. Demonstration of amplification of gene by PCR.
5. Demonstration of Protein precipitation and purification.

**Spotters:** PCR, PAGE and Agarose gel electrophoresis

## CORE PRACTICAL -II LAB IN MICROBIOLOGY/PARASITOLOGY

Semester: I  
Credits: 3

Code: P15ZY1P2  
Total Hrs: 75

### General Objectives:

1. To acquire skills in sterilization and advanced techniques in microbiology
2. To develop practical skills in the advanced molecular techniques

### Microbiology

1. Sterilization procedures and maintenance of laboratory.
2. Media preparation and bacterial culture inoculation.
3. Identification of bacteria based on colony morphology.
4. Serial dilution and pour plate method and determination of colony number/gram.
5. Culture techniques :Broth culture, Spread plate, Streak plate, Slant culture & Swab culture
6. Identification of bacteria by gram staining method.
7. Observation of bacterial motility by hanging drop method.
8. Determination of bacterial growth by spectrophotometry.
9. Enumeration of microbial colony by colony counter.
10. Antibiotic sensitivity test.
11. MPN technique for the identification of coliforms in water samples.

**Spotters:** Bacteria, Virus, Fungi and culture plates

Instruments: Laminar air flow and Colony counter

### Parasitology

1. Smear preparation and staining of rectal content of Bufo sp.
2. Preparation and staining of blood parasite from pigeon blood.
3. Identification: *Plasmodium* sp., *Leishmania* sp., *Ascaris* sp., *Fasciola* sp., *Paramphistomum* sp., *Anopheles* sp., *Culex* sp., *Columbicola* sp., *Pediculus* sp., *Cimex* sp.
4. Submission of prepared slides

## CORE – IV: ANIMAL PHYSIOLOGY

Semester: II  
Credits: 5

Code: P15ZY204  
Total Hrs. : 75

### General Objectives:

1. To understand the functions of various systems of animal body with special reference to mammals
2. To understand the roles of various hormones in coordination of activities of biological systems

### Unit – I

**\*Digestive system:** Digestion-absorption- energy balance - BMR. **Respiratory system:** Internal and external respiration-Comparison of respiration in mammals -respiratory pigments-transport of gases - exchange of gases - neural and chemical regulation of respiration.

### Unit – II

**\*Blood and circulation:** Blood corpuscles - haemopoiesis and formed elements-plasma function- blood volume -blood volume regulation. **Cardiovascular System:** Anatomy of heart - myogenic heart - principle and significance of ECG - cardiac cycle - blood pressure and neural and chemical regulation.

### Unit – III

**\*Excretory system:** kidney- urine formation- urine concentration-waste elimination- micturition - regulation of water balance- electrolyte balance- acid-base balance. **Thermoregulation:** Comfort zone-body temperature - physical, chemical, neural regulation- acclimatization- stress adaptation.

### Unit – IV

**\*Nervous system:**Central and Peripheral nervous system - Neurons - action potential – transmission of nerve impulse - neural control of muscle tone and posture. **Sense organs:** Vision, hearing, gustation, olfaction and tactile. **Muscular system:** Ultra structure of muscle - Physiology of muscle contraction.

### Unit – V

**\*Endocrine glands:** Pituitary, Thyroid, Adrenal and Parathyroid: Hormones -mechanism of action, functions and diseases. **Reproductive processes:** Menstrual cycle- neuroendocrine regulation-pregnancy- parturition – lactation.

\*With reference to mammals

### Text Book

Sherwood, L., Klandorf, H, and Yancey, P.H. Text Book of Animal Physiology. Cengage Learning India Pvt., Ltd., 2008.



## References

1. Hill R.W., Wyse G.A. and Anderson, M., Animal Physiology., 2<sup>nd</sup> Ed., Sinauer Associates, Inc Publisher, Massachusetts, 2008.
1. Moyes, C.D. and Schulte, P.M. Principles of Animal Physiology. Pearson Education, Dorling Kindersley Publication. New Delhi, 2007.
2. Guyton, A.C. Textbook of Medical Physiology. W.B. Saunders Company, Philadelphia, London, Toronto and IgakuShoin/Saunders (Tokyo), 2000.
3. Prosser, C.L. Comparative Animal Physiology. 3<sup>rd</sup> Ed., W.B. Saunders & Co. Philadelphia, 1973.
4. Hoar, W.S. General and Comparative Physiology, Prentice Hall, 1968.

## CORE – V BIOCHEMISTRY

Semester: II  
Credits : 5

Code: P15ZY205  
Total Hours: 75

### General Objectives:

1. To understand the chemical basis of life.
2. To study the bio molecules, their structure and reactions and energy metabolism of the cell.

### Unit – I

**Chemical bonds and interaction:** Hydrogen bond, ionic bond and covalent bonds- vanderwaals and hydrophobic interactions - Water as a solvent - **pH and buffers:** Acid-base reactions- dissociation constants ( $K_a$ ) for weak acids and weak bases- role of buffers in biological systems. **Carbohydrates:** monosaccharides: linear and heterocyclic structure- conformational structure- isomers - epimers. Disaccharides - oligosaccharides - polysaccharides- Glycoproteins and glycolipids.

### Unit – II

**Proteins:** Primary structure – peptide bond. Secondary structure – $\alpha$ helix -  $\beta$  pleated sheet and bends- Prediction of secondary structure: Ramachandran plot. Tertiary structure - Forces stabilizing tertiary structure - Domains and motifs. Quaternary structures - Molecular chaperones - prions. **Lipids:** Structure – Steroids – Cholesterol.

### Unit – III

**Enzymes:** Classification of enzymes - co-enzymes- iso-enzymes- ribozyme - abzymes. Enzyme specificity: Mode of action of enzymes - Formation of enzyme substrate complex. **Enzyme kinetics:** Equilibrium and steady-state assumptions- Michaelis -Menten equation-significance of  $K_m$  Value- MM & LB plots - Enzyme regulation

### Unit – IV

**Carbohydrate metabolism:** Glycolysis- Pentose phosphate pathway- citric acid cycle-oxidative phosphorylation. Gluconeogenesis - Cori cycle. Glycogen metabolism: Glycogenesis - Glycogenolysis - Adenylate cascade system- Regulation of glycogen synthesis – Intermediate metabolism.

### Unit – V

**Metabolism of Proteins:** Deamination, transamination and transdeamination. **Metabolism of lipids:** $\beta$  oxidation – alpha oxidation - omega oxidation -synthesis of triacylglycerols - **Synthesis of essential amino acids:** methionine and valine - synthesis of purine and pyrimidine nucleotides.

## Text Books

1. Cox M.M. and Nelson D.L. Lehninger's Principles of Biochemistry, 4<sup>th</sup> Ed., New York: W.H. Freeman, 2005.
2. Ambika Shanmugam, Fundamentals of Biochemistry for Medical Students, Revised Ed., 2001.

## References

1. VoetD. and Voet, J.G., Biochemistry, 4<sup>th</sup> Ed., John Wiley & Sons, 2011.
2. BergJ.M., TymoczkoJ.L. and StryerL. Biochemistry, 6<sup>th</sup> Ed., W.H Freeman and Company, New York, 2007.
3. Zubay G.L., Principles of Biochemistry, Dubuque, Williams C, Brown Publishers, 2000.
4. MurrayR.K., Granner D.K. and Mayer P.A., Harper`s Illustrated Biochemistry: A Lange Medical Book, 26<sup>th</sup> Ed., New Delhi, McGraw-Hill, 2003.
5. Bayens J.W. and Marek D, Medical Biochemistry, 2<sup>nd</sup> Ed., Elsevier, 2005.
6. Mathews C.K., Van holde, K.E. and AHERNK.G., Biochemistry, 3<sup>rd</sup> Ed., New Delhi, Pearson Education, 2004.
7. ElliottW.H. and ElliottD.C., Biochemistry and Molecular Biology, 3<sup>rd</sup> Ed., Oxford University Press, Indian Edition, 2005.
8. DevlinT.M., Text book of Biochemistry with Clinical Correlation, John Wiley & Sons, 2002.
9. Price N.C. and Stevens L., Fundamentals of Enzymology, 3<sup>rd</sup> Ed., Oxford University Press, 2006.
10. Conn E.E., Stump P.K., Bruening G. and DOI R.H., Outlines of Biochemistry, 5<sup>th</sup> Ed., John Wiley & Sons, Indian Edition, 2007.

## CORE PRACTICAL – III : LAB IN ANIMAL PHYSIOLOGY AND IMMUNOLOGY / ENDOCRINOLOGY

**Semester: II**  
**Credits : 3**

**Code: P15ZY2P3**  
**Total Hrs. : 75**

### **General Objectives:**

1. To develop practical skills in the physiological functions of animals
2. To understand the immunological significance of mammals through experiments

### **Animal Physiology**

1. The rate of oxygen consumption in fish with reference to body weight.
2. Rate of salt loss and salt gain in crab.
3. Estimation of urea in the blood and urine by DAM method.
4. Effect of Humulin on blood glucose level (Demonstration)
5. ECG (Demonstration).
6. **Slides:** T.S of endocrine organs: Pituitary, thyroid, parathyroid, pancreas, adrenal, ovary and testis.

### **Immunology**

1. Differential counting of WBCs.
2. Blood grouping and Rh factor analysis.
3. Quantitative estimation of antigen by ELISA (Demonstration).
4. Double immune-diffusion (Demonstration)
5. WIDAL test
6. Haemagglutination
7. **Slides:** T.S of lymphoid organs: Thymus, Bone marrow, lymph node, spleen, T cells and B cells.

### **Endocrinology**

1. Pituitary cytology: a comparative study following histology, histochemistry and immunocytochemistry.
2. Adrenalectomy in rat.
3. Effect of adrenalectomy on glycogen assay.
4. Effect of metyrapone and saline administration on adrenal cortex following light microscopy.
5. Thyroidectomy in rats.
6. Effect of thyroidectomy and thyroid hormone replacement therapy on ecdysis and testicular functions in reptiles.
7. Steroid and thyroid hormone assay by ELISA.
8. Calcium estimation following fluorometry in PTH/Calcitriol treated rats.
9. Effect of orexigenic and anorexigenic hormones on feeding behaviour of rats.
10. Induction of vitellogenesis in a seasonally breeding non-mammalian vertebrate.

## CORE PRACTICAL - IV: LAB IN BIOCHEMISTRY

Semester: II  
Credits : 3

Code: P15ZY2P4  
Total Hrs. : 75

### General Objectives:

1. To understand the biochemical reactions through quantitative estimations
2. To develop practical skills in the advanced techniques for quantitative estimation of protein, amino acids, nucleic acids, etc.

### BIOCHEMISTRY

1. Preparation of solutions: i) Molarity ii) Normality iii) Percentage solution
2. Calculation of moles, millimoles and nanomoles
3. Basic and Standardization procedures
  - i) Preparation and testing of buffers: Acetate and Phosphate buffers.
  - ii) Acid-base titration and determination of pKa value.
  - iii) Measuring pH of different solutions.
4. Quantitative estimation of reducing sugars by Anthrone method.
5. Quantitative estimation of amino acids by ninhydrin method.
6. Quantitative estimation of protein by Lowry *et al.* method.
7. Quantitative estimation of nucleic acids.
8. Separation of micromolecules by Thin layer Chromatography: Sugars and drugs
9. Separation of micromolecules by Paper chromatography: Amino acids

## ELECTIVE – II: IMMUNOLOGY

Semester: II  
Credits : 4

Code: P15ZY2:1  
Total Hrs. : 60

### General Objectives:

1. To study the immune system and Immune response.
2. To understand the various immunological techniques and its applications.

### Unit – I

**Immunity:** Innate and Acquired immunity- Ultra structure and functions of primary and secondary lymphoid organs. Cell types - origin and specific functions. Antigens and Immunogens - characteristics - epitopes. **Immunoglobulins:** 3D structure-classes- antigenic determinants- class switching-generation of antibody diversity.

### Unit – II

**Immune response:** antigen recognition- processing and presentation-interaction of T and B cells - cell mediated and humoral immunity - cytokines and immune response –immunological memory – agglutination - antigen-antibody interactions.

### Unit – III

**Major Histocompatibility Complex:** structure of MHC molecules –types - MHC and antigens presentation. **Transplantation immunology:** HLA typing-immunology of graft rejection- - Hypersensitivity reactions -immunotolerance and autoimmune diseases –complements - classical and alternative pathway and immunological significance.

### Unit – IV

**Immunology of cancer:** tumor antigens- immune response to tumor antigens - immuno therapy. **Primary immunodeficiency:** SCID -**Secondary immunodeficiency:** Immunological abnormalities associated with AIDS – CD4 and CD8 cells.**Vaccines:**Vaccination schedule - Polysaccharide vaccines-toxoids- vaccines from recombinants vectors- DNA vaccines.

### Unit – V

**Immunotechniques:****Precipitin reactions:** immunodiffusion and immunoelectrophoresis RIA – ELISA- Western blotting- Complement fixation -Flow cytometry - Monoclonal antibody production -principles of immunohistochemistry- Fluorescent immunoassay (FIA)

### Text Book

Roitt, I.M., and Delves, P.J. Roitt's Essential Immunology. 10<sup>th</sup> Ed., Oxford: Blackwell Science, 2001.

## References

1. Goldsby, R.A., Kindt, T. J. and Osborne, B. A. Kuby's Immunology. 5<sup>th</sup> Ed., WH Freeman & Co., 2003.
2. Abbas, A.K. and Lichtman, A.H. Cellular and Molecular Immunology. 6<sup>th</sup> Ed., Saunders Elsevier, 2007.
3. Janeway, C. Immunobiology. 5<sup>th</sup> Ed., Garland Publications, 2001.
4. Benjamin, E., Richard, C., and Sunshine, G. Immunology: A Short Course. 4<sup>th</sup> Ed., John Wiley, New York, 2000.
5. Tizard, I.R. Immunology 4<sup>th</sup> Ed., Thomson, Singapore, 2004.
6. Chakravarty, A.K. Immunology and Immunotechnology. Oxford University Press. New Delhi, 2006.

## ELECTIVE – II: ENDOCRINOLOGY

Semester: II  
Credits : 4

Code: P15ZY2:2  
Total Hrs. : 60

### General Objectives:

1. To understand the general principles of endocrinology
2. To acquire knowledge of the hormones and its role in coordination of activities in the biological systems.

### Unit – I

**General principles of endocrinology:** hormone: classification, biosynthesis, transport and excretion-hormone receptors – identification, structures, recognition; coupling domain, physio-chemical properties, regulation of receptors Mechanism of hormone action: group I – steroid hormone receptor, mechanism of gene expression- group II peptide hormone action – membrane receptors, signal transduction, cAMP, cGMP, phosphotidyl inositol and calcium as second messenger, insulin receptors, orphan receptors – feedback mechanism – bio assay and radio immune assay of hormones.

### UNIT- II

**Endocrinology of vertebrates:** Study of hypothalamus – pituitary and pineal: Anatomy, microstructure, biosynthesis, transport and metabolism, physiology and regulation of hormones secreted. Disorders of pituitary – growth hormone- dwarfism, gigantism, acromegaly, ACTH – Cushing's disease, Vasopressin – diabetes insipidus.

### UNIT- III

**Thyroid, Parathyroid and Pancreas:** Anatomy, microstructure, biosynthesis, transport and metabolism, physiology and regulation of hormone secreted. Disorders of thyroid - Goiter, Grave's disease, cretinism, thyroiditis Disorders of parathyroid – Osteoporosis, Osteomalacia Disorders of pancreas – Diabetes mellitus.

### UNIT- IV

**Adrenal and testis:** Anatomy, microstructure, biosynthesis, transport and metabolism, physiology and regulation of hormones secreted- Disorders of Adrenal cortex – Addison's disease, hyper aldosteronism, cushing's syndrome- Disorders of testis – hypogonadism, impotence, gynaecomastia.

### UNIT- V

**Ovary:** Anatomy, microstructure, biosynthesis, transport and metabolism, physiology and regulation of hormones secreted Hormonal control of female reproductive cycles, pregnancy , parturition and lactation Disorders of ovary – amenorrhea, dysmenorrhea, polycystic ovary syndrome, hirsutism, ovarian disorders, neoplasms, menopause – hormonal contraceptive agents, hormone replacement therapy (HRT). Gastro- intestinal hormones, renal and thymic hormones



## **Text Book**

Wilson, J.D., Foster, D.W., Korenberg, H.M. and Larson P.R. William's Textbook of Endocrinology. 9<sup>th</sup>Ed. W.B. Saunders Company, Philadelphia, 1998

## **References**

1. Jeffcoate W. Lecture Notes on Endocrinology. 5<sup>th</sup> Ed., Blackwell Scientific Publication.
2. Murray R.K., Granner D.K., Mayes P.A. and Rodwell V.W. Harpers Biochemistry 22<sup>nd</sup> Ed., Prentice Hall International Inc.
3. Laycock J.F. and Wise P.H., Essential Endocrinology, 2<sup>th</sup> Ed., ELBS, Oxford University Press.
4. Watts D.H., Handbook of Medical Treatment, 17<sup>th</sup> Maruzen Asian Ed., Jones Medical Publications, 1983.
5. Walter J.B, An Introduction to the Principles of disease, 2<sup>nd</sup> W.B. Saunders Company Philadelphia, 1982.
6. Barrington, Hormones and Evolution, Vol. 1 & 2 Academic Press, New York, 1979.
7. Williams R.H., Text Book of Endocrinology, 10<sup>th</sup> Ed., W.B. Saunders Company Philadelphia, 1974.
8. Austin C.R. and Short R.V., Artificial control of Reproduction-Reproduction in Mammals, University Press, Cambridge, 1972.

## CORE –VI: ENVIRONMENTAL BIOLOGY

Semester: III  
Credits : 5

Code: P15ZY306  
Total Hrs. : 75

### General Objectives:

1. To understand the interrelation existing between abiotic and biotic environment.
2. To acquire knowledge on the environmental factors, population ecology, community ecology, ecosystem, habitat ecology and biodiversity and its conservation.

### UNIT-I

Importance and scope of ecology – **Environmental factors:** light – temperature – humidity - edaphic and biotic factors. Ecosystems: Characteristics of ecosystems - food chain – herbivorous and detritus food chains and food web - bio-magnification - Energy flow in an ecosystem– productivity - trophic levels.

### Unit - II

**Population Ecology:** Definition, Characteristics of Population: Density- Natality – Mortality – Age distribution – Growth form-Population Equilibrium – Biotic potential – Carrying capacity – Dispersal – Dispersion – Population fluctuations – Population regulation – r and K strategists. Niche concept – Types of niches: Spatial, Trophic and Multidimensional – Niche parameters: Form, Position and Width – Niche Partitioning - Realized and Fundamental Niche.

### Unit III:

**Community Ecology:** Characteristics of a Community - Ecological succession – Primary and Secondary succession –Natural and man-influenced succession - Hydrarch and Xerarch - Ecotone and Edge effect - Ecological equivalents - Ecotypes and Ecophenes - Ecological indicators.

### Unit V:

**Habitat Ecology:** Characteristics and types of fresh water and estuarine habitat. Marine habitat: Characteristics and types – Ecology of benthic zone, intertidal zone and deep sea. Physico-chemical characteristics of terrestrial habitat – Tundra, Forest, Desert and mountain biomes - Biogeographical zones of India.

### Unit-V

Biodiversity and its conservation-global environmental change – biodiversity-status, monitoring and documentation-Megadiversity and hotspots - biodiversity management approaches. Conservation biology: Principles of conservation, major approaches to management, Indian initiatives for conservation (Project Tiger, Project Elephant Biosphere reserves).

## **Text Book**

Odum, E.P. and Barrett, G.W. Fundamental of Ecology. 5<sup>th</sup> Ed., Cengage Learning India. New Delhi, 2005.

## **References**

1. Peter J.R., Stephan, L.W., Paule H., Ceche S. and Beverly, M. Ecology, Cengage learning India, New Delhi, 2008.
2. Wright, R.T., Environmental Science, 10<sup>th</sup> Ed., Pearson Education, New Delhi, 2008.
3. Smith T.M. and Smith R.L., Elements of Ecology, 6<sup>th</sup> Ed., Pearson Education, New Delhi, 2008.
4. Kormondy E.J, Concepts of Ecology, 4<sup>th</sup> Ed., PHI Cengage Learning India, New Delhi, 1996.
5. Turk A. and Turk J., Environmental Science., 4<sup>th</sup> Ed., Saunders, 1993.
6. Primark R.B., A Primer of Conservation Biology, 2<sup>nd</sup> Ed., Sinauer Associates, 2000.

## CORE-VII: DEVELOPMENTAL BIOLOGY

Semester: III  
Credits : 5

Code: P15ZY307  
Total Hrs. : 75

### General Objectives:

1. To understand the basic principles of genetic growth and development in animals
2. To acquire knowledge on the role of genes in the gonad and embryonic development in animals

### Unit – I

Introduction to Developmental Biology- spermatogenesis and oogenesis in mammals - **Fertilization in mammals:** translocation and capacitation of sperm - cell surface interactions between egg and sperm - gamete fusion- cleavage and formation of blastula- gastrulation and formation of germ layers.

### Unit – II

Concepts of induction, competence, totipotency, cell specification, commitment, determination and morphogenetic gradients - cell lineages – cell differentiation and cell aggregation in *Dictyostelium* -axis and pattern formation in drosophila – gradient and polarity.

### Unit – III

**Organogenesis:** Development and differentiation in *Caenorhabditiselegans*– development of vertebrate eye – development of tetrapod limb. **Environmental regulation of animal development:** developmental symbiosis - nutritional and seasonal polyphenism. **Abnormal development:** Teratoma and teratogens.

### Unit – IV

**Organiser:** Spemann's experiment- functions of organiser – mechanism of noggin, chordin, Follistatin, BMP4, Wnt, FGF and retinoic acid for the action of organiser.

**Metamorphosis in amphibia:** morphological changes associated with metamorphosis. **Regeneration:** Mechanism of regeneration in salamander. **Ageing:** The biology of senescence.

### Unit – V

**Genes in Gonad development:** Function of SF1, WNT4, SRY, SOX genes. **Genes in embryonic development:** Role of Homeobox genes in Drosophila and Hox genes in Mouse. Concepts of Gene Knock out, Genomic imprinting and Genomic equivalence.

### Text Book

1. Gilbert B.F., Developmental Biology, 8<sup>th</sup> Ed., Sinaur Associates Inc. Publishers, Sunderland, Massachusetts, USA, 2006.

## References

1. Wolpert L, Principles of Development, 2<sup>nd</sup> Ed., Oxford University Press, 2002.
2. Twyman R.M. Developmental Biology, Viva, New Delhi, 2008.
3. Balinsky B.I., An Introduction to Embryology, 5<sup>th</sup> Ed., Thomas Asia Pvt. Ltd., 2004.
4. Russo V.E.A, Brody S., Cove D and Ottolenghi S, Development: The Molecular Genetic Approach, Springer Verlag, Berlin, 1992.
5. Rao.V, Developmental Biology: A Modern Synthesis, Oxford IBH New Delhi, 1994.

## CORE-VIII: GENETICS

Semester: III  
Credits : 5

Code: P15ZY308  
Total Hrs. : 75

### General Objectives:

1. To understand the basic principles of Genetics
2. To acquire knowledge on the applied branches of Genetics

### Unit I

**Mendelian Genetics:**Mendelian laws of inheritance–**Classical Genetics:**Linkage – crossing over– types and mechanics – chromosome mapping –Heterogameticand Homogametic – Haplodiploidy- Mosaics andGynandromorphs. Human Y chromosome- evolution, structure, molecular organization and its role in sex determination- Dosage compensation.

### Unit-II

Extranuclear inheritance and maternal effects: Organelle heredity (mitochondria)- Infectious heredity (Cytoplasmic inheritance) in symbionts (Paramecium and Drosophila). **Maternal inheritance:**Ephestia pigmentation and snail coiling.**Environmental effects and gene expression**– Phenocopies- Twin studies and IQ- Concordance – Discordance- Penetrance and expressivity.

### Unit-III

**Microbial Genetics:**Evidence of genetic materials in Bacteria.**Bacterial transformation:** molecular mechanism-mapping by transformation. **Bacterial conjugation:** insertion of F into the bacterial chromosome- Hfr transfer- recombination in recipient cells. Transduction: DNA transfer by means of transduction- cotransduction and linkage. **Specialized transducing particles:** characteristics- role as cloning vectors.

### Unit-IV

**Evolutionary Genetics:**Genetics of races and species formation – genetic load – genetic polymorphism – X inactivation – genomic imprinting.

**Population Genetics:**Gene pool and gene frequencies – equilibrium of gene frequencies – Hardy-weinberg equilibrium – changes in gene frequencies- factors affecting Hardy-weinberg equilibrium.

### Unit-V

**Human Genetics:** Pedigree construction, inheritance patterns (autosomal, sex-linked,sex-limited and sex-influenced)-Inborn errors of metabolism in man-Haemoglobin disorders – sickle cell anemia and thalassemia. Human karyotype preparation and chromosomal syndromes in man.

## **Text Book**

1. Gardner E.J, Simmons, M.J. and Snustad D.P, Principles of Genetics, 7<sup>th</sup> Ed., John Wiley India, 2007.

## **References**

1. WilliamK.S. and CummingsM. Concepts of Genetics, 7<sup>th</sup> Ed., Pearson Education Inc, Dorling Kindersley Publication, 2011.
2. SnustadD.P. and SimmonsM.J. Genetics, VI Ed., John Wiley & Sons, Singapore, 2012.
3. SudberyP, Human Molecular Genetics, 2<sup>nd</sup> Ed., Dorling Kindersley (India) Pvt. Ltd., 2009.
4. Nancy T and TrempeyJ, Fundamental Bacterial Genetics, 2<sup>nd</sup> Ed., Malden MA; Blackwell Science, 2006.
5. Stent G.S. and Calendar R. Molecular Genetics: An Introductory Narrative, 2<sup>nd</sup> Ed., CBS Publishers and Distributers, New Delhi, 2004.
6. Klug W.S. and CummingsM.R. Concepts of Genetics. 7<sup>th</sup> Ed., Pearson Education, 2003.
7. RusselP.J. Genetics: A Molecular Approach, 2<sup>nd</sup> Ed., Pearson Education, 2006.
8. MaloyS.R.,Cronan, J.E. and Freifelder, D. Microbial Genetics 2<sup>nd</sup> Ed., Narosa Publishing House, New Delhi, 2008.
9. Pasternak, J.J. An Introduction to Molecular Human Genetics. Fitzgerald Science Press, Bethesda 2000.
10. Hancock, J.T. Molecular Genetics. New Delhi. Viva, 2008.

## CORE – IX: RESEARCH METHODOLOGY

Semester: III  
Credits : 5

Code: P15ZY309  
Total Hours: 75

### General Objectives:

1. To know the principles of research design and thesis writing.
2. To learn the methods of data collection and the application of statistical tools in solving biological problems.
3. To understand the principle and applications of the instruments used in biological sciences.

### Unit – I

**Research:** Objectives – types – significance-Components of research- Research process-Selection and Defining of a research problem- **Sources and retrieval of information:** journals, monographs, books and computeraided searches-search engines- Formulating a research Hypothesis- **Research Design:** need-features of a good design – concepts-principles of Experimental design.

### Unit – II

**Thesis writing:** format of thesis- preparation of manuscript and editing- forms of presentation of results-components of Discussion- citing the references- Research papers for publication-writing a research proposal-Impact factor-citation index- manuscript preparation-IPR and patenting.

### Unit – III

**Chromatography:** Principle and methodology of column, ion exchange and affinity chromatography-GLC and HPLC-**Centrifugation:** Differential and gradient centrifugation-Ultra centrifuge-Principles and applications of Autoradiography and X-ray crystallography.

### Unit –IV

**Spectrophotometry:** Principle, methodology and applications of Atomic absorbance spectrophotometer, Flame Photometer, UV-VIS spectrophotometer, Nuclear magnetic resonance spectrometry (NMR) and Electron spin resonance spectrometry(ESR).**Electrophoresis:** Principle, types, procedure and applications.Cell lines-cell lines culture.

### Unit – V

**Biostatistics:**Collection of data – Collection of primary data, sampling. **Descriptive statistics:** Measures of central tendency-Mean, median, mode. Measures of dispersion – Standard deviation, standard error, co-efficient of variance. Diagrammatic representation- Bar diagram, Pie diagram, histogram, frequency curve and line graph. **Inferential statistics:** Hypothesis testing, Student t' test, Chi square test, Analysis of variance (ONE-WAY ANOVA), Correlation, Regression – Application of SPSS package.



## Text Book

Kothari, C.R. Research Methodology: Methods and Techniques. 2<sup>nd</sup> Ed., New Age International Publishers, New Delhi, 2004.

## References

1. Pingoud, A. Biochemical Methods. Wiley-VCH, 2003.
2. Venn, R.F. Principles and Practice of Bioanalysis. Taylor & Francis, 2003.
3. Holme, D.J. and Peck, H. Analytical Biochemistry. 3<sup>rd</sup> Ed., Pearson Education, 1998.
4. Wilson, K. and Walker, J. Practical Biochemistry: Principles and Techniques. 5<sup>th</sup> Ed., Cambridge University Press, 2000.
5. Wilson, K. and Walker, J. Principles and Techniques of Biochemistry and Molecular Biology. 7<sup>th</sup> Ed., Cambridge University Press, 2010.
6. Holmes, D., Moody, P., Dine, D., Moody, P. and Holmes, D.S. Research Methods for the Biosciences. Oxford University Press, New Delhi, 2006.
7. Kothari, C.R. Research Methodology: Methods and Techniques. 2<sup>nd</sup> Ed., New Age International Publishers, New Delhi, 2004.
8. Ramadass, P. and Wilson Aruni, A. Research and Writing-across the Disciplines. MJP Publishers, Chennai, 2009.
9. McCleery, R.H. and WATT, T.A. Introduction to Statistics for Biology. 3<sup>rd</sup> Ed., Chapman & Hall / CRC, 2007.

**CORE PRACTICAL - V: LAB IN ENVIRONMENTAL  
BIOLOGY, DEVELOPMENTAL BIOLOGY AND GENETICS**

**Semester III**  
**Credits : 3**

**Code : P15ZY3P5**  
**Total Hours: 75**

**General Objectives:**

1. To analyze water quality through quantitative estimations
2. To observe the developmental stages in frog and chick
3. To understand the genetic significance in human being

**Environmental Biology**

Spatial variations of dissolved oxygen concentration in water and percentage saturation  
Estimation of Dissolved free carbon dioxide  
Estimation of nitrates  
Estimation of total hardness  
Estimation of total alkalinity  
Estimation of total phosphates

**Developmental Biology**

Observation of sperms in Bull's semen  
Observation of blastoderm in chick embryo  
**Slides:** Whole mount of early hours of chick embryo development (24 hrs, 48 hrs, 72 and 96 hours).  
Yolk Plug stage, neural plate, neural fold and neural tube of frog

**Genetics**

Pedigree analysis  
Study of various genetic traits in Human being  
Preparation of Human karyotype  
Identification of syndromes  
Study of sex chromatin in human buccal smear.

## ELECTIVE – III: ANIMAL BIOTECHNOLOGY

Semester: III  
Credits : 4

Code : P15ZY3:1  
Total Hrs. : 75

### General Objectives:

1. To understand the Recombinant DNA and recent advances in biotechnology.
2. To apply the concepts of biotechnology in genetic Engineering, medical, bioremediation, Human genome project and forensic sciences.

### Unit – I

Introduction- brief history-**Recombinant DNA technology**:Steps in rDNA technology. Molecular tools: restriction enzymes and DNA manipulative enzymes – gene cloning vectors: plasmids, phagemids, cosmids, bacteriophages,artificial chromosomes (BACs, PACs, YACs, MACs, and HACs)- shuttle vectors, prokaryotic and eukaryotic expression vectors-specialized vectors for expression of foreign gene.

### Unit – II

Construction of cDNA - genomic DNA libraries – preparation of radioactive and nonradioactive probes- screening of libraries using oligo probes and antibodies-Nucleic acid amplification and its application in medicine– DNA sequencing- site directed mutagenesis and protein engineering.

### Unit – III

**Genetic engineering in animals**: methods of transferring genes in to animals oocytes, eggs embryos and specific tissues (physical chemical and biological methods)- cell lines and their applications- transgenic animals (mice,cow, goat,pigs, sheep and insects)

### Unit – IV

**Medical biotechnology**: Animal biotechnology for production of regulatory proteins, blood products, vaccines, hormones and other therapeutic proteins- gene therapy- cloning. **Human Genome project**: objectives, strategies and progress.

### Unit – V

**Bioremediation**: Bio sensors, bioleaching, biochips and biofuels. Applications of Probiotics - **Forensic biotechnology**: DNA finger printing. Environmental applications of biotechnology –Biosafety and Bioethics.

### Text Book

Glick, B.R. and Pasternak, J.J. Molecular Biotechnology: Principles and Applications of Recombinant DNA. 3<sup>rd</sup> Ed., ASM Press, Washington. Indian Reprint, 2007

## References

1. Primrose, S.B. and Twyman, R.M. Principles of Gene Manipulation and Genomics. Blackwell Scientific Publications, 2006.
2. Griffiths, A.J.F., Miller, J.H., Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. Introduction to Genetic Analysis. 8<sup>th</sup> Ed., W. H. Freeman and Company, New York, 2005.
3. Brown, T.A. Gene Cloning and DNA Analysis: An Introduction. 5<sup>th</sup> Ed., Blackwell Publishing, 2006.
4. Watson, J.D., Gilman, M., Witkowski, J. and Zoller, M. Recombinant DNA. 2<sup>nd</sup> Ed., W. H. Freeman, Scientific American Books, New York, 1992.
5. Winnacker, E.L. From Genes to Clones: Introduction to Gene Technology. Panima Publishing Corporation, New Delhi. 2003.
6. Tamarin, R.H. Principles of Genetics. 7<sup>th</sup> Ed., Tata-McGraw Hill Publishing Company Ltd., New Delhi, 2006.
7. Kreuzer, H. and Massey, A. Recombinant DNA and Biotechnology. 2<sup>nd</sup> Ed., ASM Press, Washington, 2001.

## ELECTIVE III: GENOMICS AND PROTEOMICS

Semester: III  
Credits : 4

Code: P15ZY3:2  
Total Hrs. : 75

### General Objectives:

1. To understand the concepts of Genomics and Proteomics
2. To acquire knowledge on the genome and proteome applications

### Unit – I

Introduction to Genomics- Structure and organization of prokaryotic and eukaryotic genomes - nuclear, mitochondrial and chloroplast genomes- Recognition of coding and non-coding regions and annotation of genes. **Mapping of genomes:** mapping strategies –linkage maps- physical maps-low and high resolution physical mapping.

### Unit – II

Genome sequencing projects – Microbes, plants and animals. Comparative genomics of relevant organisms such as pathogens and non-pathogens. Human genome project- Taxonomic classification of organisms using molecular markers- 16S rRNA typing/sequencing. Computational analysis – Sequence analysis – similarity searches and pairwise alignment- multiple sequence alignment- phylogenetics.

### Unit – III

Functional Genomics of microbes, plants and animals- Global gene expression analysis- Microarray-comparative transcriptomics- Differential gene expression. Databases of expressed sequence tags. Data mining.

### Unit – IV

**Proteomes:** definition of proteomes; genome-proteome relationship; deducing proteome from genome. **Tools for proteomics:** Isoelectric focusing, 2D protein gels, HPLC, MS, Tandem mass spectrometry and protein sequencing and peptide fingerprinting.

### Unit – V

**Data base search in proteomics:** Hidden Markov models- protein family based homology detection. **Proteome applications:** Protein expression profiling. Protein-protein interaction- Yeast Two hybrid system - Application in drug discovery - Systems biology and metabolomics.

### Text Books

1. Cantor, C. and Smith, C.L. Genomics: The Science and Technology behind the Human Genome Project. Wiley-Interscience, New York, 2000.
2. Totowa, N.J. Introduction to Proteomics: Tools for New Biology. Humana Press, 2002.

## References

1. Brown, T.A. Genome 3. Garland Science Publishing, New York, 2007.
2. Davies, J.M. Genome Analysis: A Practical Approach. Oxford University Press, Oxford, 1995.
3. Dear, P.H. Genome Mapping: A Practical Approach. Oxford University Press, Oxford, 1997.
4. Schena, M. DNA Microarrays: A Practical Approach. Oxford University Press, Oxford, England, 1999.
5. Timothy, P. Proteomics. Kluwer Academic Publishers, 2002.
6. Pennington, A. and Dunn, M.J. Proteomics: From Protein Sequences to Function. Springer Publications, 2001.
7. Hartwell, L., Hood, L. and Goldberg, M. Genetics: from Genes to Genomes. 2<sup>nd</sup> Ed., McGraw-Hill, New Delhi, 2004.
8. Whitford, D. Proteins: Structure and Function. John Wiley & Sons, 2005.
9. Blot, M. Prokaryotic Genomics. Springer International Edition, 2003.
10. Hamden, M. and Righetti, P.G. Proteomics Today. Wiley Interscience, 2005.

## CORE-X: EVOLUTION AND ANIMAL BEHAVIOUR

**Semester-IV**  
**Credits: 5**

**Code: P15ZY410**  
**Total Hours: 75**

### General Objectives:

1. To study the Geological time scale and evolution of animals
2. To study the different aspects of behavior in animals

### Evolution

#### Unit – I

Origin of life – Abiogenesis – Cosmozoic and naturalistic theories – chemical evolution and origin of life – evidences and objections – Lamarckism – Mutation theory of De Vries – Darwinism : Theory of Natural selection – Facts that influence Darwin's thoughts - Current challenges to Darwinism: DNA and protein phylogenies – protein evolution and neutrality theory – Molecular evolutionary clock – Group selection – Altruism and kin selection – Sexual selection – Punctuated equilibrium, Micro and macroevolution.

#### Unit – II

Isolation and Speciation: Isolating mechanism – Pre and post zygotic – origin of isolation – Koopman's experiment - Speciation – definition – modes – Sympatric – allopatric and quantum speciation. The evolutionary time scale: eras-periods and epoch-major events in the evolutionary time scale. Fossil history and phylogeny of man – Cultural evolution and evolutionary future of mankind – Concepts of Exobiology.

### Animal Behaviour

#### Unit – III

Introduction to Ethology- Animal psychology, classification of behavioural patterns, analysis of behaviour (ethogram) - Reflexes and complex behavior - Perception of the environment: mechanical, electrical, chemical, olfactory, auditory and visual - Neural and hormonal control of behavior - Genetic and environmental components in the development of behavior - Communication: Chemical, visual, light and audio, evolution of language (primates).

#### Unit - IV

Ecological aspects of behaviour: Habitat selection, food selection, optimal foraging theory, anti-predator defenses, aggression, homing, territoriality, dispersal, host parasite relations. Biological rhythms: Circadian and circannual rhythms, orientation and navigation, migration of fishes and birds. Learning and memory: Conditioning, habituation, insight learning, association learning and reasoning.

#### Unit – V

Reproductive behaviour: Evolution of sex and reproductive strategies, mating systems, courtship, sexual selection, parental care. Social behaviour: aggregations, schooling in fishes, flocking in birds, herding in

mammals, group selection, kin selection, altruism, reciprocal altruism, inclusive fitness, social organization in insects and primates.

### **Text Books**

1. Brian, K. H. and Benedikt Hall, G. Strickberger's Evolution. 4<sup>th</sup> Ed., Jones and Bartlett Publishers, Inc, 2008.
2. Goodenough, J., Betty, M. and Wallace, R.A. Perspectives on Animal Behaviour. John Wiley, 1993.

### **References**

1. Futuyma, D.J. Evolutionary Biology. 3<sup>rd</sup> Ed., Sinauer Associates, Sunderland, Massachusetts, 1998.
2. Alcock, J. Animal Behaviour: An Evolutionary Approach. 7<sup>th</sup> Ed., Sinauer Associates, Inc.
3. 2001.
4. Krebs, J.R and Davis, N.B. Behavioural Ecology. 3<sup>rd</sup> Ed., Blackwell, 1993.
5. Ridley, M. Evolution. 2<sup>nd</sup> Ed., Indian Edition. Blackwell Scientific Publishers, Oxford, UK, 2004.
6. Rastogi, V.B. Organic Evolution. 12<sup>th</sup> Ed., Kedar Nath Ram Nath, Meerut.



## ELECTIVE – IV: APPLIED ENTOMOLOGY

Semester-IV  
Credits : 4

Code: P15ZY4:1  
Total Hrs. : 75

### General Objectives:

1. To study the different types of insects and their economic importance
2. To understand the different pest control measures and Integrated Pest Management

### Unit- I Insect Classification

Introduction to Entomology - General characters of Class Insecta – Classification of insects upto orders  
Classification of following insect orders (a) Orthoptera (b) Hemiptera (c) Diptera (d) Hymenoptera (e)  
Lepidoptera (f) Coleoptera- Insect Pest and their Classification

### Unit-II Pest of Agricultural and industrial importance

Life history, nature of damage and control measures of major pests of Pest of rice: Rice stem borer (*Scirpophagaincertulas*) - Pest of Sugarcane: The shoot borer (*Chiloinfuscatellus*) - Pest of coconut: The rhinoceros beetle (*Oryctes rhinoceros*) - Pest of cotton: The spotted bollworm (*Eariasinsulana*). **Insects of Industrial importance** -Biology and rearing of Honey bees, Silk worm, Lac insect – Useful Products and their Economic Values.

### Unit-III -Pest of medical and veterinary importance

Insect vectors of human diseases; Mosquitoes, Housefly, Bedbug, Sand fly, TseTse fly - Identification, nature of attack, and control measures. Veterinary pests: Identification, nature of attack, and control measures of insect pest of domestic animals – cattle, sheep and goat, fowl. Insects of forensic importance – crime detection using entomological science.

### Unit-IV

**Pest control measures:** Cultural – mechanical – physical and legal methods-Chemical control- Insecticides - classification of insecticides based on mode of entry – mode of action and chemical nature – Insecticidal formulations– insecticidal toxicity (LD<sub>50</sub> / LC<sub>50</sub>).

### Unit-V

**Insect pest-Management:Biological control;** Ecological basis and agents of biological control – Parasites, Parasitoids, Predators. Autocidal control – Sterile male technique, Chemo sterilants, methods of sterilisation, Pheromonal control, Insect repellents, Insect anti feedants, Insect attractants – definition, applications, advantages and disadvantages. Microbial control of crop pests by employing bacteria, virus and fungi- Integrated pest management(IPM).

### Text Books

1. David, B.V. and Ananthkrishnan, T.N. General and Applied Entomology. 2<sup>nd</sup> Ed., Tata McGraw Hill, New Delhi. 2004.
2. Ignacimuthu, S. S and Jayaraj S, Biological Control of Insect Pests. Phoenix Publ, New Delhi, 2003.

## References

1. David, B.V. Elements of Economic Zoology. Popular Book Depot, Chennai, 2003.
2. Nalinasundari, M.S. and Santhi, R. Entomology. MJP Publishers Chennai, 2006.
3. Awasthi, V.B. Introduction to General and Applied Entomology. Scientific Publishers, Jodhpur, 2002
4. Norris, R.F., Caswell-chen, E.P. and Kogan, M. Concepts in Integrated Pest management Prentice Hall, New Delhi, 2002.
5. Racheigl and Racheigl. Biological and Biotechnological Control of Insect Pests. CRC Press, 1998.
6. Srivastava, K. P., A textbook of Applied Entomology Vol.I. 2<sup>nd</sup>ed. Kalyani Publishers, New Delhi, 1988.

## ELECTIVE -IV: BIOINFORMATICS

**Semester-IV**  
**Credits : 4**

**Code: P15ZY4:2**  
**Total Hours: 75**

### **General Objectives:**

1. To know the metabolic databases, gene and genome analysis.
2. To understand the concepts of molecular modeling and drug designing.

### **Unit - I**

Overview of Bioinformatics – Literature, sequence and structure databases – Pattern and motif searches: PROSITE, BLOCKS, PRINTS, PFAM – Structural classification: SCOP, CATH – Metabolic pathway databases: KEGG and Biocyc - Protein structure visualization tools: RasMol, Swiss PDB Viewer

### **Unit - II**

Molecular sequence alignment: Pair wise alignment - Local and Global alignment concepts – Dynamic programming – Heuristic approach - Scoring matrices - Databases searching - FASTA and BLAST - Multiple sequence alignment – CLUSTALW and TCOFFEE.

### **Unit - III**

Gene and Genome analysis: Genome projects - Genome Mapping, Sequencing, Assembly and Annotation - genome anatomy and methods of gene prediction in prokaryote and eukaryote – comparative genomics. Protein and proteome analysis: protein identification tools – protein property prediction - protein structure prediction: secondary structure prediction - Chou-Fasman /GOR method; three-dimensional protein structure prediction: Homology modeling.

### **Unit -IV**

Molecular modeling and drug designing: Historical development of drug discovery – modern drug discovery – impact of structural bioinformatics in drug discovery – future directions - Recent advances in drug design methodologies – Structure based drug design – Drug receptor interactions – Structure activity relationships.

### **Unit – V**

Metabolomics – Transcriptomics: Genome expression analysis using microarray techniques - Applications of Microarray - Genetic variations analysis, using Single Nucleotide Polymorphism (SNP) – Systems Biology – Applications of E-cell, V-cell – Virtual rice project.

### **Text Book**

Selzer, P.M., Marhofer, R.J. and Rohwer, A. Applied Bioinformatics -An Introduction. Springer-Verlag Berlin Heidelberg, 2008.

## References

1. Lesk, A.M. Introduction to Bioinformatics. Oxford University Press, New Delhi, 2003.
2. Baxevanis, A.D. and Ouellette, B.F. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. 3<sup>rd</sup> Ed., Wiley Interscience, Hoboken, NJ. 2005.
3. Mount, D.W. Bioinformatics: Sequence and Genome Analysis. 2<sup>nd</sup> Ed., Cold Spring Harbor Laboratory Press, New York, 2004.
4. Higgins, D. and Taylor, W. Bioinformatics: Sequence, Structure and Databanks, Ed., Oxford University Press, New Delhi, 2000.
5. Gibson, G. and Muse, S.V. A Primer of Genome Science. Sinauer Associates, Inc. Publishers, 2002.
6. Campbell, A.M. and Heyer, L.J. Discovering Genomics, Proteomics & Bioinformatics. Pearson Education, New Delhi, 2004.
7. Creighton, T.E. Protein Function: A Practical Approach. Oxford University Press, 2004.
8. Pennington, S.R. and Dunn, M.J. Proteomics: from Protein Sequence to function. BIOS Scientific Publishers, 2002.
9. Sensen, C.W. Essentials of Genomics and Proteomics. Ed., Wiley-VCH, 2002.

**PROJECT**

**Semester-IV**  
**Credits : 5**

**Code: P15ZY4PJ**  
**Total Hrs. : 300**

**PG - NMEC Courses**  
**(Offered to Students of other Disciplines)**

(For the candidates admitted from the academic year 2016 onwards)

Sem.	Course	Code	Title	Hrs./ week	Credits	Marks		
						CIA	ESA	TOTAL
II	NMEC	P15ZY2E1	Zoology For Entrepreneurship	4	2	25	75	100

## NMEC I: ZOOLOGY FOR ENTREPRENEURSHIP

Semester: II  
Credits : 2

Code: P15ZY2E1  
Total Hrs. : 60

### General Objectives:

1. To acquire knowledge on small scale industries like vermiculture, apiculture, sericulture, aquaculture, poultry farming and their economics.
2. To promote entrepreneurship related to the field of Zoology.

### Unit I

Introduction and scope- **Vermiculture**: Introduction – species of earthworm -Preparation of vermibed - management: factors affecting management practices – harvesting -vermiwash – Economics - organisation.

### Unit II

**Apiculture**: Introduction - species of honeybees - bee colony - Newton hive - care and management- extraction of honey - nutritive and medicinal value of honey – Economics – Agencies involved.

### Unit III

**Sericulture**: Introduction - types of silkworm - life cycle of silkworm (*Bombyx mori*) Species of Mulberry - rearing – reeling - Economic importance of silk – Economics.

### Unit IV

**Aquaculture**: Construction of pond: nursery, stocking - management of a pond- Freshwater cultivable fishes: Major carps:Catla, Rohu, Mrigala - fish feed - induced breeding - Economics. Ornamental fish culture – management and economics.

### Unit V

**Poultry farming**: Desi class: Aseel and Gagus - Exotic class: leghorn and Rhode Island - housing of chicken: deep litter system, cage system, brooder housings, grower housings - poultry equipments: feeder, waterer, brooder, cages - Economics.

### Text book:

1. Shukla G.S and Upadhyay V.B,Economic Zoology, Rastogi Publications 2004.

### Reference

1. Gnanamani M.R,Poultry Keeping, Deepam Publication 1978
2. Srinivasulu Reddy M,Sambasiva Rao K.R.S,A Text Book of Aquaculture. DPH 1994