

**SYLLABUS for M. Sc. Zoology**  
**Choice Based Credit System (Semester Pattern)**  
**Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur**  
**With effect from 2018-19**

Candidates opting for this course are advised to go through the direction relating to the course “DIRECTION RELATING TO THE EXAMINATION LEADING TO THE DEGREE OF MASTER OF SCIENCE, SEMESTER PATTERN (CHOICE BASED CREDIT SYSTEM) AND DEGREE OF MASTER OF SCIENCE AND TECHNOLOGY (APPLIED GEOLOGY). SEMESTER PATTERN, (CHOICE BASED CREDIT SYSTEM) (FACULTY OF SCIENCE & TECHNOLOGY)” which is available on R. T. M. Nagpur University website.

The direction will provide details on admission criteria, rules for ATKT, scheme of examination, absorption scheme for CBS students into CBCS pattern, elective papers, foundation course papers, subject centric papers, coding pattern, pattern of question papers, practicals, distribution of marks, seminars, project work, internal assessment, calculation of SGPA and CGPA, etc.

**Syllabus for M. Sc. Zoology (Semester with credit based Pattern) w e f 2018-19 Academic session**

**Scheme of teaching and examination under semester pattern Choice Based Credit System (CBCS) for M.Sc. Program in Zoology**

<b>M. Sc. Zoology Semester I</b>											
Code	Theory / Practical	Teaching scheme (Hours / Week)				Credits	Examination Scheme				
		Th	Pract	Total	Duration in hrs		Max. Marks		Total Marks	Minimum Passing Marks	
							Exte rnal	Inter nal		Th	Prac
Core 1	Paper <b>1T<sub>1</sub></b> : Structure and Function of Invertebrates	4	-	4	4	3	80	20	100	40	
Core 2	Paper <b>1T<sub>2</sub></b> : General Physiology	4	-	4	4	3	80	20	100	40	
Core 3	Paper <b>1T<sub>3</sub></b> : Cell Biology and Genetics	4	-	4	4	3	80	20	100	40	
Core 4	Paper <b>1T<sub>4</sub></b> : Advanced Reproductive Biology	4	-	4	4	3	80	20	100	40	
Pract. Core 1 & 2	Practical <b>1P<sub>1</sub></b> : Based on theory Paper <b>1T<sub>1</sub>&amp; 1T<sub>2</sub></b>	-	8	8	4	3-8*	100*	-	100		40
Pract. Core 3 &	Practical <b>1P<sub>2</sub></b> : Based on	-	8	8	4	3-8*	100*	-	100		40

4	theory Paper <b>1T<sub>3</sub>&amp; 1T<sub>4</sub></b>											
Seminar 1	<b>Seminar -1S<sub>1</sub></b>	2	-	2	1			25	25	10		
	<b>TOTAL</b>	<b>18</b>	<b>16</b>	<b>34</b>	<b>25</b>			<b>520</b>	<b>105</b>	<b>625</b>	<b>170</b>	<b>80</b>

### M. Sc. Zoology Semester II

Code	Theory / Practical	Teaching scheme (Hours / Week)				Credits	Examination Scheme					
		Th	Pract	Total	Duration in		Max. Marks		Total Marks	Minimum Passing Marks		
							Exte rnal	Inter nal		Th	Pract	
Core 5	Paper <b>2T<sub>1</sub></b> : Structure and Function of Vertebrates	4	-	4	4	3	80	20	100	40		
Core 6	Paper <b>2T<sub>2</sub></b> : Comparative Endocrinolog y	4	-	4	4	3	80	20	100	40		
Core 7	Paper <b>2T<sub>3</sub></b> : Molecular Biology and Biotechnolog y	4	-	4	4	3	80	20	100	40		
Core 8	Paper <b>2T<sub>4</sub></b> : Advanced Development al Biology	4	-	4	4	3	80	20	100	40		
Pract. Core 5 & 6	Practical <b>2P<sub>1</sub></b> : Based on theory Paper <b>2T<sub>1</sub>&amp; 2T<sub>2</sub></b>	-	8	8	4	3- 8*	100* *	-	100		40	
Pract. Core 7 & 8	Practical <b>2P<sub>2</sub></b> : Based on theory Paper <b>2T<sub>3</sub>&amp; 2T<sub>4</sub></b>	-	8	8	4	3- 8*	100* *	-	100		40	
Seminar 2	<b>Seminar -2S<sub>2</sub></b>	2	-	2	1			25	25	10		
	<b>TOTAL</b>	<b>18</b>	<b>16</b>	<b>34</b>	<b>25</b>			<b>520</b>	<b>105</b>	<b>625</b>	<b>170</b>	<b>80</b>

### M. Sc. Zoology Semester III

Code	Theor y Practi cal	Teaching scheme (Hours / Week)			Credit	Examination Scheme			
		T	P	T		D	Max. Marks	T	Minimum

										Passing Marks	
							Exte rnal	Inter nal		Th	Pract
Core 9	Paper <b>3T<sub>1</sub></b> : Parasitology and Immunology	4	-	4	4	3	80	20	100	40	
Core 10	Paper <b>3T<sub>2</sub></b> : <b>Special Group- Paper I</b> • Entomology • Fish and Fisheries • Mammalian Reproductive Physiology (MRP) • Animal Physiology • Environment al Biology	4	-	4	4	3	80	20	100	40	
Core 11	<b>Special Group- Paper 3T<sub>3</sub></b> • Entomology • Fish and Fisheries • Mammalian Reproductive Physiology (MRP) • Animal Physiology • Environment al Biology	4	-	4	4	3	80	20	100	40	
Foundati on Course 1 (NOTE: Only for students of other M. Sc. Subjects	Paper <b>3T<sub>4</sub></b> : Foundation - I • Basic Entomology / • Core (Subject Centric)- I Wild Life and Avian	4	-	4	4	3	80	20	100	40	

)	Biology										
Pract. Core 9	Practical <b>3P<sub>1</sub></b> : Based on theory of <b>3T<sub>1</sub></b>	-	8	8	4	3-8*	100*	-	100		40
Pract. Core Elective 1 and 2	Practical <b>3P<sub>2</sub></b> : Based on theory of <b>3T<sub>2</sub></b> and <b>3T<sub>3</sub></b>	-	8	8	4	3-8*	100*	-	100		40
Seminar 3	Seminar - <b>3S<sub>3</sub></b>	2	-	2	1			25	25	10	
	<b>TOTAL</b>	<b>18</b>	<b>16</b>	<b>34</b>	<b>25</b>		<b>520</b>	<b>105</b>	<b>625</b>	<b>170</b>	<b>80</b>

### M. Sc. Zoology Semester IV

Code	Theory / Practical	Teaching scheme (Hours / Week)				Examination Scheme					
		Th	Pract	Total	Credits	Duration in hrs.	Max. Marks		Total Marks	Minimum Passing Marks	
							Ext ern	Int ern		Th	Pract
Core 11	<b>Paper 4T<sub>1</sub></b> : Biotechnology, Biostatistics, Ethology, Toxicology and Bioinformatics	4	-	4	4	3	80	20	100	40	
Core 12	<b>Paper 4T<sub>2</sub></b> : <b>Special Group- Paper 4T<sub>2</sub></b> • Entomology • Fish and Fisheries • Mammalian Reproductive Physiology (MRP) • Animal Physiology • Environmental Biology	4	-	4	4	3	80	20	100	40	
Core	Paper <b>4T<sub>3</sub></b> :	4	-	4	4	3	80	20	100	40	

Elective 2	<b>Special Group- Paper 4T<sub>3</sub></b> <ul style="list-style-type: none"> <li>• Entomology</li> <li>• Fish and Fisheries</li> <li>• Mammalian Reproductive Physiology (MRP)</li> <li>• Animal Physiology</li> <li>• Environmental Biology</li> </ul>										
Foundation Course 2 (NOTE: Only for students of other M. Sc. Subjects)	<b>Paper 4T<sub>4</sub>: Foundation- II</b> <ul style="list-style-type: none"> <li>• Applied and Industrial Entomology /</li> <li>• Core (Subject Centric)-II Radiation and Chronobiology</li> </ul>	4	-	4	4	3	80	20	100	40	
Pract. Core 11, 12 & Elective 2	<b>Practical 4P<sub>1</sub>: Based on theory of 4T<sub>2</sub> and 4T<sub>3</sub></b>	-	8	8	4	3-8*	100**	-	100		40
Project	Project - <b>Pro</b>	-	8	8	4	3-8*	100**	-	100		40
Seminar 4	Seminar- <b>4S<sub>4</sub></b>	2	-	2	1			25	25	10	
	<b>TOTAL</b>	<b>18</b>	<b>16</b>	<b>34</b>	<b>25</b>		<b>520</b>	<b>105</b>	<b>625</b>	<b>170</b>	<b>80</b>

Note: Th = Theory; Pr = Practical/lab, \* = If required, for two days.

\*\* = The Practical and Project shall be evaluated by both the External and Internal Examiner in the respective Department / Center / Affiliated College.

**Changes in practical curriculum as per UGC Notification No. F.14-6/2014 (CPP-II) Dated 1<sup>st</sup> August 2014 (w.e.f. academic session 2015-16)**

**Important Instructions**

- I. Use of animals for dissection for practical purpose in the curriculum is banned by UGC vide its notification No. F.14-6/2014 (CPP-II) dated 1<sup>st</sup> August 2014. It is now essential to use necessary alternatives to stop dissection and promote and orient students towards the knowledge component rather than skill development using ICT and available resources without disturbing natural habitat. To understand anatomy of

any animal, virtual dissection of the animal should be conducted through various computer simulations. These digital learning devices and available resources are to be used to demonstrate the dissection of the animals and other laboratory exercises and to evaluate the students at the time of examination and to ensure compliance of the aforesaid notification.

- II. Those institutions which are already having Zoology museum / Permanent Slides / Skeleton and Loose Bones of any animals should use them till they last. No new specimens/ slides or any other laboratory material procured from animal source shall be purchased for conducting practicals mentioned here- in above. If needed, they should purchase charts/ models/ photographs or digital sources as alternatives.
- III. During regular practical and practical examination, for anatomical observations, demonstration and detailed explanation of the given system of Invertebrate/ Vertebrate animal, the student will expose/ explain the given system of the animal and draw, label and comment on it.
- IV. During regular practical and practical examination, for mounting of given material and permanent stained preparation, the student is expected to describe the process and/or identify, draw, label and describe the given material.

## **Semester-I**

### **Paper-IT1, Structure and function of Invertebrates**

#### **Unit-I**

- 1.1 Classical and molecular taxonomic parameters, species concept, systematic gradation of animals, nomenclature, modern scheme of animal classification into sub-kingdom, division, section, phyla and minor phyla.
- 1.2 Ultrastructure of protozoan locomotory organs (pseudopodia-cytoplasmic organelles, flagella, cilia and pellicular myonemes) and mechanism of various modes of locomotion.
- 1.3 Dermal cells and skeletal organization in calcareous sponges, Hexactinilida and Demospongiae (Porifera).
- 1.4 Polymorphism and metagenesis in coelenterate. Types of polyps, medusa and metamorphosis.

#### **Unit-II**

- 2.1 Origin of metazoan-colonial, syncytial and molecular theories.
- 2.2 Reproductive system-structure and mechanism of reproduction in *Dugesia*, *Fasciola*, *Taenia* and *Ascaris*.
- 2.3 Formation, Evolution and significance of coelom, metamerism and symmetry in classification of animals, particularly coelomata.
- 2.4 Evolution of nephridia and mechanism of excretion (nitrogenous excretory products, transport of water and salts) in Polychaeta, Oligochaeta and Hirudinea of Annelida.

#### **Unit-III**

- 3.1 *Peripatus* (Onychophora) structure, affinities and taxonomic position.
- 3.2 Respiratory organs in Arthropoda. Mechanism of gaseous exchange in tracheal respiration in Insecta and gill respiration in Crustacea.
- 3.3 *Neopilina* ( Monoplacophora): structure, affinities and taxonomic position.
- 3.4 Neuroanatomy in Gastropoda, Bivalvia and Cephalopoda.

#### **Unit-IV**

- 4.1 Water vascular system in Echinodermata: structure and functions.
- 4.2 Larval forms in Echinodermata: Metamorphosis and phylogenetic significance.
- 4.3 General account and affinities of Ctenophora and Rotifera.
- 4.4 General account and affinities of Entoprocta and Ectoprocta.

#### **Semester-I**

##### **Paper-IT2, General Physiology**

#### **Unit-I**

- 1.1 Enzyme: Classification, mechanism of enzyme action. Factors affecting enzyme action, regulation of enzyme activity, activators and inhibitors.
- 1.2 Respiratory pigments- types, distribution and properties, structure of haemoglobin and mechanism of O<sub>2</sub> transport.
- 1.3 Neurotransmitters: chemical nature, biosynthesis and mechanism of synaptic transmission.
- 1.4 Colour change mechanism: Chromatophores and melanophores- structure, physiology and significance.

#### **Unit-II**

- 2.1 Bioluminescence: light producing organs- distribution in invertebrates and vertebrates, physiology and significance.
- 2.2 Thermoregulation in poikilotherms and homeotherms, adaptations and regulatory mechanisms.
- 2.3 Osmoregulation in Pisces and Amphibia, mechanism of salt and water transport by gills and kidney.
- 2.4 Molecular mechanism of peptide and steroid hormonal action. Membrane receptors and signal transduction.

#### **Unit-III**

- 3.1 Myogenic and neurogenic heart, Cardiac cycle- Phases of cardiac cycle, ECG pace maker, and heart valves.
- 3.2 Digestion and absorption of carbohydrate, proteins and lipids in the gastrointestinal tract.
- 3.3 Carbohydrates- classification and metabolism- glycogenesis, glycogenolysis, glycolysis, TCA cycle, electron transport system and oxidative phosphorylation.
- 3.4 Lipids- classification and metabolism- oxidation of fatty acids, cholesterol metabolism. Proteins- classification and metabolism- oxidative deamination, decarboxylation and trans amination of amino acids, arginine-ornithin cycle.

#### **Unit-IV**

- 4.1 Hydromineral metabolism-water electrolyte balance, mineral metabolism in bone and egg shell formation.
- 4.2 Cerebrospinal fluid: Chemistry and functions.
- 4.3 Mechanism of reflex action.
- 4.4 Physiology of environmental stress and strain- tolerance, avoidance, resistance and physiological adaptations.

#### **Semester-I**

##### **Paper-IT3, Cell Biology and Genetics**

## **Unit-I**

- 1.1 Membrane structure and function - structure of model membrane, lipid bilayer, membrane protein diffusion, osmosis, active transport, uniport, multiport, symport, antiport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.
- 1.2 Structural organization and functions of cell organelles- nucleus, mitochondria, endoplasmic reticulum, Golgi complex, lysosomes and peroxisomes.
- 1.3 Structure and Functions of microfilaments, microtubules and their role.
- 1.4 Cell division and cell cycle - phases of cell cycle, checkpoints of cell cycle, regulation of cell cycle, mitosis, meiosis.

## **Unit-II**

- 2.1 Cell signaling - hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, Receptor protein- tyrosin kinase and ion channel receptors.
- 2.2 Signal transduction pathways, primary and secondary messenger systems, regulation of signaling pathways.
- 2.3 Cellular communication - general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix and integrins.
- 2.4 Cancer - genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis.

## **Unit-III**

- 3.1 Mendelian, non-Mendelian inheritance - mono / dihybrid inheritance, types of dominance, multiple allelism, probability, exercises for solving genetics problems.
- 3.2 Extensions of Mendelian principles - codominance, incomplete dominance, gene interactions, linkage and crossing over, sex linkage, sex limited and sex influenced characters.
- 3.3 Quantitative Genetics - polygenic traits and mode of inheritance, analysis of variation, genetic and environmental factors, heritability, inbreeding and consequences, coefficient of inbreeding and consanguinity.
- 3.4 Mutation - types, causes and detection, mutant types- lethal, conditional, biochemical, loss of function, gain of function, germinal versus somatic mutants.

## **Unit-IV**

- 4.1 Structural and numerical alterations of chromosomes - deletion, duplication, inversion, transversion, translocation, ploidy and their genetic implications.
- 4.2 Extra chromosomal inheritance - cytoplasmic inheritance, inheritance of mitochondrial genes, maternal inheritance.
- 4.3 Microbial genetics - recombination in bacteria and gene mapping, transformation, conjugation, transduction (generalized and specialized), fine structure mapping of genes.
- 4.4 Human genetics- pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.

## **Semester-I**

### **Paper-IT4, Advanced Reproductive Biology**

## **Unit-I**

- 1.1 Various methods of asexual and sexual reproduction in Protozoa.



- 1.2 Regeneration in *Hydra*, *Dugesia* and Annelid worms; Morphogenesis and hormonal control.
- 1.3 Metamorphosis in insects: Partial and complete metamorphosis, metamorphic forms- nymph, larvae and pupae.
- 1.4 Mechanism of vitellogenesis in insects.

#### **Unit-II**

- 2.1 Spermatogenesis: Process, hormonal control and ultra-structure of spermatozoa of man.
- 2.2 Mechanism of oogenesis: Process, biochemical events, hormonal regulation.
- 2.3 Cytological and molecular events of fertilization.
- 2.4 Types of cleavage, blastulation, gastrulation and embryonic induction.

#### **Unit-III**

- 3.1 Male accessory sex glands in mammals: structure, secretion and functions.
- 3.2 Semen- biochemical composition and sperm abnormality.
- 3.3 Sperm capacitation and decapacitation- molecular mechanism and significance.
- 3.4 Pheromones and sexual behavior in mammals.

#### **Unit-IV**

- 4.1 Neurohormonal control of fish reproduction and mechanism of vitellogenesis.
- 4.2 Molecular induction (Morphogenetic gradients) and organizer concept.
- 4.3 Cryopreservation of gametes, embryo and test-tube baby.
- 4.4 In vitro fertilization (IVF) and its significance.

### **Semester I, Practical-1P1, Structure and Function of Invertebrates and General Physiology Section-A**

- 1 Study of museum specimens using already available specimens in the museum/ charts/ models/ photographs/ digital alternatives etc.**  
Classification upto order and comments on the specimens representing all phyla.
- 2 Anatomical Observations**  
Anatomical observations, demonstration and detailed explanation of a) **Digestive system** of Earthworm, Leech, Cockroach, Silkworm and Honey bee b) **Nervous system** of Prawn, Cockroach, Silkworm and Honey bee and c) **Reproductive system** of Earthworm, Leech, Cockroach and Honey bee with the help of ICT tools/ Models/ Charts/ Photographs etc.
- 3 Mounting-** Whole mount preparation of plankton and/or study of permanent preparation of the following with the help of already available permanent slides/ ICT tools/ charts/ photographs etc.
  - a. Earthworm – Nerve ring, ovary, spermatheca, nephridia.
  - b. Leech – jaws, ciliated organ.
  - c. Cockroach – Mouth parts, Salivary glands, trachea.
  - d. Prawn –Appendages, Statocyst.
  - e. Protozoans- rhizopods , flagellates , ciliates (fresh water forms).
  - f. Porifera – Spicules and gemmules of fresh water sponges.
  - g. Crustaceans and rotifers - Planktonic copepodes, cladoceran, ostracoderm and rotifers.
  - h. Larval forms of the free living invertebrates.
  - i. Larval forms of parasitic invertebrates.



2. Preparation of human karyotypes by using photographs/pictures.
3. Demonstration of Barr body in human female leucocytes.
4. Demonstration of polytene chromosome in dipteran larvae with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
5. Problems on genetics based on monohybrid/dihybrid ratios, sex linked inheritance and blood groups.
6. Study of various human genetic traits.

### Section-B

- 1 Study of meiotic chromosomes and spermatogenesis in grasshopper with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
- 2 Demonstration of oogenesis in earthworm/ fish/ rat ovary with the help of already available permanent slides/ ICT tools/ charts/ photographs etc.
- 3 Semen analysis: physical viscosity, pH, liquefaction time, agglutination test, motility and sperm count (Source of semen: Government artificial insemination centre).
- 4 Sperm vitality study using suitable stains (Source of semen: Government artificial insemination centre).
- 5 Hypo-osmotic swelling (HOS) for the assessment of normal semen.
- 6 Study of vaginal smear in rat by temporary mounting (methylene blue) or by permanent stained (Haematoxylin-eosin) with the help of already available permanent slides/ ICT tools/ charts/ photographs etc.
- 7 Histology of male and female reproductive organs and accessory reproductive glands with the help of already available permanent slides/ ICT tools/ charts/ photographs etc.

### Distribution of Marks

	<b>Marks</b>
1. Cytological preparation	20
2. Problems on genetics (any two)	20
3. Spermatogenesis/oogenesis/spermvitality	15
4. Sperm count/vaginal smear/hypo-osmotic test for fertility	10
5. Identification and comment on spots (1-5)	15
6. Class record	10
7. Viva-voce	10

**Total marks**100

- **Suggested Readings**

#### Structure and function of Invertebrates

1. Hyman L.H. The Invertebrate Vol. I, Protozoa through Ctenophora. McGraw-Hill Co., New York.
2. Barrington E.J.W. Invertebrate structure and function. Thomas Nelson and sons Ltd., London.
3. Jagerstein G. Evolution of Metazoan life cycle . Academic press, New York and London.
4. Hyman L.H. The invertebrate vol. 2 McGraw-Hill Co., New York.
5. Hyman L.H. The invertebrate vol. 8 McGraw-Hill Co., New York.
6. Barnes R.D. Invertebrate Zoology W.B. Saunders and Co., Philadelphia
7. Russet HunterW.D.D. biology of higher invertebrate The Macmillan Co. Ltd., London.

8. Hyman L.H. The Invertebrates, smaller coelomate groups. Vol. 5 McGraw-Hill Co. New York.
9. Read C.P. Animal Parasitism. Prentice Hall. New-Jersey.
10. Kudo R.R. (1966) Protozoology, Charler, C. Thomas Springfield, Illinois.
11. Barradailes L.A. and potts F.A. Invertebrates (1961) The Eastham L.E. S. Saunders, Cambridge University Press, Cambridge.
12. Russel W.D. Hunter, Biology of lower invertebrates McMillan, New York.
13. Marshall A.J. and Williams W.D. (1972) J. B. Zoology of Invertebrates , EIBs and McMillan, London.
14. Gtryyrt V. and Graham A. A Functional anatomy of Invertebrates. Academic press, New York.
15. Backlemiccher W.N. Principles of comparative anatomy of Invertebrates Oliver and Boyed Edinberg.
16. Hadisi J. The Evolution of Metazoa. Pergamon Press, Oxford.
17. Dales R.P. Annelids, Hutchinson, London.
18. Green J. Biology of Crustacea, Wither by, London.
19. Morton J. E. Mollusca, Hutchinson, London.
20. Nichols D. Echinodermata, Hutchincon, London.

### **General Physiology**

1. Text Book of Physiology & Biochemistry: Bell, G.E. & Davidson, J.N. & Emslie D. Smith, 1922.
2. Medical Physiology: A Wiley Medical Publication, John Wiley & Sons, New York.
3. Mineral Metabolism: Comar, C.L. & Felix Bronner (1961) Acad Press, New York & London.
4. A Text Book of General Physiology: Dayson (1964): Little Brown & Co. Boston.
5. Animal Physiology: R. Eckert & D. Randall (1983) 2nd Edn., W.H. Rexeman & Co.
6. Biochemistry & Physiology of the Cell: (2nd Edn.), M.A. Edwards & K.A. Hassall (1980) Mc. Graw Hill Co.
7. The Physiology of Cells: Cuthe F. (1968): The Macmillan Co.
8. Textbook of Medical Physiology: Guyton, A.G. (1968). 7th Edn.Saunders Pub.
9. Samson Wrights Applied Physiology: Oxford University Press.
10. Comparative Animal Physiology C.L. Prosser, W.B. Saunders & Company.
11. Animal Physiology: Mechanism & Application, R. Eckert, W.H. Freeman & Company.
12. General & Comparative Animal Physiology: W.S. Hoar.
13. Medical Physiology: W.F. Ganong (1981): 10th Edn. Lange Medical Publications.
14. Principles of Anatomy and Physiology: Tortora Grabowski, 9th Edn.John Willey & Sons.
15. Reproductive Physiology of Vertebrates: Van Tienhoven, A. (1983): 2nd Edn. Cornell Univ. Press, New York.

### **Cell Biology and Genetics**

1. Cell and Molecular Biology by De Robertis- E. D. P., I. S. E. publication.
2. Molecular Biology by Turner P. C. and Mc Lennan , Viva Books Pvt. Ltd.
3. Advanced Molecular Biology by Twyman R. M., Viva Books Pvt. Ltd.
4. Molecular Biology by Freifelder D., narosa publication House.
5. Gene VI by Benjamin Lewis, Oxford press.
6. Gene VIII by Benjamin Lewis, Oxford press.

7. Molecular biology of Gene by Watson J. D. et. al., Benjamin publication.
8. Molecular cell Biology by Darnell J. Scientific American Books USA.
9. Molecular Biology of the Cell by Alberts B., Bray D. Lewis J., Garland publishing Inc.
10. Genetics Vol. I and II by Pawar C. B., Himalaya publication.
12. Essentials of Molecular Biology by Freifelder D., Narosa publication House.
13. Molecular Cell Biology by Lodish H., Berk A., Zipursky S. L., Matsudaira P., Baltimore D. and Darnell J., W. H. Freeman and Co.
14. The Cell: Molecular Approach by Cooper G. M.
15. Molecular Biology by Upadhyay A and Upadhyay K. Himalaya publication.

### **Advance reproductive Biology**

1. Developmental Biology. 2<sup>nd</sup> Edition. Leon W. Browner Saunders College publishing.
2. Current Topics in Developmental Biology eds. R. A. Pedersen and G. P. Schatten.
3. Principles of animal developmental biology: S. C. Goel, Himalaya Publishing House.
4. Developmental Biology, S.F. Gilbert. 4<sup>th</sup> Edn. Sinauer Associates Inc. Publishers.
5. An Introduction to Developmental Biology: D. A. Ede.
6. Principles of developmental: Paul Weiss edited by Hafner publishing company New York.
7. Cells into organs. 2<sup>nd</sup> Edition. The forces that shape the Embryo. John Philip Trinkaus ed. Tom Aloisi.
8. Principles of development: Lewis Wolpert et al. 1998. Oxford University Press.
9. Foundations of Embryology. B. M. Patten & B. M. Carlson. Tata McGraw Hill Publishing Company Ltd., New Delhi.
10. An Introduction to Embryology: Balinsky (1981) 5<sup>th</sup> Ed. (CBS College Publishing).
11. Embryonic and foetal development. Cambridge University Press by Austin and Short, 1982, 1994 2<sup>nd</sup> Ed.
12. Marshall's Physiology of Reproduction Longmont, Green and Co. London Vol. 1 & 2. Lamming 1984, 2000.

## **Semester-II**

### **Paper-2T1, Structure and Function of Vertebrates**

#### **Unit-I**

- 1.1 Origin and ancestry of Chordata.
- 1.2 General organization and affinities of Cephalochordata.
- 1.3 Structure, development and metamorphosis of Amocoetus.
- 1.4 General characters and affinities of Dipnoi.

#### **Unit-II**

- 2.1 Organs and mechanism of respiration in Pisces and Amphibia.
- 2.2 Vertebrate integument and its derivatives.
- 2.3 Appendicular skeleton (Limbs and girdles) in Amphibia, Reptilia, Aves and Mammals.
- 2.4 General body organization and classification in Chelonia.

#### **Unit-III**

- 3.1 Evolution of urinogenital organs in vertebrates.
- 3.2 Origin of Birds.
- 3.3 Cetacea: general characters and adaptations.
- 3.4 Comparative anatomy of the brain in vertebrates (teleost, frog, lizard, fowl and rat).

#### **Unit-IV**

- 4.1 Autonomous nervous system in vertebrates: structure and functions.

- 4.2 Evolution of heart in vertebrates.
- 4.3 Sense organs in vertebrates.
- 4.4 Evolution of Man.

## **Semester-II**

### **Paper-2T2, Comparative Endocrinology**

#### **Unit-I**

- 1.1 Hormones and functions in Coelenterata and Helminths.
- 1.2 Neurosecretory system in Annelida: structure, hormones and functions.
- 1.3 Neuroendocrine system in Mollusca: structure, hormones and functions.
- 1.4 Hormones and functions in Echinodermata.

#### **Unit-II**

- 2.1 Neuroendocrine system in crustacean; structure and hormones.
- 2.2 Endocrine control of metamorphosis, reproduction and colour change mechanisms in crustacea.
- 2.3 Cephalic neuroendocrine system in insects: structure and hormones.
- 2.4 Endocrine control of metamorphosis and reproduction in insects.

#### **Unit-III**

- 3.1 Pineal organ: structure, hormones and functions.
- 3.2 Hypothalamo hypophysial system: structure, hypothalamic nuclei, hormones and function.
- 3.3 Pituitary: cell types, hormones and functions.
- 3.4 Thyroid: Structure, hormones and function.

#### **Unit-IV**

- 4.1 Parathyroid ultimobranchial glands: Structure, hormones and regulatory mechanisms.
- 4.2 Gastro-entero-pancreatic endocrine system: endocrine pancreas and gastro intestinal tract: endocrine cells, hormones and functions.
- 4.3 Adrenal gland: structure, hormones and functions in vertebrates.
- 4.4 Gonadal hormones in vertebrates and their hormonal actions, feedback mechanisms.

## **Semester-II**

### **Paper-2T3, Molecular Biology and Biotechnology**

#### **Unit-I**

- 1.1 Cot  $\frac{1}{2}$  and Rot  $\frac{1}{2}$  values, organelle genome, DNA structure, forms of DNA.
- 1.2 DNA replication – molecular mechanisms of prokaryotic and eukaryotic DNA replication, regulation of replication.
- 1.3 DNA damage and repair – types of DNA damages, excision repair system.
- 1.4 Mismatch repair, recombination repair, double strand break repair, and transcription coupled repair.

#### **Unit-II**

- 2.1 Transcription- prokaryotic and eukaryotic transcription, RNA polymerases, transcriptional unit, initiation, elongation, termination, transcriptional factors.
- 2.2 Regulation of transcription – Operon, positive and negative control, attenuation phage strategies, anti-termination, response elements and inducible elements.
- 2.3 Translation - prokaryotic and eukaryotic translation, genetic code, altered code in elongation, termination factors, fidelity of translation, post translational modifications.

- 2.4 Mobile DNA elements – transposable elements, IS elements, P elements, retroviruses, retrotansposons.

### **Unit-III**

- 3.1 Antisense and ribozyme technology – initiation of splicing, polyadenylation, molecular mechanisms of antisense molecules, miRNA, siRNA, gene silencing.
- 3.2 Isolation and sequencing of DNA, gene amplification, PCR, RAPD, RFLP, Maxam-Gilbert, Sanger's dideoxy methods.
- 3.3 Splicing and Cloning – Cloning vectors for recombinant DNA technology- plasmids, cosmids, phagemids, YACS, gene replacement, restriction enzymes.
- 3.4 Hybridization techniques – Southern- Northern hybridization, microarray.

### **Unit-IV**

- 4.1 Medical biotechnology-Application of restriction fragment length polymorphism (RFLP) in forensic science, disease prognosis and genetic counseling.
- 4.2 Agricultural biotechnology- biofertilizers, bioinsecticides, biogas.
- 4.3 Immunobiotechnology-Hybridoma technology and monoclonal antibodies.
- 4.4 Industrial and Environmental biotechnology-microbial production of fermentation products, enzymes, antibiotics, single Cell proteins and biosensors.

## **Semester-II**

### **Paper-2T4, Advanced Developmental Biology**

#### **Unit-I**

- 1.1 Implantation in Mammals.
- 1.2 Foetal membranes- types structure and functions.
- 1.3 Placenta-types, structure, functions. Hormones of placenta and their functions.
- 1.4 Metamorphosis in Amphibia: morphogenetic and biochemical mechanism,hormonal control.

#### **Unit-II**

- 2.1 Regeneration in vertebrates: tail, limb, lens and retina.
- 2.2 Apoptosis- mechanism and significance.
- 2.3 Ageing- mechanism, concepts and models.
- 2.4 Polymorphism (caste differentiation) in insect (Termites, Honey bees and Ants).

#### **Unit-III**

- 3.1 Multiple ovulation and embryo transfer technology (MOET).
- 3.2 Application of embryonic stem cells, clinical and economic significance.
- 3.3 Embryonic sexing, cloning, screening for genetic disorder diagnosis (ICSI, GIFT etc.)
- 3.4 Cloning of animals by nuclear transfer.

#### **Unit-IV**

- 4.1 Immunocontraception- fertilization, inhibition and pregnancy termination.
- 4.2 Classical contraceptive techniques: Physical, chemical, surgical and IUCD devices.
- 4.3 Anti-androgen and anti-spermiogenic compounds (LDH-CY and SP-10)
- 4.4 Role of mutants and transgenics in human welfare.

## **Semester-II, Practical-2P1, Structure and Function of Vertebrates and Comparative Endocrinology**

### **Section-A**

- 1 **Study of museum specimens using already available specimens in the museum/ charts/ models/ photographs/ digital alternatives etc.**

Classification of vertebrates up to order and comments on the specimens representing all phyla.

2 **Anatomical Observations**

Anatomical observations, demonstration and detailed explanation of the following with the help of ICT tools/ models/ charts/ photographs etc.

a) Brain and cranial nerves- Fish/ Rat. b) Arterial and venous systems- Fish/Rat c) Urinogenital system- Fish/Rat. d) Reproductive systems- Fish/Rat. e) Internal ear in fish, Weberian ossicles in fish, accessory respiratory organs in fish.

3 **Mounting:** Study of Stained Permanent preparation of scales, ampullae of Lorenzini, otolith, striated muscles and cartilage of fish using animal wastes from local recognized fish markets or with the help of already available permanent slides/ ICT tools/ charts/ photographs etc.

4 **Microtomy, Histology and Skeleton**

a. Fixation, embedding, sectioning and staining of the internal organs of vertebrates (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry farms/ fish markets etc.)

b. Study of slides of internal organs of vertebrates with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.

c. Axial and appendicular skeleton of fowl and rabbit using already available skeleton/ ICT tools/ models/ charts/ photographs etc.

**Section-B**

1 **Microtomy** - Fixation, embedding, sectioning and staining of the endocrine gland (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry farms/ fish markets etc.)

2 **Histological study** – a) Histological slide of endocrine glands and gonadal endocrine components, EM structure of endocrine gland. b) Identification of pituitary cell type. c) Identification of  $\alpha$ ,  $\beta$ ,  $\gamma$ , cells of Islets of Langerhans with the help of already available permanent slides/ ICT tools/ charts/ photographs etc.

3 **Anatomical Observations-** Anatomical observations, demonstration and detailed explanation of the endocrine glands in a) Cockroach and b) Endocrine glands- pituitary, thyroid parathyroid, adrenal in fish/rat with the help of ICT tools/ models/ charts/ photographs etc.

**Distribution of Marks**

	<b>Marks</b>
1. Anatomical observations of fish/rat	15
2. Stained permanent preparation:	10
3. Identification and comment on the spots (1-10)	30
4. Submission of stained permanent slides	05
5. Anatomical observations of Endocrine glands	10
6. Histological staining of endocrine gland	10
7. Class Record	10
8. Viva-voce	10



**Total marks**

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100

**Semester-II, Practical-2P2–, Molecular Biology, Biotechnology and Developmental Biology**

**Section-A**

1. Demonstration of glycogen/ carbohydrate- PAS reaction (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry forms/ fish markets etc.)
2. Demonstration of DNA: Feulgen's reaction (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry forms/ fish markets etc.)
3. Demonstration of DNA: RNA: Methyl Green- Pyronin reaction (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry forms/ fish markets etc.)
4. Demonstration of Lipid: Sudan Black B staining (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry forms/ fish markets etc.)
5. Demonstration of Protein: HgBP staining (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry forms/ fish markets etc.)
6. Histochemical analysis of alkaline phosphatase (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry forms/ fish markets etc.)
7. Histochemical analysis of acid phosphatase (Source of tissue: Animal wastes from local recognized slaughter houses/ poultry forms/ fish markets etc.)
8. Biochemical estimation of sugar: O-toluidine method (Source of blood: Local recognized pathology laboratory)
9. Biochemical estimation of protein: Lowrey's method (Source of blood: Local recognized pathology laboratory)
10. Biochemical estimation of DNA: Diphenylamine method (Source of blood: Local recognized pathology laboratory)
11. Biochemical estimation of RNA: Orcinol method (Source of blood: Local recognized pathology laboratory)To perform tests for qualitative analysis of saliva
12. To perform tests for qualitative analysis of bile
13. Demonstration of separation of amino acids by paper chromatography and TLC

**Section-B**

- 1 Study of the reproductive system in mammals with the help of ICT tools/ models/ charts/ photographs etc.
- 2 Study of different types of eggs on the basis of their yolk content.
- 3 Study of developmental stages of live eggs of Lymnea or any gastropod with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
- 4 Study of developmental stages of insects/ fishes with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
- 5 Study of developmental stages of frog with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
- 6 Chick embryo mounting by window method.
- 7 Study of developmental stages of chick through slides and whole mounts.
- 8 Morphological study of different types of placenta with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
- 9 Histological study of placenta with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
- 10 Sperm count from any domestic animal (Source of semen: Government artificial insemination centre).

<b>Distribution of Marks</b>	<b>Marks</b>
1. Histochemical demonstration of DNA/RNA protein / carbohydrate/lipids/enzymes	20
2. Estimation of sugar/protein/DNA/RNA/ qualitative analysis of saliva/bile	20
3. Whole mount preparation of chick embryo/sperm count.	15
4. Preparation of development stages of live eggs of Lymnea	10
5. Identification and comment on spots (1-5)	15
6. Class record	10
7. Viva voce	10
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<b>Total marks</b>	<b>100</b>

• **Suggested Readings**

**Structure and function of Vertebrates**

1. Alexander R.N., The Chordata, Cambridge University Press London.
2. Barrington EJW, The Biology of Hemichordates and Protochordates, Oliver and Boid Edinberg.
3. Bourne G.H., The structure and function of nervous tissue Academic press New York.
4. Kingslay J.S, Outlines of Comparative anatomy of vertebrates, Central Book Depot, Allahabad.
5. Honyelli A.R. The Chordates Cambridge University Press, London
6. Smith H.S. Evolution of Chordate structure, Hold Rinehart and Winton Inc. New York
7. Walter H.A. and Sayles L.D. Biology of Vertebrates Macmillan and co. New York
8. Romer A.S. Vertebrate body W.P. Sanders co., Philadelphia.
9. Young J.Z. Life of Vertebrates Oxford University Press, London.
10. Young J.Z. Life of Mammals Oxford University Press, London.
11. Colbert E.H. Evolution of Vertebrates John Wiley and sons Inc. New York.
12. Kent C.J. Comparative anatomy of Vertebrates.
13. Waterman A.J. Chordate Structure and Functions Macmillan Co. New York.
14. Montagna W. Comparative anatomy clarendon press, Oxford
15. Weichert C.K. Preach W. Elements of Chordates anatomy McGraw-Hill book co., New York.
16. Lovettrup S. The phylogeny of Vertebrates John Wiley and sons Inc., London.
17. Joysey K.A. and Kemp T.S. Vertebrate Evolution Oliver and Boyd, Edinberg.
18. Romer A.S. Vertebrate Paleontology University of Chicago Press, Chicago.
19. Newman Phylum Chordata.
20. Goodrich E.S. Structure and development of vertebrates. Dover publications Inc., New York
21. Hardisty M.W. and Potter I.C. Biology of Lampreys Academic Press New York
22. T.B. of Zoology Parker and Haswell W.A. Macmillan co. Ltd. London
23. The Biology of Amphibia Noble G.K. Dover Publication Inc New York

**Comparative Endocrinology**

1. General & Comparative Endocrinology: E.J.W., Barrington, Oxford, Clarendon Press.
2. Text Book of Endocrinology: R.H. Williams, W.B. Saunders.
3. Endocrine Physiology: C.R. Martin, Oxford University Press.
4. Comparative Endocrinology: A Gorbman et al, John Wiley & Sons.

5. Medical Physiology: W.F. Ganong (1981): 10th Edn. Lange Medical Publications.
6. Principles of Anatomy and Physiology: Tortora Grabowski, 9th Edn., John Willey & Sons.
7. Reproductive Physiology of Vertebrates: Van Tienhoven, A. (1983): 2nd Edn. Cornell Univ. Press, New York.
8. The Pituitary Gland: Imura, H. (1994), 2nd Edn., Comprehensive Endocrinology Revised Series Raven, New York.
9. Comparative Vertebrate Endocrinology: Bentley, P.J. (1976) Cambridge University Press, Cambridge.
10. General & Comparative Endocrinology: E.J.W., Barrington, Oxford, Clarendon Press.
11. Text Book of Endocrinology: R.H. Williams, W.B. Saunders.
12. Comparative Vertebrate Endocrinological: Bentley, P.J. (1976) Cambridge University Press, Cambridge.
13. Invertebrate endocrinology: D. B. Tembhare, Himalaya publishing House (2012)

### **Molecular Biology and Biotechnology**

1. Harper's Review of Biochemistry, Prentice Hall.
2. Principles of Biochemistry by Lehninger and Nelson, CBS publications and Distributors.
3. The Biochemistry "Students companion" by Allen J. Scism, Prentice Hall.
4. Fundamentals of Biochemistry by Jain J. L., S. Chand Publication.
5. Principles of Biochemistry by Zubay J. L., WM. C. Brown Publishers.
6. Principles of Biochemistry by Horton, Prentice Hall.
7. Concept of Biochemistry by Boyer R., Coel publication co.
8. Harper's Biochemistry eds. Murray, R. K. P. and Granner, D. K. Prentice Hall.
9. Biochemistry by Mathews C. K. and Van Holde K. E., Benjamin C. publishing Co.
10. Biochemistry by Garrett R. H. and Grisham C. M., Saunders College publication.
11. Cell and Molecular Biology by De Robertis- E. D. P., I. S. E. publication.
12. Molecular Biology by Turner P. C. and Mc Lennan , Viva Books Pvt. Ltd.
13. Advanced Molecular Biology by Twyman R. M., Viva Books Pvt. Ltd.
14. Molecular Biology by Freifelder D., narosa publication House.
15. Gene VI by Benjamin Lewis, Oxford press.
16. Gene VIII by Benjamin Lewis, Oxford press.
17. Molecular biology of Gene by Watson J. D. et. al., Benjamin publication.
18. Molecular cell Biology by Darnell J. Scientific American Books USA.
19. Molecular Biology of the Cell by Alberts B., Bray D. Lewis J., garland publishing Inc.
20. Genetics Vol. I and II by Pawar C. B., Himalaya publication.
21. Essentials of Molecular Biology by Freifelder D., narosa publication House.
22. Molecular Cell Biology by Laodish H., Berk A., Zipursky S. L., Matsudaira P., Baltimore D. and Darnell J., W. H. Freeman and Co.
23. The Cell: Molecular Approach by Cooper G. M.
24. Molecular Biology by Upadhay A and Upadhay K. Himalaya publication.

### **Gamete and Developmental Biology**

1. Developmental Biology. 2<sup>nd</sup> Edition. Leon W. Browwer Saunders College publishing.
2. Current Topics in Developmental Biology eds. R. A. Pedersen and G. P. Schatten.
3. Principles of animal developmental biology: S. C. Goel, Himalaya Publishing House.

4. Developmental Biology, S.F. Gilbert. 4<sup>th</sup> Edn. Sinauer Associates Inc. Publishers.
5. An Introduction to Developmental Biology: D. A. Ede.
6. Principles of developmental: Paul Weiss edited by Hafner publishing company New York.
7. Cells into organs. 2<sup>nd</sup> Edition. The forces that shape the Embryo. John Philip Trinkaus ed. Tom Aloisi.
8. Principles of development: Lewis Wolpert et al. 1998. Oxford University Press.
9. Foundations of Embryology. B. M. Patten & B. M. Carlson. Tata McGraw Hill Publishing Company Ltd., New Delhi.
10. An Introduction to Embryology: Balinsky (1981) 5<sup>th</sup> Ed. (CBS College Publishing).
11. Embryonic and foetal development. Cambridge University Press by Austin and Short, 1982, 1994 2<sup>nd</sup> Ed.
12. Marshall's Physiology of Reproduction Longmont, Green and Co. London Vol. 1 & 2. Lamming 1984, 2000.

### **Semester- III**

#### **Paper- 3T1, Parasitology and Immunology**

##### **Unit I:**

- 1.1 *Vibrio cholera* and *Clostridium titani*- Life cycle, mode of transmission, infection and treatment
- 1.2 *Yersinia pestis*- Life cycle, mode of transmission, infection and treatment
- 1.3 Influenza and H1 N1 viruses- Life cycle, mode of transmission, infection and treatment.
- 1.4 Dengue and Hepatitis- Life cycle, mode of transmission, infection and treatment

##### **Unit II:**

- 2.1 *Trypanosoma* and *Entamoeba* - Life cycle, mode of transmission, infection and treatment
- 2.2 *Leishmania* and Malaria- Life cycle, mode of transmission, infection and treatment
- 2.3 *Wuchereria* and *Trichinella* - Life cycle, mode of transmission, infection and treatment
- 2.4 Toxins and antitoxins

##### **Unit III:**

- 3.1 Immune system- innate and adaptive immunity; Antigens and antibodies and its interaction
- 3.2 Cells and organs of immune system; T cells and B cells - maturation, activation and differentiation, T cell receptors
- 3.3 Major Histocompatibility Complex (MHC)- general organization and inheritance of the MHC, MHC molecules and genes
- 3.4 Complement system- classical, alternative and lectin pathways, regulation of complement system, biological consequences of complement activation

##### **Unit IV:**

- 4.1 Cytokine receptors- properties of cytokines, cytokine receptors, cytokine secretion by TH1 and TH2 subsets; Cell mediated cytotoxic responses- effector mechanisms, leukocyte activation and migration.
- 4.2 Hypersensitivity reactions- types, mechanisms of type I to IV hypersensitivity reactions; Autoimmunity- Organ specific autoimmune disease and treatment
- 4.3 Transplantation immunology- blood antigens, transplantation rejection, graft rejection, familial grafting, tissue typing, cross matching, immunosuppression.
- 4.4 Tumor immunology- Types and roles of tumor antigens, immune response to tumor; Immunotechniques- RIA and ELISA

#### **Semester-III, Practical-3P1, Parasitology and Immunology**



8. Medical and Veterinary Protozoology M. G. Kathering , A. James paul and V. Zaman. Churchill Livingstone.

### **Immunology**

1. Immunology – R. C. Kuby et al.
2. Immunology - Tizzard.
3. Immunology -. Roitt, Brostoff and D. Male.
4. Microbiology- M. T. Pelzer. Jr. E. C. S. Chan and N. R. Krieg. Tata McGraw -Hill
5. Immunology - Abbas

## **Semester-III**

### **Paper-3T2, Special Group-Entomology-I**

#### **Insect Morphology and Physiology**

##### **Unit-I**

- 1.1 Integument: molecular structure, moulting and sclerotization.
- 1.2 Morphology of head, thorax and abdomen.
- 1.3 Appendages: antennae, legs and genitalia.
- 1.4 Wing structure and mechanism of flight.

##### **Unit-II**

- 2.1 Mouth parts: type, morphology and feeding mechanism.
- 2.2 Structure of alimentary canal and salivary glands, mechanism of digestion.
- 2.3 Respiratory system: tracheal, aquatic and plastron respiratory mechanism.
- 2.4 Circulatory system: organs, mechanism of circulation, haemolymph- cellular and chemical composition. Functions of haemocytes.

##### **Unit-III**

- 3.1 Excretory system: organs and physiology of excretion.
- 3.2 Nervous system: structure and anatomy of brain and ventral nerve cord.
- 3.3 Neuroendocrine system: structure and function, role in metamorphosis and reproduction.
- 3.4 Exocrine glands: Pheromones and allomones-chemistry and functions.

##### **Unit-IV**

- 4.1 Reproduction: male and female reproductive system, structure of testis and ovary, mechanism of spermatogenesis and vitellogenesis.
- 4.2 Specialized reproductive mechanism: viviparity, polyembryony, paedogenesis and parthenogenesis.
- 4.3 Early embryonic development up to germ band formation.
- 4.4 Metamorphosis: types of larvae and pupae.

## **Semester-III, (M. Sc. Part-II)**

### **Paper-3T3, Special Group-Entomology-II**

#### **Classification and Industrial Insects**

##### **Unit-I**

- 1.1 Modern scheme of insect classification and general characters of various Orders.
- 1.2 General characters and classification of Thysanura and Collembola.
- 1.3 General characters and classification of Mallophaga and Siphunculata.
- 1.4 General characters and classification of Siphonaptera.

##### **Unit-II**

- 2.1 General characters and classification of Orthoptera.

- 2.2 General characters and classification of Hemiptera.
- 2.3 General characters and classification of Lepidoptera.
- 2.4 General characters and classification of Coleoptera.

**Unit-III**

- 3.1 Mulberry silkworm *Bombyx mori*, life cycle, silk gland and silk proteins.
- 3.2 Silkworm rearing, cocoon harvesting and seed production.
- 3.3 Bacterial and viral diseases in silkworm.
- 3.4 Lac insect-biology, lac cultivation and economic importance.

**Unit-IV**

- 4.1 Tasar sericulture- life cycle, host plant, rearing, cocoon formation and silk production.
- 4.2 Eri sericulture- life cycle, host plant rearing and silk production.
- 4.3 Honey bee- types, life cycle, colony formation and apiary products.
- 4.4 Bee keeping- movable frame hive, bee rearing management and diseases.

**Semester-III, Practical-3P2, Special Group-Entomology**

- 1 Anatomical observations, demonstration and detailed explanation of the various organs and systems in insects such as cockroach, grasshopper, cricket, molecricket, red cotton bug, honey bee, beetle, house fly, butterfly/ moth and caterpillars with the help of ICT tools/ models/ charts/ photographs etc.
- 2 Histological study of alimentary canal, salivary glands, gastric caecae, malpighian tubules, testis, ovary, sex accessory glands, exocrine glands, endocrine glands, brain and other ganglia with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
- 3 Whole mount preparation of insect parts using insects from agricultural wastes or with the help of already available permanent slides/ ICT tools/ charts/ photographs/ models etc.
- 4 Insect study- Identification, classification and characters up to families belonging to orders- Odonata, Orthoptera, Dictyoptera, Hemiptera, Lepidoptera, Coleoptera, Hymenoptera, Diptera etc. with the help of already available museum specimens, permanent slides/ ICT tools/ charts/ photographs/ models etc.
- 5 **Physiological Experiments:**
  - a. Estimation of total proteins/carbohydrates/lipids
  - b. Chromatographic separation of free amino acids
  - c. Separation of proteins by electrophoresis
  - d. Estimation of Na<sup>+</sup> and K<sup>+</sup> by flame photometer.
  - e. Estimation of DNA and RNA.
- 6 Visits to agricultural fields, national parks and forests for observations of insect population dynamics, behavior and diversity.  
**Note:** Student should submit insect photographs of 10 locally available species at the time of examination.

<b>Distribution of Marks</b>		<b>Marks</b>
1.	Anatomical observations	15
2.	Physiological Experiment	10
3.	Identification of histological slides and insects (1-15)	45
4.	Mounting	05
5.	Class records and submission of insect photographs	10

6.	Submission of histological slides	05
7.	Viva-voce	10
	<b>Total marks</b>	----- 100

### **Semester –III**

#### **Paper-3T2, Special Group-Fish and Fisheries -I**

##### **General studies**

##### **Unit-I**

- 1.1 Origin and Evolution of fishes: Fossil record, classification, cyclostoms, ostracoderms, placoderms, Sharklike fisher, Bony fishes
- 1.2 Development of jaws and limbs in fishes.
- 1.3 Classification and general characters of Placoderms: Acanthodii, Coccostei, Pterychthyes, Stegoselachii, Palaeospondyli.
- 1.4 Affinities of Placoderms and fossil record.

##### **Unit-II**

- 2.1 Classification and general characters of Elasmobranch/Chondrichthyes: Sharks and Rays, Holocephali
- 2.2 Affinities of Elasmobranchs, specialized characters of Elasmobranchs.
- 2.3 Classification and general characters of Actinopterygii/Ray finned fishes: Palaeonisciformes, Polypteriformes, Acipenseriformes, Amiiformes, Teleostea (Osteoglossomorpha, Elopomorpha, Clupeomorpha, Euteleostei)
- 2.4 Affinities of Actinopterygians.

##### **Unit-III**

- 3.1 Dipnoi: General characters, classification, origin, fossil Dipnoians and distribution of Dipnoians.
- 3.2 Specialized characters of Dipnoi, Blood vascular system of Protopterus and affinities of Dipnoians.
- 3.3 Respiratory system: Structure of gills in fishes, gill histology
- 3.4 Blood supply and mode of respiration and gaseous exchange in teleosts.

##### **Unit-IV**

- 4.1 Accessory respiratory organs: Origin of air breathing organs; skin, buccopharynx opercular cavity, air bladder
- 4.2 Mechanism of air breathing, function of accessory respiratory organ.
- 4.3 Air bladder: Origin, Development, types of air bladder; physostomous, physoclists, structure of gas secreting complex
- 4.4 Blood supply to air bladder and functions of air bladder

### **Semester-III**

#### **Paper-3T3, Special Group-Fish and Fisheries -II**

##### **Applied fisheries**

##### **Unit-I**

- 1.1 Fresh water fisheries of India, Riverine and Reservoir fisheries.
- 1.2 Estuarine and Marine fisheries of India.
- 1.3 Breeding of Indian Major carps: i Natural breeding, ii Induced breeding, iii Methods



of obtaining eggs, spawn, fry and fingerlings from natural resources.

- 1.4 Neuroendocrine control of carp reproduction.

#### **Unit-II**

- 2.1 Culture of exotic fishes – common carp, Composite culture.
- 2.2 Monoculture, Monosex culture.
- 2.3 Integrated Fish farming – Poultry, Duck, Fish rice culture.
- 2.4 Sewage fed fisheries

#### **Unit-III**

- 3.1 Catfish culture
- 3.2 Trout culture
- 3.3 Ornamental fish culture: i) Oviparous, ii) Live bearers.
- 3.4 Culture of sea weeds and Spirulina.

#### **Unit-IV**

- 4.1 Pearl culture
- 4.2 Oyster culture: i) Species- edible ii) Culture methods.
- 4.3 Prawn culture (Life cycle and breeding)
- 4.4 Frog culture

#### **Semester-III, Practical-3P2, Special Group-Fish and Fisheries**

1. Identification of local fishes upon species.
2. Anatomical observations, demonstration and detailed explanation of fish in general, reproduction and urino genital system, Endocrine glands with the help of ICT tools/ models/ charts/ photographs etc.
3. Study of cranial nerves in *Wallago* and *Labeo* with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
4. Identification of various stages of fry and fingerlings of major carps with the help of already available preserved material, permanent slides/ charts/ models / photographs/ ICT tools etc.
5. Permanent preparation of various scales using wastes from recognized fish markets..
6. Estimation of dissolve oxygen in water sample.
7. Estimation of CO<sub>2</sub> in water sample.
8. Estimation of chloride sample in water.
9. Estimation of protein in blood of fish (Source of fish blood: Local recognized fish markets).
10. Estimation of sodium in blood of fish (Source of fish blood: Local recognized fish markets).
11. Estimation of potassium in blood of fish (Source of fish blood: Local recognized fish markets).

#### **Distribution of Marks:**

	<b>Marks</b>
1. Anatomical observations (Major)	20
2. Physiology Experiment	20
3. Mounting of Scale	10
4. Identification of fishes	30
5. Practical Record	10
6. Viva voce	10

**Total marks** ----- 100

## **Semester –III**

### **Paper-3T2, Special Group-Mammalian Reproductive Physiology -I Reproductive Process in Male**

#### **Unit-I**

- 1.1 Development, descent and structure of the testis.
- 1.2 Spermatogenesis: Molecular changes, hormonal regulation, and spermiogenesis.
- 1.3 Sertoli cells: Structure , functions, blood testis barrier.
- 1.4 Leydig cells: Structure , functions and interaction with peritubular and Sertoli cells.

#### **Unit-II**

- 2.1 Epididymis: Structure and function.
- 2.2 Structure of spermatozoa and anomalies.
- 2.3 Sperm capacitation: molecular and biochemical changes, decapacitation.
- 2.4 Vas deferens: Structure and function.

#### **Unit-III**

- 3.1 Seminal Vesicle: Structure, function and regulation.
- 3.2 Prostate gland: Structure, function and prostatic cancer.
- 3.3 Cowpers gland: Structure, function and anomalies.
- 3.4 Penis: Structure and mechanism of erection.

#### **Unit-IV**

- 4.1 Male reproductive behaviour: Mating system, neural and hormonal control.
- 4.2 Pheromones:types, structure and function.
- 4.3 Infertility: causes and remedy.
- 4.4 Andrologically relevant diseases in advanced age.

## **Semester-III**

### **Paper-3T3, Special Group-Mammalian Reproductive Physiology-II Reproductive Process in Female**

#### **Unit- I**

- 1.1 Differentiation of the ovary and female genital tract.
- 1.2 The process of folliculogenesis and its hormonal control.
- 1.3 Recruitment, selection, dominance of follicle and signaling for ovulation.
- 1.4 Follicle wall: Theca, differentiation, steroid hormone synthesis (2-gonadotropin,2- cell concept).

#### **Unit-II**

- 2.1 Estrous cycle in mammals.
- 2.2 Menstrual cycle and Menopause.
- 2.3 Mechanism and hormonal control of ovulation .
- 2.4 Corpus luteum: histogenesis, function, maintenance and luteolysis.

#### **Unit-III**

- 3.1 Oviduct: structure, regional differentiation and function.
- 3.2 Uterus: Types, abnormalities.

- 3.3 Cervix-structure, functions.
- 3.4 Vagina-structure, function, detection of various stages of oestrous cycle by vaginal cytology, vaginal plug.

#### **Unit-IV**

- 4.1 Onset of puberty and delayed puberty.
- 4.2 Prostaglandins and their role in reproduction .
- 4.3 Anatomy and growth of mammary glands.
- 4.4 Lactogenesis and galactopoiesis.

#### **Semester-III, Practical-3P2, Special Group-Mammalian Reproductive Physiology (MRP)**

1. Demonstration of surgical operation in rat/ mice Orchidectomy or Vasectomy or Epididymectomy with the help of ICT tools
2. Anatomical observations, demonstration and detailed explanation of the male reproductive system of rat/ mice with the help of ICT tools/ models/ charts/ photographs etc.
3. Sperm count for the assessment of fertility (Source of semen: Government artificial insemination centre).
4. Study of spermatogenesis and identification of its various stages with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
5. Estimation of fructose/ sialic acid in reproductive tissue using animal wastes from recognized slaughter houses/ poultry farms etc.
6. Experimental studies (histological slides for identification) of the following with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
  - a. Effects of castration and androgen replacement on sex accessory glands
  - b. Effects of anti-androgen on testis and sex-accessory glands
  - c. Effect of anti-cancer drugs on testis and sex-accessory glands, different duration and different regimen studies
  - d. Effect of heavy metals on testis and sex accessory glands
7. Histology: Histological changes in male reproductive organs and sex accessories during active and inactive stage with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
8. Study of following endocrine glands with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
  - a. Pituitary gland: anatomy, cell types and identification of cell types
  - b. Thyroid gland: Histology of active and inactive glands, effects of antithyroid drugs
  - c. Adrenal: Normal histology and effects of metapyrone and corticosteroids administration
9. Field Work: Visit to Artificial insemination centre.

#### **Distribution of marks**

	<b>Marks</b>
1. Surgical operation	20
2. Anatomical observations	15
3. Minor experimental analysis	10
4. Biochemical estimation	20
5. Identification and comments on spots (1-5)	15
6. Practical record	10
7. Viva-voce	10

**Semester –III****Paper-3T2, Special Group-Animal Physiology-I****Physiology of Digestion and Excretion****Unit-I**

- 1.1 Histology of salivary glands, Mechanism of salivary secretion, composition and functions of saliva.
- 1.2 Histology of stomach, mechanism of secretion of gastric juice, composition and functions of gastric juice.
- 1.3 Histology of pancreas, mechanism of pancreatic secretion, composition and functions of pancreatic juice.
- 1.4 Histology of liver, bile secretion, its composition and functions.

**Unit-II**

- 2.1 Histology of small and large intestine, intestinal glands, its secretion and control, intestinal bacteria.
- 2.2 Neural and endocrine regulation of gastro intestinal movements and secretions.
- 2.3 Gastrointestinal hormones - Synthesis, chemical structure and functions.
- 2.4 Digestion and absorption of proteins, carbohydrates and fats in the gastrointestinal tract.

**Unit-III**

- 3.1 Functional anatomy of kidney.
- 3.2 Mechanism of formation of urine.
- 3.3 Normal and abnormal constituents of urine.
- 3.4 Mechanism of concentration and dilution of urine – The Counter current system.

**Unit-IV**

- 4.1.1 Regulation of urine and body fluid concentration and volume, hormonal mechanism of Antidiuratic hormone, Aldosterone and Renin – Angiotensin system in renal physiology.
- 4.2 Regulation of water, electrolytes and acid base, renal clearance.
- 4.3 Physiology of nitrogen excretion
- 4.4 Renal failure.

**Semester –III****Paper-3T3, Special Group- Animal Physiology-II****Physiology of Circulation****Unit-I**

- 1.1 Types of heart (Myogenic and Neurogenic ).
- 1.2 Anatomy, histology and nerve innervation of the heart, heart valves.
- 1.3 Pace maker and specialized conducting fibers.
- 1.4 Blood pressure and factors affecting blood pressure.

**Unit-II**

- 2.1 Cardiac cycle, Electrocardiogram (ECG).
- 2.2 Cardiac output, heart sound.
- 2.3 Haemodynamics.
- 2.4 Cardiac Failure.

**Unit-III**

- 3.1 Cellular composition and functions of blood.
- 3.2 Blood groups and Blood transfusion.

- 3.3 Blood sugars – Causes and control of hypoglycemia and hyperglycemia
- 3.4 Blood lipids- Causes and control of hypolipidimia and hyperlipidimia

#### **Unit-IV**

- 4.1 Plasma proteins- Albumins, globulins.
- 4.2 Haemostasis, Cascade of biochemical reactions involved in coagulation of blood.
- 4.3 Transport of O<sub>2</sub>& CO<sub>2</sub> by blood.
- 4.4 Lymph – composition, formation and functions.

### **Semester-III Practical-3P2, Special Group- Animal Physiology**

#### **I. Physiology Experiments**

- 1 Effect of pH, temperature and incubation on human salivary amylase activity.
- 2 Determination of:-
  - a) Clotting time, bleeding time.
  - b) Erythrocyte sedimentation rate and c) Haemoglobin concentration.
- 3 Determination of protein, glucose in Urine.
- 4 Study of structure of RBCs in vertebrates with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
- 5 Determination of protein, glucose in Urine from diabetic patient.
- 6 Total leukocyte count and differential leukocyte count.
- 7 Total erythrocyte count.

#### **II. Quantitative Analysis**

- 1 Estimation of blood Glucose (Source of blood: Local recognized pathology laboratory)
- 2 Estimation of blood proteins (Source of blood: Local recognized pathology laboratory)
- 3 Estimation of blood triglycerides (Source of blood: Local recognized pathology laboratory)
- 4 Estimation of blood cholesterol (Source of blood: Local recognized pathology laboratory)
- 5 Estimation of blood Sodium, potassium, Calcium (Source of blood: Local recognized pathology laboratory)
- 6 Estimation of blood alkaline & acid phosphates (Source of blood: Local recognized pathology laboratory).
- 7 Blood amino-acid separation by TLC / Paper chromatography (Source of blood: Local recognized pathology laboratory).

#### **III. Qualitative Analysis**

- 1 Normal & abnormal constituents of human urine.
- 2 Blood group detection by antisera.
- 3 Preparation and study of Urine crystals.
- 4 Estimation of serum urea (Source of blood: Local recognized pathology laboratory)
- 5 Preparation and study of haemin crystals.

- IV. **Histological Study of** Stomach, Liver, Small intestine, Large intestine, Pancreas, Kidney, Thyroid, Pituitary, Blood smear, Heart, T.S. Vein, T.S. Artery with the help of already available permanent slides/ ICT tools/ charts/ photographs etc.

**Distribution of Marks:**

**Marks**

1.	Physiology Experiment	20
2.	Major quantitative analysis	20
3.	Minor quantitative analysis	10
4.	Qualitative analysis	15
5.	Identification and comment on spots(1-5)	15
6.	Practical Record	10
7.	Viva-voce	10
		-----
	Total marks	100

### **Semester –III**

#### **Paper-3 T<sub>2</sub>, Special Group-Environmental Biology-I**

#### **Ecosystems and Communities**

##### **Unit-I**

- 1.1 Ecosystem: Structure and functions of marine and freshwater ecosystems, grassland, desert and forest ecosystems, abiotic and biotic components of ecosystems.
- 1.2 Energy flow: Y shaped and universal model.
- 1.3 Food chain, food web, ecological pyramid-types and diversity.
- 1.4 Planktons: nature, distribution, seasonal succession, beneficial and harmful effects, qualitative and quantitative estimation

##### **Unit-II**

- 2.1 Nekton, Benthos: nature, distribution and analysis, Periphyton- definition, collection, preservation and importance.
- 2.2 Eutrophication: Definition, types, effects and control measures.
- 2.3 Biogeochemical Cycles in Nature- Gaseous Cycles: Water, Carbon and Oxygen cycle.
- 2.4 Sedimentary Cycles in nature- Nitrogen, sulphur and Phosphorus cycles.

##### **Unit-III**

- 3.1 Productivity: concept, Primary and secondary productivity, measurement of productivity by light and dark bottle method, factors affecting primary and secondary productivity.
- 3.2 Biotic community: definition, concept and characteristics of community, community structure, stratification and periodicity, ecotone and edge effect.
- 3.3 Ecological niche, ecotype, ecophene and ecological indicators.
- 3.4 Ecological succession: definition, types and process of ecological succession, significance.

##### **Unit –IV**

- 4.1 Biosphere: Major biomes of the world with emphasis on Indian biomes.
- 4.2 Biometeorology: scope and factors
- 4.3 Water and soil as essential factors for the meteorological studies.
- 4.4 Radiant energy, temperature and light.

### **Semester –III**

#### **Paper-3 T<sub>3</sub>, Special Group- Environmental Biology-II**

#### **Adaptations, Population dynamics, and Animal Behaviour**

##### **Unit-I**

- 1.1 Adaptations of animals with reference to physical conditions: temperature and light.
- 1.2 Chemical conditions: oxygen, carbon dioxide.
- 1.3 Physiological process: osmoregulation and thermoregulation.
- 1.4 Physiological process: Bioluminescence and Echolocation.

## Unit-II

- 2.1 Influence of physical environment on organism: viscosity, surface tension, salinity, pressure, buoyancy and surface film animals.
- 2.2 Biological Rhythms: photoperiodism, biological clock, annual and lunar periodicity.
- 2.3 Mimicry and protective colouration: definition of mimicry, kinds of mimicry.
- 2.4 Batesian and Mullerian mimicry and significance.

## Unit-III

- 3.1 Population dynamics: population structure, pattern of population distribution, population growth and density relationship, population fluctuations and dispersal of population.
- 3.2 Dispersal: Barriers of dispersal, means of dispersal, migration.
- 3.3 Interspecific relationship: mutualism, commensalism, parasitism, synergism, antagonism and competition.
- 3.4 Prey and Predator relationship

## Unit-IV

- 4.1 Intraspecific relationship: aggregations and social organization.
- 4.2 Animal behavior: innate or inherent behavior, learned behavior, vision and behavior, sound and behavior.
- 4.3 Social behaviour: mating, family, and group behavior, advantages of social behavior
- 4.4 Genetic, hormonal and evolutionary aspects of behavior.

## Semester –III, Practical-3P<sub>2</sub>, Special Group-Environmental Biology

- 1 Sampling of water determination of pH, temperature and turbidity.
- 2 Plankton study and analysis of zooplankton.
- 3 Identification of crustaceans, insects, snails from fresh water/ lake/ pond with the help of already available specimens, permanent slides/ ICT tools/ charts/ models/ photographs etc.
- 4 Identification of common aquatic weeds, predatory fishes and harmful insects from the pond with the help of already available specimens, permanent slides/ ICT tools/ charts/ models / photographs etc.
- 5 Study of indication of pollution - estimation of BOD and COD.
- 6 Determination of primary productivity by light and dark bottle method.
- 7 Estimation of dissolved oxygen in water sample by Winkler's method.
- 8 Estimation of carbon dioxide from given water sample.
- 9 Determination of relative humidity by hygrometer / psychrometer.
- 10 Determination of wind velocity by anemometer.
- 11 Physico-chemical analysis of water for determination of alkalinity, hardness, nitrites and phosphates.
- 12 Estimation of Sodium and potassium by flame photometry.
- 13 Identification of benthic and periphytonic organisms.

### Distribution of Marks

	Marks
1. Major experiment	20
2. Minor experiment	15
3. Minor experiment	15
4. Identification and comment on given spots (1-10)	30

5.	Class record	10
6.	Viva voce	10
	<b>Total marks</b>	----- 100

### **Semester –III**

#### **Paper-3T<sub>4</sub>, Foundation - I, Basic Entomology**

##### **UNIT- I**

- 1.1 Introduction to Insects- Its systematic position; Classification From Anamalia to Insecta.
- 1.2 General anatomical description of Insect body: head, thorax and abdomen.
- 1.3 Insect eyes and antennae. Basic structure and function.
- 1.4 Insect metamorphosis- Complete and incomplete metamorphosis.

##### **UNIT- II**

- 2.1 Insect sound production
- 2.2 Insect light production
- 2.3 Reproduction behaviour of butterflies- Copulation and egg laying
- 2.4 Reproduction behaviour of dragonflies- Copulation and egg laying.

##### **UNIT- III**

- 3.1 Chemical communication in insects- Pheromones
- 3.2 Honey Bee Dance
- 3.3 Insect pollinators- Honey bee and butterflies
- 3.4 Predatory and edible insects.

##### **UNIT- IV**

- 4.1 Introduction of five species of Order- Lepidoptera (Butterflies) of central India.
- 4.2 Introduction of five species of Order- Odonata (Dragonflies) of central India.
- 4.3 Introduction of five species of Order- Coleoptera (Beetles) of central India.
- 4.4 Introduction of five species of Order- Hymenoptera (Bees, Wasps and Ants) of central India.

### **Semester -III**

#### **Core (Subject Centric)- I**

#### **Paper-3T<sub>4</sub> Wild Life and Avian Biology**

##### **Unit I- Wild life Ecology and Behaviour**

- 1.1 Definition, importance of wildlife, Concept of conservation, Conservation movement in India
- 1.2 International conservation bodies; IUCN, UNDP, FAO, WWF, Red data book, rare and endangered animals of India.
- 1.3 Predatory-prey relationship, predator dynamics, optimal foraging theory: patch choice, diet choice, prey selectivity, anti-predator defenses.
- 1.4 Social organization in carnivores and primates.

##### **Unit- II- Wild life Population and Pest Management**

- 2.1 Population estimation of ungulates and carnivores: Faecal samples, Hair identification, Pug marks and census method.
- 2.2 Management and identification of animals by natural marking, collars, tags, branding, rings etc. Dynamic marking: beta light, radio- tracking, collars.



- 2.3 Basic Concept of forest soil dwelling arthropods, decomposer food web in forest soil, vertical distribution and aggregation of Collembola and mites.
- 2.4 Pests of Teak (Borers- *Alcterogystia cadambae* & Defoliators- *Hyblaea puera*) and Sal (Borers- *Hoplocerambyx spinicornis* and Defoliators- *Lymantria mathura*)

### **Unit- III- Avian Systematic**

- 3.1 Morphology and morphometry of birds, methods of identification and bird diversity.
- 3.2 Bird study techniques: equipments, area of study, field data recording, bird photography.
- 3.3 Bird counting technique: sampling, bird singing techniques, use of hi-tech gadgets like GPS, CCTV, Camera and high vision equipments.
- 3.4 Estimation of breeding population, breeding ground mapping.

### **Unit- IV- Bird diversity and Breeding**

- 4.1 Bird biodiversity hotspots in India, Bird sanctuaries in India.
- 4.2 Role of birds in ecosystem – pollination, seed dispersal, insect control, bird migratory routes.
- 4.3 Breeding biology, nesting territories, bird songs, courtship and mating.
- 4.4 Types of nest, nest building, nest defense and parental care.

### **Suggested reading**

1. Ali, S. and Ripley, S. D. 1983. Handbook of the Birds of India and Pakistan Compact Edition. Oxford Univ. Press. New Delhi.
2. Anon. 1975. Forest Pest Control. National academy of Science. NAS, Washington, D. C.
3. Bailey J. A. 1984. Principles of Wildlife Management John Wiley and Son. N.Y.
4. Beeson, C. F. C. 1941. The ecology and control of forest insects of India and neighboring countries, Govt. of India Press.
5. Brockman, O.F. 1959. Recreational use of Wildlife. McGraw Hill Book Company.
6. Daniel, J. C. 1983. The Book of Indian Reptiles, Bombay Natural History Society, Bombay.
7. Davis & Johnson. 1987. Forest Management. McGraw Hill Book Company.
8. Eisenbeis, G & Wichard, W. 1991. Atlas on the Biology of Soil Arthropods, Springer – verlag, London.
9. Elseth, B.D. & Baumgartner, K.M. 2003. Population Biology, Van Nostrand Co., New York.
10. Findley, W. P. K. 1967. Timber pests and diseases: Pregman Press.
11. Graham, S.A. and Knight, F.B. 1965. Principles of Forest Entomology, McGraw Hill book Company.
12. Harris, W.V. 1964. Termites: Their recognition and control. Longmans, London.
13. Krebs, J. R. & Davies, N. B. (1989) An Introduction to Behavioral Ecology. Oxford: Blackwell Scientific Publications.
14. Knight, P. V., 1980. Principles of forest entomology, McGraw Hill Publication.
15. Lenderen D. 1991. Modelling in behavioral ecology. Chapman & Hall London U.K.
16. Rodgers N.A & Panwar H.S 2001. Planning of wild life / Protected area Network in India. The report of wild life Institute of India, Dehradun.
17. Snodgrass, R. E. 1995. Principles of Insect Morphology. USDA. 1952. Insects: The Year Book of Agriculture.
18. Staddon, J.E.R. 1983. Foraging and Behavioral Ecology. Adaptive Behavior and Learning. Cambridge University Press.

19. Stephens, D.W., Brown, J.S. & Ydenberg, R.C., 2007. *Foraging: Behavior and Ecology*. Chicago: University of Chicago Press
20. Trippense, R.E. 1953. *Wildlife Management*, McGraw Hill Book Co.
21. Van Tyne, J. & Berger, A. J., 1976. *Fundamental Ornithology*, MacMillan Publishing Co. Inc. N. Y.
22. Wallace, G. J. & Mahan H. D., 1975. *An Introduction to Ornithology*. MacMillan Publishing Co. Inc. N. Y.
23. West, D.C., Shugart, H.H. & Botkin, D.F., 1981, *Forest Succession: Concepts and Application*, Springer-verlag, New York.
24. Witter, J A & Coulson, R N, 1984, *Forest entomology: ecology and management*, John Wiley and Sons, U.S.A

#### **Semester-IV**

#### **Paper-4T<sub>1</sub>, Biotechniques, Biostatistics, Ethology, Toxicology and Bioinformatics**

##### **Unit- I**

- 1.1 Sterilization techniques, media for microbial culture, inoculation methods
- 1.2 Animal cell & tissue culture- primary culture, cell lines, cell quantification, growth kinetics of cells in culture, cryopreservation of cells
- 1.3 Basic principle of sedimentation and centrifugation; Radioactive isotopes.
- 1.4 Chromatographic separation- Thin layer and gas chromatography; Electrophoretic separation techniques

##### **Unit- II**

- 2.1 Central tendency and dispersion- mean, mode and median with examples; Dispersion and variance.
- 2.2 Probability and probability distribution -Basic theory and type of probability and probability distribution with example (binomial, poisson and normal distribution).
- 2.3 Sampling – types, standard error (SE), standard deviation (SD), significance tests - t- test, z- test, Chi square test- assumption, importance and example
- 2.4 Neuronal control, genetic and environmental components in development of animal behavior; Animal ethics- Introduction, concept, organizations and their functions

##### **Unit- III**

- 3.1 Introduction and scope of toxicology
- 3.2 Environmental toxicology- Classification of environmental toxicants; Pesticides, Fertilizers, Heavy and trace metals, radioactive substances, food additives, automobile emission.
- 3.3 Translocation of toxicants- absorption, distribution, biotransformation and excretion of toxicants
- 3.4 Toxicity tests- Types (Acute and Chronic), calculation of LC<sub>50</sub> and LD 50; Antidotal therapy- Antidotes, type of antidotes and antidotal procedure.

##### **Unit- IV**

- 4.1 Introduction and scope of bioinformatics - history, scope of bioinformatics in research, business and employment opportunities; Bioinformatics in India.
- 4.2 Sequence alignment- Pair wise sequence alignment and multiple sequence alignment.
- 4.3 Biological databases– Basic local alignment search tool (BLAST), and FASTA, Variants of BLAST, PSI-BLAST.
- 4.4 Phylogenetic analysis- Tree style, tree building methods

- **Suggested Readings**

### **Tissue culture and Biotechniques**

1. Animal cell culture – A practical approach, (III Edition) Ed. John R. W. Masters. IRL Press.
2. *In vitro*-cultivation of animal cell, biotechnology by open learning (BIOTOL), Butterworth Heinemann Ltd. Linaere house, Jordan Hill Oxford.
3. Introduction to instrumental analysis, Robert Broun, McGraw Hill International Edition.
4. A Biologist Guide to Principle and Techniques of Practical Biochemistry K. Wilson and K.H. Goulding ELBS Edition.
5. Molecular Cell Biology, J. Darnel, H. Lodish and D. Baltimore. W. H. Freeman and Company New York.
6. DNA Techniques by Alcamo.
7. Insect Cell Culturing Engineering, Ed. M. F. A. Goosen, A.J. Daugulis and P. Faulkner.
8. Biotechnology - B. D. Sings.
9. Biophysical Chemistry – Upadhyay, Upadhyay and Nath.

### **Toxicology**

1. Animal Clinical Chemistry: A Primer for Toxicologists. G.O. Evans (Ed.) ISBN: 0748403515, Taylor & Francis, 1996.
2. Animal Models in Toxicology. S.C. Gad & C.P. Chengelis (Eds.), ISBN: 0824784561, Marcel Dekker, 1992.
3. Annual Reviews of Pharmacology & Toxicology, ISBN: 0824304373, 1997
4. Basic Toxicology: Fundamentals, Target Organ & Risk Assessment. F.C. Lu, ISBN: 1560323809, Taylor & Francis, 1996.
5. Casarett & Doull's Toxicology: The Basic Science of Poisons. C.D. Klaassen (Ed), ISBN: 0071054766, McGraw-Hill, 1996.
6. Comprehensive Toxicology. I. Sipes, C.A. McQueen & A. Gandolfi (Eds.), ISBN: 0080423019, Elsevier Science, 1997.
7. General & Applied Toxicology. B. Ballantyne, T. Mars & P. Turner (Eds), Vol I & II, ISBN: 0333498011, Macmillon/Stockton Press, 1993.
8. Loomi's Essentials of Toxicology, T.A. Loomis & A.W. Hayes, ISBN: 0124556256, Academic Press, 1996.
9. Encyclopaedia of Toxicology, Chemical and Concepts, P. Wexler, ISBN: 012227220-X, Academic Press, 1998.
10. Dictionary of Toxicology. E. Hogson, J.E. Chambers & R.B. Mailman, ISBN: 1561592161, Groves ic, 1997.

### **Biostatistics**

1. Biostatistics-Arora and Malhan
2. Biostatistics- Jasraj and Gurudeep Raj
3. Biostatistics- P. Ramkrishan
4. Methods in Biostatistics-Mahajan

### **Bioinformatics**

1. Mount W. 2004. Bioinformatics and sequence genome analysis 2nd Editon CBS Pub. New Delhi.

2. Bergman, N. H. Comparative Genomics. Humana Press Inc. Part of Springer Science+BusinessMedia, 2007.
3. Baxevanis, A. D. Ouellete, B. F. F. 2009. Bioinformatics: A Practical Guide to the analysis of genes and proteins. John-Wiley and Sons Publications, New York.
4. Campbell A. M. and Heyer, L. J. 2007. Discovering Genomics, Proteomics and Bioinformatics, 2<sup>nd</sup> Edition. Benjamin Cummings.
5. Des Higgins and Willie Taylor 2000. Bioinformatics: Sequence, structure and databanks. Oxford University Press.
6. Rashidi H. H. and Buehler 2002. Bioinformatics Basics: Applications in Biological Science and Medicine, CRC Press, London.
7. Gibas Cynthia and Jambeck P. 2001. Developing Bioinformatics Computer Skills: Shroff Publishers and Distributors Pvt. Ltd. (O'Reilly), Mumbai.

## **Semester-IV**

### **Paper-4T<sub>2</sub>, Special Group-Entomology-I Sense organs, social life and Agriculture pests**

#### **Unit-I**

- 1.1 Compound eyes- structure and functions.
- 1.2 Ocelli- structure and functions.
- 1.3 Sound producing organs: Structure and physiology.
- 1.4 Light producing organs: Structure and bioluminescent mechanism.

#### **Unit-II**

- 2.1 Mechanoreceptors: Sensory hairs, campaniform sensilla and chordotonal organs.
- 2.2 Tympanal organs, Johanson's organ, Chemoreceptors- sensilla trichoidea, sensilla basiconica.
- 2.3 Pigments and mechanism of colour change, mimicry and camouflage.
- 2.4 Immunity in insect: Innate immunity and molecular mechanism.

#### **Unit-III**

- 3.1 Social life: Polymorphism, nest building and social behavior in Isoptera.
- 3.2 Social life: Polymorphism, nest building and social behavior in ants.
- 3.3 Parasitic Hymenoptera-types and significance.
- 3.4 Locust migration and swarming.

#### **Unit-IV**

- 4.1 Pest of major crops: Rice, Cotton and Sugarcane-classification, life history, damage and control.
- 4.2 Pest of fruits: Citrus and Mango-classification, life history, damage and control.
- 4.3 Pest of vegetables: Cabbage and Brinjal- classification, life history, damage and control.
- 4.4 Stored grain pests: classification, life history, damage and control measures.

## **Semester-IV**

### **Paper-4T<sub>3</sub>, Special Group-Entomology-II Pest control measures and Insects vectors**

#### **Unit-I**

- 1.1 Inorganic insecticides: Properties, mode of action and use.
- 1.2 Chlorinated Hydrocarbons: Properties, mode of action and use.
- 1.3 Organophosphates: Properties, mode of action and use.

- 1.4. Natural organic compound and pyrethroids: Properties, mode of action and use.

#### **Unit-II**

- 2.1 Biological control: Historical and theoretical basis of biological control.
- 2.2 Desirable attributes of natural enemies of pests.
- 2.3 Parasitoids used in biological control programmes: life cycle and biological relationship.
- 2.4 Predators used in biological control programmes: life cycle and biological relationship.

#### **Unit-III**

- 3.1 Insect pathogenic bacteria used in biological control programmes, biological relationship, mass production and examples.
- 3.2 Insect pathogenic viruses used in biological control programmes, biological relationship, mass production and examples
- 3.3 Use of radiation, chemosterilants, hormones and pheromones in pest control programmes.
- 3.4 Integrated pest managements: principles, modeling, application and examples.

#### **Unit-IV**

- 4.1 Pest of horse and cattle: Nature of damage, life cycle and control measures.
- 4.2 Mosquitoes causing disease in man: life cycle, mode of transmission of pathogen and control measures.
- 4.3 Flies causing disease in man: life cycle, mode of transmission of pathogen and control measures.
- 4.4 Lice and fleas causing disease in man: life cycle, mode of transmission of pathogen and control measures.

#### **Semester-IV Practical-4 P<sub>1</sub>, Special Group-Entomology**

- 1 Anatomical observations, demonstration and detailed explanation of the silk gland in mulberry and non mulberry silkworms with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
- 2 Anatomical observations, demonstration and detailed explanation of the male and female reproductive system in silk moths with the help of ICT tools/ models/ charts/ photographs etc.
- 3 Anatomical observations, demonstration and detailed explanation of the salivary, pharyngeal glands and sting apparatus in honey bees with the help of ICT tools/ models/ charts/ photographs etc.
- 4 Demonstration of disease causing pathogens in insects.
- 5 Histopathological Study of baculovirus and protozoan infected tissues with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
- 6 Collection of insect photographs, identification and classification of harmful insects, parasitic hymenopteran and other beneficial insects.
- 7 Listing of insects of different orders of central India.
- 8 Study of various systems of insects and their functional significance with the help of ICT tools/ charts/ models/ photographs etc.
- 9 Preparation of photographic life history of economical important insects.
- 10 Preparation of insect biodiversity register of a specific area by photographic collection/ observation.
- 11 Visit to Apiculture, Sericulture, Lac culture centers and entomology research laboratory/center.

<b>Distribution of Marks:</b>		<b>Marks</b>
1.	Anatomical observations	20
2.	Identification, classification and economic importance of spots (1 to 10)	30
3.	Demonstration of microbial pathogen in insect	10
4.	Whole mount preparation	10
5.	Class record and submission of slides	10
6.	Submission of life history	10
7.	Viva-voce	10
		-----
<b>Total marks</b>		<b>100</b>
<ul style="list-style-type: none"> <li>• <b>Project work</b> (80 marks project evaluation including viva + 20 marks Internal assessment)</li> </ul>		100

- **Suggested Readings**

### **Entomology**

1. Imms General text book of Entomology, Eds. O. W. Richards and R. G. Davis Chapman and Hall, London.
2. General and Applied Entomology, K.K. Nayar, T. N. Ananthkrishan and B.V. Davis Tata McGraw -Hill Co.Ltd. Bombay.
3. The Insect: Structure and function, R.F. Chapman, Cambridge University Press.
4. The Physiology of Insect , Ed. M.Rockstein ,Vol, 1-5, Academic Press, New York.
5. The Physiology of Insect Reproduction, F, Englemann, Pergamon Press, New York.
6. Comprehensive Insect Physiology , Biochemistry and Pharmacology , Eds. G.A. Kerkut and I. A. Gillberd, VOL. 1-13, Pergamon Press, New York.
7. Analytical Biochemistry of Insect, Ed. R. B. Turner, Elsevier, Amsterdam.
8. Insect Hormone, M. J. A. Novak. Chapman and Hall, London.
9. Modern Entomology(Second edition): D. B. Tembhare, Himalaya Publication House, Bombay.
10. Destruction and Useful Insect, Their Habits and Control, C. L. Metcalf, W. P. Flint and R. I. Metcalf, Mc Grow I Ill Co. New York.
11. Integrated Pest Management, J.L. Apple and R. E. Smith, Plenum Publication Co., New Delhi.
12. An Introduction Of Biological Control RVD Boarscho, P. S. Y. Messenger and A. P. Gaiter, Plenum Publication Co.
13. Text Book of Entomology, K. P. Shivastava, Vol. 1 And 2 Kalyani Publication, Ludhiana.
14. Agriculture Entomology, H. S. Dennis, Timber Press Inc.
15. Entomology and Pest Management, Larry P. Pedigo, Prentice Hall.
16. Text Book of Agriculture Entomology, Alford V. David, Blackwell Science.
17. Biopesticides In Insect Pest Management, S. J. Ignacimulha and Alok Sen , Phoenix Publishing House Pvt, Ltd.
18. Biotechnology in Invertebrate Pathology and Cell culture ( Maramorosch, K. ed.). Academic Press, New York.
19. PEBFANS (2003)” (Solomon Raju, A. J. ed.). Andhara University Press, Visakhapatnam.
20. Living Resources for the Millennium 2000 (S. J. William ed.), Students Offset Press, Chennai.

## **Semester –IV**

### **Paper-4T<sub>2</sub>, Special Group-Fish and Fisheries-I**

#### **General studies**

##### **Unit-I**

- 1.1 Structure of alimentary canal in teleosts; feeding habits, histology of different parts
- 1.2 Modification of alimentary canal in relation to feeding habits, digestion and absorption of food.
- 1.3 Structure of kidney in teleosts: Head kidney and trunk kidney, histology, blood supply
- 1.4 Osmoregulation in Freshwater forms, Marine forms, Rays and Skates, Diadromous fishes.

##### **Unit-II**

- 2.1 Chemoreceptors: Structure of olfactory system, morphology of peripheral olfactory organ, cellular composition of olfactory epithelium, olfactory bulb and central projections
- 2.2 Structure and functions of taste buds.
- 2.3 Migration in fishes: Types- Anadromous, Catadromous, Amphidromous, factors responsible for migration (Intrinsic and environmental), periodicity of migration.
- 2.4 Role of hormones in migration, Orientation and Navigation during migration.

##### **Unit-III**

- 3.1 Structure of male reproductive system
- 3.2 Mechanism of spermatogenesis and its hormonal control
- 3.3 Structure of female reproductive system
- 3.4 Oogenesis, egg development, hormonal control of oogenesis

##### **Unit-IV**

- 4.1 Structure, hormones and functions of pituitary gland in fishes
- 4.2 Structure, hormones and functions of other endocrine glands.
- 4.3 Structure of Hypothalamo-hypophysial system in fishes.
- 4.4 Neurohormones and their functions.

## **Semester –IV**

### **Paper-4T<sub>3</sub>, Special Group-Fish and Fisheries -II**

#### **Fishery technology and Fish pathology**

##### **Unit-I**

- 1.1 Pond management (siting construction and problems)
- 1.2 Gear and crafts in inland water
- 1.3 Conservation of fish, Fish legislation and their importance.
- 1.4 Water pollution and inland fisheries

##### **Unit-II**

- 2.1 Plankton in relation to fish production,
- 2.2 Culture of phytoplankton and zooplankton (Daphnia, Artemia, Monia)
- 2.3 Manufacture and maintenance of Aquarium
- 2.4 Hybridization and transgenic fish

##### **Unit-III**

- 3.1 Fish marketing: Marketing practices, information, marketing channels and systems
- 3.2 Domestic and export marketing.
- 3.3 Sex control and sex reversal under condition and chromosome set manipulation in fish
- 3.4 Gamete preservation: cryopreservation and its application.





1. Fish Physiology Vol. 1 to 13: Hoar H.S. & Randall (Eds.) (1964-1994) Academic press London, New York.
2. The physiology of fishes Vol. 1&2: Brown M.E.(1957) Academic press, New York.
3. Natural history of fishes & systematic of fresh water fishes:P Datta Munshi, J.S. & Shrivastva, M.P.(1988): Narendra pub. House, Delhi.
4. Air breathing fishes of India- Their structure, function and life history: Dutta Munshi, J. S., Hunghe G.M. (1992) .Oxford and JBH publication Co. New Delhi.
5. The freshwater fishes of India, Pakistan, Bangladesh, Burma and Shri Lanka Handbook: Jayaram, K.C. (1981): Zoological Survey of India, Calcutta.
6. Fish migration: Jones, F.R. S. (1968), E.Arnold, London
7. Aquaculture, Bardach, Ryther and Mc Lamy
8. Marine fisheries: D. K. Dal, K. V. Rao
9. Ichthyology: Lagler, K. F., Bardach, J. and Miller, R.( 1977) John Wileys and sons.
10. Fish Endocrinology: Matty, A. J. (1985), Chapman and Hall, London.
11. An aid to the identification of common commercial fishes of India and Pakistan: Mishra K. S. (1982).
12. Aquaculture: The farming and husbandry of freshwater and marine organism: Bardach, J.E. (1974). Narendra Publication House, New Delhi.
13. Handbook of breeding of Indian Major Carps by pituitary hormone injection: Chonder, S. L. (1970). Satish book enterprises, Agra.
14. Diseases of fish: Duijin, C:Van Inr. (1973), life books London.
15. Fish and fisheries of India: Jhingran , V. G. (1985). Hindustan Publication Company, New Delhi.
16. Prawns and prawn fisheries of India: Kurian, C.V. and Sebastian, V. O. (19876) . Hindustan Publication Company, New Delhi.
17. The Sea food Industry: Martin, R. E.(1990). Narendra Publication House, New Delhi.
18. Ecological effects of water, applied limnology and pollutant effect: Welch, E. B. (1992).
19. A compendium of aquaculture technologies: Sinha, V.R. P.(1993). Oxford and JBH publication Co. New Delhi.

## **Semester-IV**

### **Paper-4T<sub>2</sub>, Special Group-Mammalian Reproductive Physiology-I**

#### **Reproductive Endocrinology**

##### **Unit-I**

- 1.1 Hypothalamus – Anatomy, cytoarchitecture.
- 1.2 Releasing and release inhibiting hormones.
- 1.3 Neurotransmitters and neural signals.
- 1.4 Feedback regulatory mechanism

##### **Unit-II**

- 2.1 Adenohypophysis: Anatomy, cytology.
- 2.2 Neurohypophysis: Anatomy, cytology.
- 2.3 Gonadotrophic hormones: structure, mechanism of secretion and function.
- 2.4 Anatomy and hormones of pars intermedia.

##### **Unit-III**

- 3.1 Hypothalamo – hypophyseal testis axis
- 3.2 The Androgen: Biosynthesis, mode of action, transport and functions of testosterone.
- 3.3 Physiology of inhibin-biosynthesis, mode of action and functions.

3.4 Hypothalamo – hypophyseal thyroid-gonad axis.

#### **Unit- IV**

4.1 Hypothalamo – hypophyseal ovarian axis.

4.2 The oestrogen: Biosynthesis, mode of action, transport and functions.

4.3 The progesterone: Biosynthesis, mode of action, transport and function.

4.4 Hypothalamo- hypophyseal adrenal-gonad axis.

#### **Semester-IV**

#### **Paper-4T<sub>3</sub>, Special Group-Mammalian Reproductive Physiology-II Reproductive Toxicology, Embryology and Fertility**

#### **Unit-I**

1.1 Chemical toxicants and Testicular toxicity.

1.2 Environmental factors and reproductive health.

1.3 Induction of gonadal toxicity in females.

1.4 Interruption of pregnancy by pesticides.

#### **Unit-II**

2.1 Implantation of mammalian blastocyst.

2.2 Development of chorio–allantoic placenta.

2.3 Foetal membranes – Development, structure, function of chorion, amnion, allantois, yolk sac.

2.4 Onset and endocrine control of parturition.

#### **Unit-III**

3.1 Intrauterine and intra cervical devices (IUDS and IUCDS) medicated and non-medicated IUD's, Long acting steroidal contraceptives.

3.2 Surgical sterilization and medical termination of pregnancy (MTP).

3.3 Pregnancy vaccine (anti-HCG, Antizona vaccine, immunization with FSH).

3.4 Recent advances in female contraception (inhibin, prostagladin, hormone analogues, subdermal implants).

#### **Unit- IV**

4.1 Vasectomy and reversible vas occlusion.

4.2 LH-RH antagonist, estrogen antagonist, GnRH antagonist.

4.3 Anti-androgen and anti-spermiogenic compounds (LDH-Cy and Sp-10), Inhibin.

4.4 Antibodies for acrosomal enzymes and sperm surface proteins.

#### **Semester-IV, Practical-4 P<sub>1</sub>, Special Group-Mammalian Reproductive Physiology**

- 1 Demonstration of surgical operation in rat/ mice Ovariectomy or Hysterectomy or Unilateral adrenalectomy with the help of ICT tools/ Charts/ Models / Photographs etc.
- 2 Anatomical observations, demonstration and detailed explanation of the female reproductive system of rat or mice with the help of ICT tools/ models/ charts/ photographs etc.
- 3 Vaginal smear: Vaginal cytology with relation to estrous cycle with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
- 4 Pregnancy detection test.
- 5 Study of histochemical localization of proteins in rat/ mouse thyroid by Mercury-Bromophenol blue method with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.



10. Contraceptive Technology Past, Present and Future: Das. R.P. (1989). N.I.H.F.W. New Delhi.
11. Control of ovulation: Crighton, D.B., Haynes, N.B. Foxcroft, G.R. & G.E. Lamming (1978). Butterworths, London.
12. Encyclopedia of Reproduction Vol. I, II, III, IV eds. Ernst Knobil and J.D. Neill (1998).
13. Endocrinology and metabolism. 4<sup>th</sup> edition 2001. Philip Felig & Lawrence A. Frohman McGraw Hill Inc. Medical Publishing Division.
14. Endocrinology. Vol. 1 to 3: L.J. Degroot et al. (1989). W.B. Saunders Co. Philadelphia.
15. General Endocrinology: Turner, C.D. & J.T. Bagnara (1990) W.B. Saunders Co., & Toppan Co., Philadelphia, London & Tokyo.
16. Hormonal Control of Lactation: Cowie, A.T. Forryth, I.A. and I. Hart (1980). Springer-Verlag, Berlin & New York.
17. Mammalian Oviduct: Hafez, E.S., and R.J. Blandu. The University of Chicago Press, Chicago, London.
18. Marshall's Physiology of Reproduction. 4<sup>th</sup> Edition Vol. 3 Pregnancy and Lactation Part I, II, III edited by G.E. Lamming, Champan and Hall.
19. Ovarian Cycle of Mammals: Perry, J.S. Oliver and Boyd, Edinburgh.
20. Patterns of Reproduction: Asdell, S.A. (1964). Constable and Co. London.
21. Physiology of Lactation: Smith, Vearch, Constable & Co., London.
22. Postgraduate Reproductive endocrinology. 4<sup>th</sup> Edition. 1997. R. Rajan Jaypee brothers. Medical Publishers (P) Ltd.
23. Practice of fertility control, Choudhary S. K. Churchill and Livingstone.
24. Progress in Reproductive Biology, Vol. 4. The pineal and reproduction: Reiter, R.J. Series Ed. P.O. Hubinant, Karger, Basel. Paris, London (latest edition).
25. Reproduction in Mammals Series: 1 to 6: Austin, C.R. and R. V. Short (1984 & 1994), Cambridge University Press, Cambridge.
26. Reproductive Endocrinology: Ref. No. 1, Vol. 3 Hormones in Reproduction.
27. Seasonal Patterns of Stress, immune function and disease R.J. Nelson, G.E. Demas, S.L. Klein, L.J. Kriegsfeld. 2002. Cambridge Univ. Press.
28. Shaw's textbook of Gynaecology eds. V. G. Padubidri and S. N. Daftary. 2000.
29. The Biology of Blastocyst: Blandau, R.J. (1971). The University of Chicago Press, Chicago & London.
30. The Prostaglandins Vol. I & II: Ramwell, P.W. (1974). Preum Press, New York and London.
31. The Testis Vol. 1 to 4: Jhonson, A.D. and W. R., Gomes.
32. Vertebrate Foetal Membrances: Mossman, H.W. (1989). Rutgress Press Ltd.
33. WHO laboratory manual for the examination of human semen and sperm – cervical mucus interaction. 4<sup>th</sup> Edition Cambridge Univ. Press. 2000.

#### **Semester –IV**

#### **Paper-4T<sub>2</sub>, Special Group-Animal Physiology-I**

#### **Physiology of Brain, Nerve and Muscle**

#### **Unit-I**

- 1.1 Morphological differentiation of mammalian brain
- 1.2 Brain stem
- 1.3 Cerebellum
- 1.4 Physiology of learning, memory and sleep

## **Unit-II**

- 2.1 Types and functional properties of neurons
- 2.2 Ultrastructure of neuron
- 2.3 Ultrastructure of synapse and molecular mechanism of synaptic transmission
- 2.4 Bioelectrical properties of neurons- neuronal excitability, resting membrane potential- Nernst equation, sodium and potassium pump, propagation of nerve impulses, generation of action potential.

## **Unit III**

- 3.1 Biosynthesis, storage and release of neurotransmitters: Acetylcholine, GABA, Epinephrine, Nor-epinephrine, Serotonin.
- 3.2 Neuropeptides- oxytocin, vasopressin, thyrotropin releasing hormone, cholecystokinin
- 3.3 Receptor physiology- Mechanoreception, photoreception, phonoreception, chemoreception
- 3.4 Disorders of nervous system: Alzheimer's disease, Parkinson's disease.

## **Unit-IV**

- 4.1 Ultrastructure of skeletal muscle
- 4.2 Molecular mechanism of muscle contraction- muscle proteins, Calcium receptors, Calmodulin, Calcium pump, sliding filament theory, chemistry and role of ATP in muscle contraction.
- 4.3 Properties of muscle (twitch, tetanus, summation, tonus, all or none principle fatigue), muscular disorders.
- 4.4 Ultrastructure of Neuromuscular Junction.

## **Semester –IV**

### **Paper-4T<sub>3</sub>, Special Group-Animal Physiology-II**

#### **Physiology of Respiration and Reproduction**

##### **Unit I**

- 1.1 Physiological anatomy of respiratory system.
- 1.2 Mechanism of respiration – Mechanism of breathing and the exchange of respiratory gases at pulmonary surface.
- 1.3 Transport of respiratory gases by blood.
- 1.4 Lung volumes and capacities, partial pressure of gases.

##### **Unit II**

- 2.1 Oxygen dissociation curve, Carbon -dioxide dissociation curve.
- 2.2 Carbonic anhydrate, chloride shift.
- 2.3 Neural and chemical regulation of respiration
- 2.4 Hypoxia, Cyanosis.

##### **Unit III**

- 3.1 Endocrine control of spermatogenesis and oogenesis
- 3.2 Leydig cells, Sertoli cells and their hormones
- 3.3 Follicular cells and luteal cells and their hormones
- 3.4 Corpus luteum- formation, structure, hormones and functions

##### **Unit IV**

- 4.1 Placenta - structure, hormones and functions
- 4.2 Physiology of lactation
- 4.3 Role of hormones and pheromones in reproduction
- 4.4 Causes of infertility in male and female; In vitro fertilization (IVF) and Test Tube Baby

## Semester-IV, Practical-4P<sub>1</sub>, Special Group- Animal Physiology

### I. Physiology Experiments

- 1 Study of Electrocardiograph (ECG) under different physiological conditions with the help of ICT tools/ charts/ models / photographs etc.
- 2 Body size and oxygen consumption in aquatic animals.
- 3 Effect of pH, temperature on oxygen and carbon dioxide concentration in pond water.
- 4 Biochemical estimation of tissue cholesterol (Source of tissue: Local recognized fish markets/ slaughter houses/ poultry farms etc.)
- 5 Measuring of heart beat under different physiological condition.
- 6 Study of nerve cells and neurosecretory cells of cockroach with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
- 7 Estimation of SGOT/SGPT from blood sample (Source of blood: Local recognized pathology laboratory)

### II. Quantitative Analysis

- 1 Muscle & Liver glycogen (Source of muscle/ liver: Local recognized fish markets/ slaughter houses/ poultry farms etc.)
- 2 Determination of fructose in seminal vesicle/ semen (Source of semen: Government artificial insemination centre)
- 3 Separation of protein by SDS-PAGE
- 4 Determination of semen constituents (Source of semen: Government artificial insemination centre)
- 5 Estimation of percentage quantity of lactose in milk in vertebrates.

### III. Qualitative Analysis

- 1 Estimation of lactate dehydrogenase (Source of blood: Local recognized pathology laboratory).
- 2 Estimation of RNA and DNA (Source of blood: Local recognized pathology laboratory).
- 3 Histochemical localization of a dehydrogenase (Source of tissue: Local recognized fish markets/ slaughter houses/ poultry farms etc.)
- 4 Histochemical localization of Carbohydrate (Source of tissue: Local recognized fish markets/ slaughter houses/ poultry farms etc.)
- 5 Histochemical localization of Glycogen (Source of tissue: Local recognized fish markets/ slaughter houses/ poultry farms etc.)
- 6 Histochemical localization of lipid (Source of tissue: Local recognized fish markets/ slaughter houses/ poultry farms etc.)
- 7 Histochemical localization of protein (Source of tissue: Local recognized fish markets/ slaughter houses/ poultry farms etc.)

### IV. Histological Study of Brain, Testis, Ovary, Thyroid, Adrenal, Corpus luteum in ovary, Leydig cells in testis, T. S. Muscle fiber, T. S. Spinal cord, Cerebellum & cerebrum, Nerve fiber, Lung with the help of already available permanent slides/ ICT tools/ charts/ photographs etc.

#### Distribution of Marks:

	Marks
1. Physiology Experiment	20
2. Major quantitative analysis	20
3. Minor quantitative analysis	10

4.	Qualitative analysis	15
5.	Identification and comment on spots(1-5)	15
6.	Practical Record	10
7.	Viva-voce	10
		-----
<b>Total marks</b>		100
<ul style="list-style-type: none"> <li>• <b>Project work</b></li> </ul>		100
(80 marks project evaluation including viva + 20 marks Internal assessment)		

#### **Semester –IV**

#### **Paper-4T<sub>2</sub>, Special Group-Environmental Biology-I Environmental Pollution and Aquaculture**

##### **Unit-I**

- 1.1 Pollution Ecology: definition, sources of pollution, classification of pollutants, primary and secondary pollutants.
- 1.2 Air pollution: definition, sources, air pollutants and its effects on human health and atmosphere, control of air pollution.
- 1.3 Water Pollution: definition and sources, water pollutants and its effects, control of water pollution.
- 1.4 Noise pollution, sources, physiological and psychological effects of noise pollution, control measures of noise pollution.

##### **Unit-II**

- 2.1 Land pollution: definition, sources, effects and control of insecticide pollution.
- 2.2 Radioactive pollution: definition, sources, effects and control measures of radioactive pollution.
- 2.3 Biomedical waste: sources, effects and control measures
- 2.4 Hazardous waste: definition, sources, effects.

##### **Unit-III**

- 3.1 Biological and general effects of pollutants on organism.
- 3.2 Bioassay studies: definition, purpose, methodology, calculation of LC50 value, significance.
- 3.3 Bioaccumulation and biomagnifications.
- 3.4 Biotransformation of xenobiotics.

##### **Unit-IV**

- 4.1 Aquaculture: basic concept of fisheries, marine, inland and brackish water fisheries.
- 4.2 Indian major carps and their culture: fish, seed resources, transport.
- 4.3 Planning and management of freshwater fish farm.
- 4.4 Fishery economics and management: role of fishery co-operative societies, economics of fishery, aquaculture and rural development.

#### **Semester –IV**

#### **Paper-4T<sub>3</sub>, Special Group-Environmental Biology-II Man and Environment**

##### **Unit-I**

- 1.1 Natural resources: definition, concept, types of natural resources, use and abuse of natural resources.

- 1.2 Wild life: wild life in India, endangered species of mammals, birds, amphibian and reptiles,
- 1.3 Causes of wild life depletion, necessity of wild life conservation.
- 1.4 Modes of conservation, national parks and sanctuaries, strategies for biodiversity conservation, gene pool.

#### **Unit-II**

- 2.1 National resources: minerals, nutrient cycles, exploitation of nutrient resources.
- 2.2 Biomass, biogas and solar energy.
- 2.3 Conservation and sustainable development of natural resources, bacteria and biodegradation
- 2.4 Biodiversity- definition, types, hotspots of biodiversity.

#### **Unit-III**

- 3.1 Conservation of natural resources: potable water criteria, water supply, water borne diseases and control measures, bioremediation of ponds and lakes.
- 3.2 Process of soil formation, composition, soil profile, soil erosion, methods of conservation of soil.
- 3.3 Conservation of forest: needs, afforestation, deforestation, agroforestry, forest conservation through law.
- 3.4 Social forestry and environment.

#### **Unit-IV**

- 4.1 Environmental policy, social economic and legal aspects, social forestry, enforcement of anti pollution law.
- 4.2 Environmental education: environmental education programmes, environmental education in India
- 4.3 Formal environmental education, stages of environmental education, non formal environmental education.
- 4.4 Environmental Organizations and agencies.

#### **Semester-IV, Practical-4P<sub>1</sub>, Special Group-Environmental Biology**

- 1 Bioassay test- toxicity evaluation of heavy metals/pesticides using snail/fish as test animals, determination of LC<sub>50</sub> value by using provided data.
- 2 Determination of oxygen consumption in fish.
- 3 Estimation and proximate composition (Protein / glycogen) in fish (Source of fish blood/ tissue: Local recognized fish market).
- 4 Determination of NO<sub>2</sub> and SO<sub>2</sub> in ambient air.
- 5 Determination of suspended particulate matters in ambient air.
- 6 Determination of oil and grease by Soxhlet apparatus and separating funnel.
- 7 Identification of common commercial important inland / marine fishes, Crustaceans and mollusc.
- 8 Identification of maturity stages in fish using fishes available in the local fish markets or with the help of already available permanent slides ICT tools/ charts/ models/ photographs etc.
- 9 Determination of gonadosomatic index (GSI) by using provided data.
- 10 Study of fecundity of fish.
- 11 Physicochemical analysis of Soil, pH, moisture.
- 12 Field work and study tour:
  - a. Visit to National Institute / Centre of Aquaculture.
  - b. Visit to a fish farm
  - c. Visit to National park / sanctuary to observed wildlife and maintaining the field diary.





**Semester –IV**  
**Paper-4T<sub>4</sub>, Foundation -II**  
**Applied and Industrial Entomology**

**Unit 1- Mulberry sericulture**

- 1.1 Mulberry sericulture:- life history and rearing.
- 1.2 Silk gland of mulberry silkworm:- structure and silk synthesis.
- 1.3 Cocoon formation, cocoon harvesting and reeling.
- 1.4 Mulberry plantation and silkworm rearing house.

**Unit 2- Tasar sericulture**

- 2.1 Tasar silkworm biology and life cycle.
- 2.2 Mature tasar larvae, silk gland and silk proteins.
- 2.3 Hammock and cocoon formation, cocoon harvesting.
- 2.4 Natural host plants and predators of tasar silkworm.

**Unit 3- Eri, lac culture and medical entomology**

- 3.1 Eri silkworm biology and life cycle.
- 3.2 Lac insect- biology, lac cultivation and economic importance.
- 3.3 Forensic entomology- basic concepts and importance.
- 3.4 Insect causes diseases in man- (Malaria, Filarial, Kala- Azar).

**Unit 4- Apiculture**

- 4.1 Types of honey bees, *Apis dorsata*, *A. indica* and *A. mellifera*.
- 4.2 Colony formation and Apiary products.
- 4.3 Beekeeping techniques: moveable frame hive and bee rearing management.
- 4.4 Economic importance of honey, wax and other apiary products

**Suggested Readings for foundation -I and Foundation -II**  
**Entomology**

1. Imms General text book of Entomology, Eds. O. W. Richards and R. G. Davis Chapman and Hall, London.
2. General and Applied Entomology, K.K. Nayar, T. N. Ananthkrishan and B.V. Davis Tata McGraw -Hill Co.Ltd. Bombay.
3. The Insect: Structure and function, R.F. Chapman, Cambridge University Press.
4. The Physiology of Insect , Ed. M.Rockstein ,Vol, 1-5, Academic Press, New York.
5. The Physiology of Insect Reproduction, F, Englemann, Pergamon Press, New York.
6. Comprehensive Insect Physiology , Biochemistry and Pharmacology , Eds. G.A. Kerkut and I. A. Gillberd, VOL. 1-13, Pergamon Press, New York.
7. Analytical Biochemistry of Insect, Ed. R. B. Turner, Elsevier, Amsterdam.
8. Insect Hormone, M. J. A. Novak. Chapman and Hall, London.
9. Modern Entomology(Second edition): D. B. Tembhare, Himalaya Publication House, Bombay.
10. Destruction and Useful Insect, Their Habits and Control, C. L. Metcalf, W. P. Flint and R. I. Metcalf, Mc Grow I Ill Co. New York.
11. Integrated Pest Management, J.L. Apple and R. E. Smith, Plenum Publication Co., New Delhi.
12. An Introduction Of Biological Control RVD Boarscho, P. S. Y. Messenger and A. P. Gaiter, Plenum Publication Co.

13. Text Book of Entomology, K. P. Shivastava, Vol. 1 And 2 Kalyani Publication, Ludhiana.
14. Agriculture Entomology, H. S. Dennis, Timber Press Inc.
15. Entomology and Pest Management, Larry P. Pedigo, Prentice Hall.
16. Text Book of Agriculture Entomology, Alford V. David, Blackwell Science.
17. Biopesticides In Insect Pest Management, S. J. Ignacimulha and Alok Sen , Phoenix Publishing House Pvt, Ltd.
18. Biotechnology in Invertebrate Pathology and Cell culture ( Maramorosch, K. ed.). Academic Press, New York.
19. PEBFANS (2003)” (Solomon Raju, A. J. ed.). Andhara University Press, Visakhapatnam.
20. Living Resources for the Millennium 2000 (S. J. William ed.), Students Offset Press, Chennai.

#### **Semester –IV**

#### **Core (Subject Centric)- II**

#### **Paper- 4T<sub>4</sub> Radiation and Chronobiology**

#### **Unit- I: Radiation Biology**

- 3.1. Definition, scope and significance of radiation biology.
- 3.2. General classification of radiation. Ionizing radiation, linear energy transfer, radiation dose and units.
- 3.3. Principles of radiation dosimetry, direct and indirect effects. Radiations lesions in DNA, radiobiological effect on cell.
- 3.4. Radiation sensitizers and protectors.

#### **Unit II: Effect of Radiation on Human Health**

- 4.1. Health consequences after total body irradiation from radiation accidents.
- 4.2. Long term radiation risks from low radiations doses.
- 4.3. Radiation induced cancer.
- 4.4. Radiation effects in the developing embryo and fetus, radiation induced heritable diseases.

#### **Unit- III: Circadian cycle**

- 1.1. Organization of circadian system in multicellular animals.
- 1.2. Concept of central and peripheral clock system.
- 1.3. Circadian pacemaker system in invertebrates with particular reference to *Drosophila*.
- 1.4. Circadian pacemaker system with particular reference to rodents.

#### **Unit- IV: Biological clock**

- 2.1. Centers of biological clock – Supra chiasmatic nuclei, pineal gland and optic lobes.
- 2.2. The relevance of biological clock for human welfare- clock function and dysfunction.
- 2.3. Depression and sleep disorders.
- 2.4. Chronopharmacology, chronomedicine, chronotherapy.

#### **Suggested reading**

1. Kumar, V. 2002. Biological Rhythms, Narosa Publishing House, Delhi/ Springer-Verlag, Germany
2. Dunlap, J. C., Loros, J. J. & DeCoursey, P. J. 2004. Chronobiology Biological Timekeeping, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
3. Fliedner, T. M., Friesecke, I. & Beyrer, K., 2001. Medical management of radiation accidents– manual on the acute radiation syndrome. British Institute of Radiology Supplement.

4. Kramer, K. & Merrow, G. 2013. Handbook of Experimental Pharmacology, Circadian Clocks, Springer, London.
5. Hall, E. J, Giaccia A. J. 2006. Radiobiology for the radiologist, Philadelphia, Pa: Lippincott Williams & Wilkins.
6. Saunders, D.S., Steel, C.G.H., Afopoulou X. & Lewis, R.D. 2002. Insect Clocks, Barenz and Noble Inc., New York, USA.
7. International Commission on Radiological Protection, 2003: Biological effects after prenatal irradiation (embryo and foetus), ICRP publication.
8. INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION, 2006: Low dose extrapolation of radiation-related cancer risk, ICRP publication.
9. Foster, R. & Kreitzman, L. 2014. Rhythms of Life, The Biological Clocks that Control the Daily Lives of Every Living Thing by, Profile Books Ltd.