

**Syllabus for M. Sc. Zoology (Semester with credit based Pattern) w e f 2012-13 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		Max. Marks		Total Marks	Minimum Passing Marks		
							Exte rnal	Inter nal		Th	Prac	
Core 1	Paper 1: Structure and Function of Invertebrates	4	-	4	4	3	80	20	100	40		
Core 2	Paper 2: General Physiology	4	-	4	4	3	80	20	100	40		
Core 3	Paper 3: Cell Biology and Genetics	4	-	4	4	3	80	20	100	40		
Core 4	Paper 4: Advanced Reproductive Biology	4	-	4	4	3	80	20	100	40		
Pract. Core 1 & 2	Practical 1: Based on theory Paper 1 & 2	-	8	8	4	3-8*	100*	-	100		40	
Pract. Core 3 & 4	Practical 2: Based on theory Paper 3 & 4	-	8	8	4	3-8*	100*	-	100		40	
Seminar 1	Seminar 1	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>	

<b>M. Sc. Zoology Semester II</b>												
Code	Theory / Practical	Teaching scheme (Hours / Week)				Credits	Examination Scheme					
		Th	Pract	Total	Duration		Max. Marks		Total Marks	Minimum Passing Marks		
							External	Internal		Th	Pract	
Core 5	Paper 5: Structure and Function of Vertebrates	4	-	4	4	3	80	20	100	40		
Core 6	Paper 6: Comparative Endocrinology	4	-	4	4	3	80	20	100	40		
Core 7	Paper 7: Molecular Biology and Biotechnology	4	-	4	4	3	80	20	100	40		
Core 8	Paper 8: Advanced Developmental Biology	4	-	4	4	3	80	20	100	40		
Pract. Core 5 & 6	Practical 3: Based on theory Paper 5 & 6	-	8	8	4	3- 8*	100* *	-	100			40
Pract. Core 7 & 8	Practical 4: Based on theory Paper 7 & 8	-	8	8	4	3- 8*	100* *	-	100			40
Seminar 2	Seminar 2	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	Theory / Practical	Teaching scheme (Hours / Week)				Credits	Examination Scheme					
		Th	Pract	Total	Duration		Max. Marks		Total Marks	Minimum Passing Marks		
							External	Internal		Th	Pract	
Core 9	Paper 9: Parasitology and Immunology	4	-	4	4	3	80	20	100	40		
Core 10	Paper 10: <b>Special Group- Paper I</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>• Cell Biology</li> <li>• Fresh Water Zoology</li> <li>• Aquaculture</li> <li>• Environmental Biology</li> <li>• Sericulture</li> </ul>	4	-	4	4	3	80	20	100	40		
Core Elective 1	<b>Paper 11: Special Group- Paper II</b> <ul style="list-style-type: none"> <li>• Entomology</li> <li>• Fish and Fisheries</li> <li>• Mammalian Reproductive</li> </ul>	4	-	4	4	3	80	20	100	40		

	Physiology (MRP) <ul style="list-style-type: none"> <li>• Animal Physiology</li> <li>• Cell Biology</li> <li>• Fresh Water Zoology</li> <li>• Aquaculture</li> <li>• Environmental Biology</li> <li>• Sericulture</li> </ul>										
Foundation Course 1 (NOTE: Only for students of other M. Sc. Subjects)	Paper 12: Foundation I – <ul style="list-style-type: none"> <li>• Elementary Zoology</li> <li>• Basic Entomology</li> <li>• Fresh Water Fisheries</li> <li>• Human Physiology</li> </ul>	4	-	4	4	3	80	20	100	40	
Pract. Core & 10	Practical 5: Based on theory of 9	-	8	8	4	3-8*	100*	-	100		40
Pract. Core Elective 1	Practical 6: Based on theory of 10 and 11	-	8	8	4	3-8*	100*	-	100		40
Seminar 3	Seminar 3	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)				Credits	Examination Scheme					
		Th	Pract	Total	Duration		Max. Marks		Total Marks	Minimum Passing Marks		
							Ext ern	Int ern		Th	Pra	
Core 11	Paper 13: Biotechnology, Biostatistics, Ethology, Toxicology and Bioinformatics	4	-	4	4	3	80	20	100	40		
Core 12	Paper 14: <b>Special Group- Paper III</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>• Cell Biology</li> <li>• Fresh Water Zoology</li> <li>• Aquaculture</li> <li>• Environmental Biology</li> <li>• Sericulture</li> </ul>	4	-	4	4	3	80	20	100	40		
Core Elective 2	Paper 15: <b>Special Group- Paper IV</b> <ul style="list-style-type: none"> <li>• Entomology</li> <li>• Fish and</li> </ul>	4	-	4	4	3	80	20	100	40		

	Fisheries • Mammalian Reproductive Physiology (MRP) • Animal Physiology • Cell Biology • Fresh Water Zoology • Aquaculture • Environmental Biology • Sericulture										
Foundation Course 2 (NOTE: Only for students of other M. Sc. Subjects)	Paper 16: Foundation II – • Applied Zoology • Applied and Industrial Entomology • Applied Fresh Water Fisheries • Applied Human Physiology	4	-	4	4	3	80	20	100	40	
Pract. Core 11, 12 & Elective 2	<b>Practical 7: Based on theory of 14 and 15</b>	-	8	8	4	3-8*	100**	-	100		40
Project	Project	-	8	8	4	3-8*	100**	-	100		40
Seminar 4	Seminar 4	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>

**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-I, 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-II, 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-III, 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 verses 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-IV, 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-I, 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 copepods, cladoceran, ostracoderm and rotifers.
- h. Larval forms of the free living invertebrates.
- i. Larval forms of parasitic invertebrates.

#### 4 Study of permanent Invertebrate slides

- a. Porifera – T.S. and L.S. of *Sycon*, gemmules, spongian fibres, spicules
- b. ctenophora – T.S. of *Hydra*, T.S. of Sea anemone, Ephyra larva
- c. Helminths – T.S. of *Planaria*, T.S. of *Taenia*, scolex W.M., Mature, gravid proglotids, T.S. of male and female *Ascaris*, W.M. of *Ankylostoma*, *Enterobius*, *Dracunculus*, *Wuchereria*
- d. Annelida -T.S. of *Nereis*, T.S. of Earthworm passing through various organs, T. S. of Leech.
- e. Arthropod larvae – Nauplius, Zoea, Metazoea, Megalopa, Mysis.
- f. Mollusca – T.S. of foot, Veliger and Glochidium larva.
- g. Echinodermata- pedicellariae, T.S. of arm of star fish, Bipinnaria, Oricularia larva.
- h. Hemichordata – T.S. through collar, proboscis, trunk and branchio-genital regions. Tornaria larva.

#### Section-B

##### Physiology experiments –

- a. Total leucocyte count and differential leucocyte count.
- b. Total R.B.C. count.
- c. Demonstration of action of salivary amylase, trypsin, pepsin.
- d. Demonstration of rate of O<sub>2</sub> consumption in aquatic animals, under various environmental stresses.
- e. Demonstration of haemoglobin concentration in normal and pathological condition.
- f. Estimation of sodium, potassium and chloride in blood and excretory organs by Colorimeter or flame photometer (Source of blood: Local recognized pathology laboratory).
- g. Estimation of glucose in blood by spectrophotometer or Colorimeter (Source of blood: Local recognized pathology laboratory).
- h. Estimation of total blood proteins by spectrophotometer or Colorimeter (Source of blood: Local recognized pathology laboratory).
- i. Estimation of cholesterol in blood by spectrophotometer or Colorimeter (Source of blood: Local recognized pathology laboratory).

##### Distribution of Marks:

	<b>Marks</b>
1. Anatomical observations	10
2. Stained permanent preparation:	10
3. Identification and comment on the spots (1-10)	30

4.	Physiology experiment (Major)	15
5.	Physiology experiment (Minor)	10
6.	Submission of stained permanent slides	05
7.	Class Record	10
8.	Viva-voce	10
-----		
<b>Total marks</b>		<b>100</b>

## **Semester-I, Practical-II, Cell Biology, Genetics and Advanced Reproductive Biology**

### **Section-A**

1. Study of mitotic metaphasic chromosomes in plant material.
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/sperm vitality	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
		-----
	<b>Total marks</b>	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 Hunter W.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 Laodish 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 Upadhay A and Upadhay K. Himalaya publication.

### **Advance reproductive 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-II**

### **Paper- V, 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-VI, 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-VII, 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-VIII, 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-III, 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.

<b>Distribution of Marks</b>	<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
	-----
<b>Total marks</b>	<b>100</b>

**Semester-II, Practical –IV, 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
-----	
<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 Newyork
22. T.B. of Zoology Parker and Haswell W.A. Mac millon co. Ltd. London
23. The Biology of Amphibia Noble G.K. Dover Publication Inc Newyork

### **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- IX, 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





- Parker. Prentice Hall International Publication.
2. The Nematode Parasite in Vertebrate, W. Youle and Maplestone.
  3. General Parasitology, V. A. Dogiel.
  4. Helminthology, E. C. Faussy.
  5. Platyhelminthes and Parasitism, D.R. Birt.
  6. Animal Parasite- O.W. Aisen
  7. Parasitic Protozoa, J.P. Kreier and J.R. Baker. Allen and Unwin Press.
  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-X, 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-XI, 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-VI, 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>	<b>100</b>

**Semester –III**

**Paper-X, 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-XI, 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-V, 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).

<b>Distribution of Marks:</b>	<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
	-----
<b>Total marks</b>	<b>100</b>

**Semester –III**

**Paper-X, Special Group-Mammalian Reproductive Physiology (MRP)-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-XI, 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-VI, 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**

1. Surgical operation
2. Anatomical observations

#### **Marks**

- 20  
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
<b>Total marks</b>		100

### **Semester –III**

#### **Paper-X, 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-XI, 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-VI, 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-X, Special Group-Cell Biology -I

#### Unit-I

- 1.1 Light Microscopy: principles, working and applications of Phase contrast, Interference, Fluorescence and Confocal microscopy. Electron Microscopy- Principles, working, applications of Scanning & transmission electron microscopy.

- 1.2 Basic principles of sedimentation, types of centrifuges, Preparative centrifugation, analytical centrifugation and applications of ultracentrifugation in cell fractionation. Cell separation by flow cytometry.
- 1.3 Isolation and purification of DNA, RNA & proteins.
- 1.4 NMR, ESR & X-Ray crystallography.

#### **Unit-II**

- 2.1 Principle, working and application of UV/Visible absorption spectroscopy, UV/Visible fluorescence spectroscopy, Mass spectroscopy.
- 2.2 Principle, working and applications of paper and thin layer chromatography, affinity chromatography, gel filtration chromatography, ion-exchange chromatography and Gas-liquid chromatography.
- 2.3 Cell culture techniques- Monolayer and polylayer. Design and functioning of tissue culture laboratory.
- 2.4 Tissue engineering.

#### **Unit-III**

- 3.1 Physicochemical properties of Nucleic acids. Enzymology of recombinant DNA technology- DNA modifying enzymes, restriction endonucleases, DNA ligases.
- 3.2 Cloning vectors – Plasmid, Lambda & M13 virus based vectors, phagemids, cosmids, YAC and BAC vectors.
- 3.3 Gene probes – Designing and production of gene probes for recombinant DNA technology.
- 3.4 Gene library – Construction of C-DNA & genomic library.

#### **Unit-IV**

- 4.1 Gene transformation and transfection methods for recombinant DNA. Genetic screening methods for gene constructs.
- 4.2 Applications of gene cloning – Sequencing cloned DNA, *invitro* mutagenesis, PCR based mutagenesis.
- 4.3 Applications of gene cloning – Expression of foreign genes, production of fusion proteins, phage display techniques.
- 4.4 Applications of gene cloning – Identifying and analyzing mRNA, analyzing gene *in situ*, analyzing promoter protein interactions, transgenics, detecting DNA polymorphism, DNA chip technology.

### **Semester –III**

#### **Paper-XI, Special Group-Cell Biology-II**

##### **Unit I**

- 1.1 Chromosome structure and classification – Human karyotyping and criteria for ideogram preparation. Chromosome banding methods, it's applications in genetics.
- 1.2 Chromosomal mutations, molecular mechanism of mutation. Structural abnormalities of human chromosomes and related syndromes: Deletion, Robertsonian translocation, Cri-du-chat syndrome, Prader-Willi syndrome.

- 1.3 Human metabolic disorders: Phenylketonuria, Lesch-Nyhan syndrome, Tay-Sachs disease, Alkaptonuria, Albinism, Glucose-6-phosphate dehydrogenase deficiency.
- 1.4 Molecular methods of chromosome studies and applications – *in situ* hybridization, FISH.

### **Unit-II**

- 2.1 Genome organization – Physical and genetic mapping of genome. Organelle genome – organization and expression of mitochondrial and chloroplast genome.
- 2.2 Detailed account of genome models of lambda phage, *E. coli*.
- 2.3 Functional genomics – Human genome project.
- 2.4 Molecular cytogenetic techniques – DNA fingerprinting, automated karyotyping, chromosome painting, DNA sequencing, microarray.

### **Unit-III**

- 3.1 Sex determination–Mechanism of sex determination in *Drosophila* human.and
- 3.2 Developmental genetics–Establishment of anterior-posterior polarity and role of maternal effect genes during development.
- 3.3 Cell specification and determination–Role of segmentation genes, gap genes, pair-rule genes and segment polarity genes during development. Homeobox concept in different phylogenic groups.
- 3.4 Cell differentiation and differential gene activity, totipotency and nuclear transfer experiment.

### **Unit-IV**

- 4.1 Population genetics – Demes, gene pool, gene flow and genetic drift. Hardy-Weinberg equation and its significance in population genetics.
- 4.2 Genetic selection–Selection pressure, fitness and coefficient of selection, types and examples of genetic selection.
- 4.3 Speciation and isolating mechanisms.
- 4.4 Theories of organic evolution.

### **Semester-III, Practical-VI, Special Group- Cell Biology**

- 1 Study of structure of prokaryotic cell using lactobacilli (curd)
- 2 Study of structure of eukaryotic cell and cell organelles: nucleus, mitochondria, golgi apparatus, smooth endoplasmic reticulum, rough endoplasmic reticulum, liposomes, microtubules, microfilaments, ribosomes, centrioles with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
- 3 Study of electromicrographs of eukaryotic cell and cell organelles.
- 4 Study of different types of mammalian cells (tissues) with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
- 5 Isolation of DNA from any available material.
- 6 Demonstration of Mitochondria by vital staining using buccal epithelium.
- 7 Study of mitotic stages in onion root tips.

- 8 Estimation of Mitotic Index.
- 9 Study of meiotic stages from Tradescantia buds.
- 10 Study of polytene chromosome in Chironomous larva with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
- 11 Measurement of cell size using oculometer.
- 12 Study of human karyotype using photographs: normal male and female diseases conditions (classification of chromosomes according to size and position of centromere).
- 13 Identification and study of male and female drosophila, mutants in eye color and structure, body color, wings with the help of already available permanent slides/ ICT tools/ models/ charts/ photographs etc.
- 14 Study of drosophila culture technique and life cycle of drosophila
- 15 Problems based on Hardy- Weinberg equation and its significance in population genetics.
- 16 Design and functioning of tissue culture lab

<b>Distribution of Marks</b>	<b>Marks</b>
1. Isolation of DNA/ Demonstration of mitochondria	20
2. Estimation of mitotic index/ Demonstration of meiotic stages	15
3. Measurement of cell size by oculometer/ Problems based on Hardy-Weinberg equation	15
4. Identification and comment on spots (1-10)	30
5. Class record/ submissions	10
6. Viva-voce	10
	-----
<b>Total marks</b>	<b>100</b>

### **Semester –III**

#### **Paper-X, Special Group-Fresh water Zoology -I**

#### **Limnology**

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

- 1.1 Dynamics of Aquatic Ecosystems (predators, consumers, decomposers, transformers, ecological pyramids & trophic levels), Energy flow models.
- 1.2 Lotic Habitat: Major river systems in India.
- 1.3 Lentic Habitat: Lakes and their origin
- 1.4 Bog lakes & succession of lakes, man-made lakes and reservoirs

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

- 2.1 Physical conditions of water: Movement of water, Viscosity, Density.
- 2.2 Buoyancy, Surface film and surface film animal.
- 2.3 Temperature and Light, Transparency and turbidity.
- 2.4 Influence of physical conditions on pH of surface and bottom water.

### **Unit-III**

- 3.1 Chemical conditions of water: Dissolved oxygen & carbon dioxide
- 3.2 Phosphates, Nitrates & Silicates.
- 3.3 Hardness: Total Hardness, Mg - hardness & Ca – Hardness.
- 3.4 Nitrogen and Ammonia, Importance of Chemical Parameters.

### **Unit-IV**

- 4.1 Primary and secondary productivity in aquatic ecosystems.
- 4.2 Classification of waterbodies based on productivity.
- 4.3 Methods of measurement of productivity.
- 4.4 Factors affecting primary productivity and significance of productivity studies

## **Semester-III**

### **Paper-XI, Special Group-Fresh water Zoology-II**

#### **Fishery Biology**

#### **Unit-I**

- 1.1 Schemes of classification of fishes by Berg (1940) and Romer (1971).
- 1.2 Biology of Indian major carps and culturable exotic carps.
- 1.3 Food and feeding habits of some common fresh water fishes.
- 1.4 Methods of gut content (food) analysis.

#### **Unit-II**

- 2.1 Structure and function of gills.
- 2.2 Electroreceptors in fishes and their functions.
- 2.3 Growth and age studies on fish
- 2.4 Length- weight relationship and condition factor.

#### **Unit-III**

- 3.1 Maturation, spawning periodicity and fecundity of fish.
- 3.2 Maturity stages of male & female fish, and atretic follicles.
- 3.3 Genetic engineering methods for fish stock improvement.
- 3.4 Fish diseases caused by pathogens and parasites.

#### **Unit-IV**

- 4.1 Aquarium-fish keeping and its maintenance.
- 4.2 Breeding of ornamental fishes - egg depositors and live bearers.
- 4.3 Exotic and larvivorous fishes and their importance
- 4.4 Threatened fresh water fishes and conservation measures.

## **Semester –III Practical-VI, Special Group- Fresh water Zoology**

### **Section: A**

- 1 Measurement of transparency of water body by Secchi disk method.
- 2 Analysis of pH & Turbidity of water.

- 3 Estimation of Dissolved Oxygen (DO) & free carbon dioxide from water.
- 4 Estimation of Alkalinity (Carbonates & Bicarbonates), Hardness (Total, Ca & Mg)
- 5 Estimation of Chlorides, Phosphates & Nitrates from water.
- 6 Biochemical oxygen demand (BOD) from given water sample.
- 7 Determination of primary productivity of a water body by light and dark bottle method.

**Section: B**

- 1 Identification of commercially important freshwater fishes and prawns using fishes available in local recognized fish markets or with the help of already available specimens/ ICT tools/ models/ charts/ photographs etc.
- 2 Morphometric study of fish available in local recognized fish markets or with the help of already available specimens/ ICT tools/ models/ charts/ photographs etc.
- 3 Study of spawning periodicity by provided data.
- 4 Determination of length - weight relationship of fish available in local recognized fish markets or with the help of already available specimens/ ICT tools/ models/ charts/ photographs etc.
- 5 Determination of condition factor by using given data.
- 6 Study of maturity stages of fish by using pictures.
- 7 Histological study of fish organs with the help of already available permanent slides/ ICT tools/ charts/ Models / Photographs etc.
- 8 Identification of common parasites of fish with the help of already available permanent slides/ ICT tools/ charts/ models / photographs etc.
- 9 Permanent mounting of fish scales using wastes from local recognized fish markets.
- 10 Visit to a fresh water body for the study of aquatic ecosystem.

<b>Distribution of marks</b>	<b>Marks</b>
1. Water analysis: Major expt.	15
2. Water analysis: Minor expt.	10
3. Determination of spawning periodicity / Length - weight relationship by provided data.	10
4. Explanation of morphometry of fish / Determination of Condition factor by given data.	05
5. Identification of spots (1 to10) by pictures	20
6. Study of maturity stages of fish with the help of photos/ Study of Fish scales by using pictures.	05
7. Practical record & submission photographs of fishes.	10
8. Viva – voce	05
	-----
	80
<b>Internal Assessment</b>	20
	-----
<b>Total marks</b>	<b>100</b>



## **Semester-III**

### **Paper-X, Special Group-Aquaculture-I**

#### **Fresh water Aquaculture**

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

- 1.1 Aquaculture: Definition, importance and present status in India.
- 1.2 Physicochemical conditions of pond water.
- 1.3 Biological conditions – Aquatic vegetation, Association of macro vegetation.
- 1.4 Plankton: Seasonal distribution, Diurnal movement and its role in fisheries.

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

- 2.1 Pond soil, Chemical conditions.
- 2.2 Pond ecosystem: Trophic level, food chain and food web in pond.
- 2.3 Methods of productivity measurement.
- 2.4 Planning and construction of fresh water fish farm.

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

- 3.1 Biology of culturable indigenous carps.
- 3.2 Biology of culturable exotic carps.
- 3.3 Reproductive system and breeding behavior in Indian carps.
- 3.4 Fisheries of major river systems in India.

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

- 4.1 Reverine collection of fish seed.
- 4.2 Fish breeding in wet and dry bundhs.
- 4.3 Induced breeding by hypophysation.
- 4.4 Hatching techniques and types of hatcheries.

## **Semester –III**

### **Paper-XI, Special Group-Aquaculture-II**

#### **Aquaculture and Rural Development**

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

- 1.1 Culture of zooplankton
- 1.2 Prawn culture & Methods of breeding
- 1.3 Culture of crabs
- 1.4 Pearl culture / Oyster culture

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

- 2.1 Development and advancement of aquaculture in India.
- 2.2 Larvivorous fishes in relation to public health.
- 2.3 Culture of Exotic and transplanted fishes
- 2.4 Breeding and care of fresh water aquarium fishes.

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

- 3.1 Definition of economics and application of economic principles to aquaculture.

- 3.2 Aquaculture and rural development in India.
- 3.3 Role of FFDA in development of aquaculture in India.
- 3.4 Fishery extension techniques.

**Unit-IV**

- 4.1 Socio-economic status of fishermen community.
- 4.2 Fisheries co-operatives and their role in fish production and marketing.
- 4.3 Organization and operational problems in fisheries co-operative societies.
- 4.4 Fishery legislation and their role in fishery development.

**Semester-III, Practical-VI, Special Group- Aquaculture**

- 1 Physicochemical analysis of pond water for determination of pH, Turbidity, DO, Free CO<sub>2</sub>, Ammonia, Alkalinity, Hardness, Nitrates and Phosphates.
- 2 Physicochemical analysis of pond soil to determine its texture, pH, particle size, available nitrogen, phosphorus and free CaCO<sub>3</sub>.
- 3 Qualitative and quantitative study of plankton and benthos.
- 4 Study of food chain in fresh water pond ecosystem
- 5 Estimation of primary productivity by light and dark bottle method.
- 6 Identification of local fish fauna using fishes available in the local recognized fish markets or with the help of ICT tools/ Charts/ Models / Photographs etc.
- 7 Identification and classification of Indian and exotic carps using fishes available in the local recognized fish markets/ ICT tools/ charts/ models/ photographs etc.
- 8 Estimation of fecundity.
- 9 Anatomical observations, demonstration and detailed explanation of pituitary gland of carp/ Catfish with the help of ICT tools/ models/ charts/ photographs etc.
- 10 Visit to a fish seed hatchery.

<b>Distribution of marks</b>	<b>Marks</b>
1. Analysis of pond water	15
2. Analysis of pond soil	15
3. Quantitative analysis of plankton / detection of primary productivity.	10
4. Estimation of Fecundity	05
5. Identification of spots (1 to10)	30
6. Anatomical observations / mounting	05
7. Practical record & submission	10
8. Viva – voce	10
	-----
<b>Total marks</b>	<b>100</b>

## **Semester –III**

### **Paper-X, 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-XI, 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-VI, 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.

<b>Distribution of Marks</b>		<b>Marks</b>
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>		<b>100</b>

**Semester –III**  
**Paper-X, Special Group-Sericulture-I**  
**Moriculture**

**Unit-I**

- 1.1 Sericulture: Definition, history, present status of sericulture industry in India, economic importance.
- 1.2 Silkworms: Systematic position, types of silkworm, their host plants and geographic distribution.
- 1.3 Problems and prospects of sericulture in India
- 1.4 Sericulture Extension: Principles and importance of extension education in sericulture, methods of sericulture extension.

**Unit-II**

- 2.1 Economics of Sericulture: Economics of mulberry cultivation, cocoon production, silkworm rearing, silk reeling and processing.
- 2.2 Sericulture Organizations: Central Silk Board, Directorate of Sericulture at state level, role of sericulture organization in extension of sericulture.
- 2.3 Marketing and Management of Sericulture: Marketing of cocoons and raw silk yarn, traditional and regulated markets.
- 2.4 Silk exports - challenges and growth.

**Unit-III**

- 3.1 Mulberry Plant: Taxonomy and morphology of mulberry plant, anatomy of leaf, root, stem and flowers, mulberry varieties.
- 3.2 Mulberry Cultivation: Selection and preparation of land, climate and soil conditions for mulberry cultivation, propagation of mulberry, manuring and irrigation, intercultivation and pruning.
- 3.3 Pests of Mulberry: Identification, classification, life cycle, nature of damage and control measures of pests of mulberry - bihar hairy caterpillar, jassids, mealy bugs, thrips, stem borers, gall midge.
- 3.4 Diseases of Mulberry: Factors, symptoms, disease cycle and control measures of diseases of mulberry - leaf spot, powdery mildew, red rust, root knot, common mulberry dwarf.

#### **Unit-IV**

- 4.1 Physiology: Mineral nutrition, photosynthesis, respiration, growth regulators, photoperiodism and transcription.
- 4.2 Genetics of Mulberry: Spontaneous and induced mutation, molecular basis of DNA damage and repair, biological diversity in mulberry. Germplasm conservation - methods, centres of collection and significance.
- 4.3 Cytogenetics of mulberry, genetic control of disease resistance in mulberry.
- 4.4 Breeding of Mulberry: Breeding of mulberry for drought resistance, application of tissue culture in mulberry breeding, hybridization and selection of mulberry for genetic improvement. Pure line clonal and mass selection - application, advantages and limitations. Evaluation of mulberry genotype - Primary, secondary and multilocational traits.

#### **Semester –III**

#### **Paper-XI, Special Group- Sericulture-II**

#### **Mulberry and non mulberry silkworms**

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

- 1.1 Mulberry Silkworm: Classification, geographical distribution and life cycle of *B. mori*
- 1.2 Moulting and Voltinism: Univoltine, bivoltine and multivoltine races.
- 1.3 Morphology: Morphology of egg, larva, pupa, adult, mouth parts of larva, sexual dimorphism.
- 1.4 Anatomy: Silk gland, digestive, circulatory, respiratory, excretory, male and female reproductive system, neuroendocrine system and sense organs.

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

- 2.1 Physiology: Physiology of digestion, excretion, respiration; mechanism of circulation, silk synthesis and diapause.
- 2.2 Neuroendocrine system - neurosecretory cells, corpora allata, corpora cardiaca, ecdysial gland. Hormonal control of moulting and metamorphosis. Exocrine glands and pheromones.
- 2.3 Pests of Silkworm, *B. mori*: Identification, classification, life cycle and control measures of invertebrate pests (Uzi fly, dermestid beetle, ant, praying mantis, mites) and vertebrate pests (Lizard, bird, squirrel, rat) of silkworm.
- 2.4 Diseases of Silkworm, *B. mori*: Etiology, structure, symptoms, pathogenesis and diagnosis of diseases - pebrine, grasserie, flacherie and muscardine.

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

- 3.1 Tasar Silkworm: Distribution, life cycle and food plants.
- 3.2 Anatomy of Tasar Silkworm: Silk gland, digestive, respiratory and reproductive system.
- 3.3 Rearing of tasar silkworm and reeling of cocoons.
- 3.4 Pests and diseases of tasar silkworm.

#### **Unit-IV**

- 4.1 Distribution, life cycle and food plants of muga silkworm.
- 4.2 Rearing of muga silkworm and reeling of cocoon.
- 4.3 Distribution, life cycle and food plants of eri silkworm.
- 4.4 Rearing of eri silkworm and reeling of cocoon.

#### **Semester –III, Practical-VI, Special Group-Sericulture**

- 1 Study of external morphology of the egg, larva, pupa and adult of different silkworm types, sexual dimorphism in larva, pupa and adults with the help of already available specimens, permanent slides/ ICT tools/ charts/ models / photographs etc.
- 2 Study of life history of different silkworm types with the help of already available specimens, permanent slides/ ICT tools/ charts/ models/ photographs etc.
- 3 Anatomical observations, demonstration and detailed explanation of the digestive system, silk gland, nervous system, circulatory system and mouth parts of larva; Reproductive system of larva and adults with the help of ICT tools/ models/ charts/ photographs etc.
- 4 Identification of the locally available varieties of mulberry.
- 5 Study of the locally available non-mulberry host plants.
- 6 Study of the anatomy of leaf, stem, root and petiole of different locally available varieties of mulberry.
- 7 Propagation of mulberry through cutting, grafting and layering.
- 8 Analysis of organic, inorganic contents and pH of the soil.
- 9 Identification and Study of economic importance of the local pests of mulberry silkworm with the help of already available specimens, permanent slides/ ICT tools/ charts/ models/ photographs etc.
- 10 Identification and Study of economic importance of the locally found pests and diseases of mulberry with the help of already available specimens, permanent slides/ ICT tools/ charts/ models/ photographs etc.
- 11 Identification of diseases of mulberry silkworm with the help of already available specimens, permanent slides/ ICT tools/ charts/ models/ photographs etc.

#### **Distribution of marks**

	<b>Marks</b>
1. Anatomical observations	20
2. Identification and Comment on the spots (1-5)	15
3. Temporary slide preparation (Mouth parts/plant structure	10
4. Characteristics of mulberry leaves of different varieties and their stomatal frequency.	10
5. Analysis of soil (test report)	15
6. Submission of Tour diary and herbarium	10
7. Practical record	10
8. Viva voce	10

**Semester –III**

**Paper-XII, Foundation I, Elementary Zoology**

**Unit I- Wonders of animal world**

- 1.1 Introduction to animal classification upto classes
- 1.2 Bioluminescence in animals (Insects and Fish): Mechanism and its significance
- 1.3 Coral formation and types of coral reefs
- 1.4 Parental care in pisces, amphibia and mammals

**Unit II- Biodiversity and its conservation**

- 2.1 Introduction to biodiversity: Definition, scope and significance
- 2.2 Biodiversity hotspots in India, Western ghats
- 2.3 Threats to biodiversity, List of threatened animals
- 2.4 National parks and Sanctuaries of India: wildlife conservation and management

**Unit III- Animal Biotechnology**

- 3.1 Introduction to animal cell
- 3.2 Transgenic and cloned animals
- 3.3 DNA Fingerprinting: Technique and its application in forensic science (Crime Investigation)
- 3.4 Immunization, Immunodeficiency syndrome (AIDS)

**Unit IV- General aspects**

- 4.1 Evolution of man
- 4.2 Poisonous and non poisonous snakes, Snake venom and its importance
- 4.3 Vermiculture and its importance
- 4.4 Bird migration: Definition, types and factors inducing bird migration

**Semester –III**

**Paper-XII, 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**

### **Paper-XII, Foundation I, Fresh Water Fisheries**

#### **Unit – I**

1.1 Brief outline of freshwater fisheries.

1.2 Lacustrine and reservoir fisheries.

1.3 Physico-chemical characteristics of fresh water.

1.4 Construction and layout of ideal fish farm.

#### **Unit – II**

2.1 History of fish culture in India.

2.2 Brief outline of commercially important species of fresh water fishes and prawns.  
Indian & exotic carps, Cat fishes, Snake headed fishes and *Macrobrachium* spp.

2.3 Present status, scope and importance of fisheries.

2.4 Fishery products and by-products.

#### **Unit – III**

3.1 Induced breeding.

3.2 Bundh breeding (Dry & Wet bundh).

3.3 Fish seed production by Chinese circular hatchery.

3.4 Transportation of brood fish and fish seed.

#### **Unit - IV**

4.1 Food & Feeding habits of commercially important fishes.

4.2 Nutritional requirements of fish.

4.3 Artificial feeds and their composition.

4.4 Crafts and gears used in fresh water fish capture.

## **Semester –III**

### **Paper-XII, Foundation I, Human Physiology**

#### **Unit- I: Digestion**

- 1.1 Digestive tract, digestive glands, its secretion and role in digestion
- 1.2 Gastrointestinal hormones
- 1.3 Digestive disorders- Diarrhea, constipation and peptic ulcer
- 1.4 Antioxidant nutrients, free radicals and physiology of ageing

#### **Unit- II: Respiration**

- 2.1 Respiratory system
- 2.2 Respiratory pigment- Haemoglobin
- 2.3 Transport of respiratory gases (O<sub>2</sub> and CO<sub>2</sub>)
- 2.4 Respiratory disorders- Asthma and Bronchitis

#### **Unit- III: Excretion**

- 3.1 Human kidney (Structure)
- 3.2 Mechanism of urine formation
- 3.3 Adrenal gland and water electrolyte balance
- 3.4 Renal function test; Dialysis

#### **Unit- IV: Endocrine glands**

- 4.1 Pituitary gland and its hormones
- 4.2 Thyroid gland and its hormones
- 4.3 Adrenal gland and its hormones
- 4.4 Endocrine pancreas

## **Semester III**

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

#### **Paper- XII 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 – verlak, 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-XIII, 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 LC50 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. Ouellate, 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-XIV, Special Group-Entomology-III**

#### **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-XV, Special Group-Entomology-IV**

#### **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-VII, 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.





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-XIV, Special Group-Fish and Fisheries-III**

#### **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 XV, Special Group-Fish and Fisheries -IV**

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

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

- 1.1 Pond management (sitting 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.

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

- 4.1 Methods of curing and preservation of fish.
  - i. Refrigeration and freezing, ii. Drying, iii. Salting, iv. Smoking, v. Canning
- 4.2 Fish products and by-products: i. Fish body oil, ii. Fish liver oil, iii. Fish meal, iv. Isinglass, v. Fish protein concentrate, vi. Fish glue, vii. Fish manure
- 4.3 Fish pathology: i) Signs of sickness and effects on fish, ii) Pathological procedure for diagnosis of fish diseases
- 4.4 Fish diseases and its control: Biotic (fungal, bacterial and viral etc.) and Abiotic.
  - a) Viral diseases, b) Bacterial diseases, c) Fungal diseases, d) Protozoan diseases

## **Semester- IV, Practical-VII, Special Group-Fish and Fisheries**



4. Air breathing fishes of India- Their structure, function and life history: Dutta Munshi, J. S., Hungnes 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 compemendum of aquaculture technologies: Sinha, V.R. P.(1993). Oxford and JBH publication Co. New Delhi.

## **Semester-IV**

### **Paper-XIV, Special Group-Mammalian Reproductive Physiology-III**

#### **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-XV, Special Group-Mammalian Reproductive Physiology-IV 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-VII, 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.
- 6 Study of histochemical localization of lipids in rat / mouse ovary by Sudan Black–B method (Propylene glycol method) with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
- 7 Experimental (histological slides for identification) study of the following with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
  - a) Effects of ovariectomy and oestrogen replacement on pituitary, uterus and vagina.
  - b) Effects of some female antifertility drugs on ovary and adrenal gland
- 8 Histology: (Identification of slides) Histological changes in female reproductive organs during different phases of oestrous cycle in continuous and seasonal breeder with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
- 9 Embryology: Study of various stages of development of mammalian egg, development of foetal membranes, different types of placenta, progestational changes in uterus with the help of already available permanent slides/ ICT tools/ charts/ models / photographs etc.
- 10 Field work: Visit to laboratory for embryo transfer and family planning clinics.

<b>Distribution of marks</b>	<b>Marks</b>
1. Surgical operation	20
2. Anatomical observations	20
3. Vaginal smear and oestrous cycle stages	10
4. Experimental analysis	15
5. Identification and comment on spots	15
6. Practical Record	10
7. Viva voce	10
	-----
<b>Total marks</b>	100
• <b>Project work</b>	100
(80 marks project evaluation including viva + 20 marks Internal assessment)	

- **Suggested Readings**

1. A textbook of in vitro fertilization and assisted reproduction edited by P.R. Brinsden and P. A. Rainsbur Jaypee brothers 1992.
2. Advances in Reproductive Physiology, Vol. 1 to 6: McLaren, (1968). Logos Press Ltd., London.
3. Advances in Reproductive Toxicology eds. S. C. Joshi and A. S. Ansari Pointer publishers.
4. Andrology. 2<sup>nd</sup> Edition Male Reproductive health and dysfunction (Eds. E. Nieschlag & H.M. Behre) 2000.
5. Biochemistry of Mammalian Reproduction: Zanveld, L.J.D. & R.T. Chatterton (1982). John Wiley & sons, New York. The Ovary. Vol. I, II & III: Zuckerman, S, (1962). Academic Press, London.
6. Biology of Gestation: Assalye, N.S. (1968). Academic Press, London.
7. Biology of ovarian follicles in mammals (1985). S. S. Guraya Springer-Verlag.
8. Comparative cellular and molecular biology of testis in vertebrates (Trends in endocrine, paracrine and autocrine regulation of structure of functions) (2001) S.S. Guraya, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, Calcutta.
9. Comparative Endocrinology and Reproduction. Eds. K.P. Joy, A. Krishna and C. Haldar, Narosa Publishing House (1998).
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. Frohmon 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). Plenum Press, New York and London.
31. The Testis Vol. 1 to 4: Johnson, A.D. and W. R., Gomes.
32. Vertebrate Foetal Membranes: 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- XIV, Special Group-Animal Physiology-III**

#### **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 XV, Special Group-Animal Physiology-IV**

#### **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-VII, 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.**

<b>Distribution of Marks:</b>	<b>Marks</b>
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
• <b>Project work</b>	100
(80 marks project evaluation including viva + 20 marks Internal assessment)	

## Semester –IV

### Paper-XIV, Special Group-Cell Biology-III

#### Molecular Cell Biology

##### Unit-I

- 1.1 Prebiological chemical evolution and proto cells.
- 1.2 Receptors.
- 1.3 Cytoskeleton – Microtubules & microfilaments – Structure and dynamics. Microfilaments membrane binding proteins and their function.
- 1.4 Cell-cell interactions and adhesion. Adhesion molecules involved. Cell-matrix interactions and adhesions. Adhesion molecules involved. Proteins of extracellular matrix. Types of junctions.

##### Unit-II

- 2.1 Protein structure – Primary, secondary, tertiary and quaternary, Domains and motifs, Protein folding, Ramchandran plot.
- 2.2 Molecular chaperons and heat shock proteins. Prion structure and functions.
- 2.3 Protein synthesis in eukaryotes. Up take into ER, Modifications in ER, Protein sorting in Golgi apparatus, Transport of proteins across nuclear membrane. Lysosomal assembly and functions.
- 2.4 DNA binding proteins – Leucine zipper, zinc finger, helix turn helix, beta barrel and OB fold.

##### Unit-III

- 3.1 Origin, epidemiology, causes and types of cancer.
- 3.2 Cytogenetical properties of normal and abnormal cells.
- 3.3 Proto-oncogenes and viral oncogenes, Mechanism of oncogene activation.
- 3.4 Tumor markers and tumor suppressor genes.

##### Unit-IV

- 4.1 Model organisms for molecular studies –Importance of *Drosophila melanogaster*, *C. elegans*, *S. cerevisiae*, zebra fish studies.

- 4.2 Cell senescence and apoptosis.
- 4.3 Somatic cell hybridization and chromosome mapping, Cell fusion and applications.
- 4.4 Protein and tissue engineering.

## **Semester –IV**

### **Paper-XV, Special Group-Cell Biology-IV**

#### **Applied Biotechnology**

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

- 1.1 Marker assisted improvement of crop. Genetically modified food and future implications.
- 1.2 DNA and ribosomes as drug targets–Recent developments in drug delivery System, Ion channels as drug target, Drug metabolism.
- 1.3 Nanobiotechnology – Nanomaterial and its applications. Molecular motors.
- 1.4 Bio-safety and bioethical considerations on biotechnology, biological warfare.

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

- 2.1 Biology, cause, diagnosis and treatment of influenza and hepatitis.
- 2.2 Biology, cause, diagnosis and treatment of Parkinson's disease.
- 2.3 Biology, cause, diagnosis and treatment of diabetes.
- 2.4 Biology, cause, diagnosis and treatment of cystic fibrosis.

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

- 3.1 Properties of stem cells. Types of stem cells – Embryonic, umbilical, adult.
- 3.2 Haemopoietic stem cells and formation of blood cells. Bone marrow transplantations.
- 3.3 Stem cell disorders. Stem cell therapy, Stem cell and cancer, Stem cell research in India.
- 3.4 Stem cells and tissue engineering, ethical, legal and social implications (ELSI) of Stem cell technology.

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

- 4.1. World Trade Organization and trade related intellectual property rights (TRIPS).
- 4.2. Intellectual property rights – Patents and patent documentation.
- 4.3. Patent search methods & tools for patent search.
- 4.4. Indian patent laws and recent amendments, examples of patents in India & abroad.

## **Semester –IV Practical-VII, Special Group-Cell Biology**

- 1 Measurement of maximum absorption of colored solutions & verification of Beer-Lambert's law.
- 2 Biochemical estimation of blood cholesterol (Source of blood: Local recognized pathology laboratory)
- 3 Biochemical estimation of blood glucose (Source of blood: Local recognized pathology laboratory)

- 4 Biochemical estimation of acid phosphatase (Source of blood: Local recognized pathology laboratory)
- 5 Biochemical estimation of alkaline phosphatase (Source of blood: Local recognized pathology laboratory)
- 6 Isolation of lymphocytes.
- 7 Comparison of RBC and WBC in different group of vertebrates with the help of already available permanent slides/ ICT tools/ Charts/ Photographs etc.
- 8 Media preparation for prokaryotic cell culture.
- 9 Different methods of sterilization (Dry, wet and UV sterilization).
- 10 Gram staining of micro-organisms.
- 11 Bacterial motility under microscope.
- 12 Preparation of neem extract as an antimicrobial agent.
- 13 Separation of amino acids by paper chromatography.
- 14 Separation of amino acids/ lipids by thin layer chromatography.
- 15 Uses and functioning of different types of microscopes.
- 16 Study of metaphase chromosomes from rat bone marrow with the help of already available permanent slides/ ICT tools/ charts/ models etc.
- 17 Study of G banding of metaphase chromosome with the help of already available permanent slides/ ICT tools/ charts/ models / photographs etc.
- 18 Study of C banding with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
- 19 Study of histology of normal tissue and cancerous tissue with the help of already available permanent slides/ ICT tools/ charts/ models / photographs etc.
- 20 Demonstration of tools used for patent search and patent filing system.

<b>Distribution of marks</b>	<b>Marks</b>
1. Biochemical estimation of alkaline/acid phosphatase/ Cholesterol/ glucose	20
2. Separation of amino acids/ lipids by paper/ thin layer Chromatography	20
3. Isolation of lymphocytes/ Gram staining of micro-organisms/Bacterial motility	20
4. Identification and comment on spots (1-5)	20
5. Class record/ submissions	10
6. Viva-voce	10

---

**Total marks** 100

- **Project work** 100
- (80 marks project evaluation including viva + 20 marks Internal assessment)

- **Suggested Readings**

1. The cell theory, QAMS: Vol. 89,96,1948-55,Bakar.

2. Synthetic activity of polythene chromosomes: Berendes (Int. Rev. Cytol. vol. 35, 1973)
3. The Nucleolus in the cell Metabolism: Bimstiel, Ann. Rev. Plant Physical vol.11 1967.
4. Elements of cytology: Cohen.
5. The nucleic Acid: Chargaff & Davidson.
6. The Bio-chemistry of DNA: Davidson.
7. Cell Biology- De Reoberts.
8. The cell-Biology: Dowbwn Haper.
9. Cell Biology: C. B. Powar.
10. DNA & Chromosomes, D.Praw.
11. Mitochondria structure & function: Ernster & Drahota.
12. Nuclear Envelope: Franke.
13. The structure of cell membrane: Fox.
14. Energy& Mitochondria: Green & H Baum.
15. Biological membrane: structure & function: Harrison & Lunt.
16. Studies in basic Genetics & Molecular Biology: Hayes & Wiley.
17. Cell Biology: Johan Paul.
18. The Mitochondria: Loghinger.
19. Hand book of Molecular Cytology: Lirna-de-Paria.
20. Cell structure & function: Loewy& Siskevit P.
21. Structure & function of biological membranes: Roth Field.
22. Molecular Genetics: Stent.
23. Cytogenetic: SwansonJ, Yount Yodyrdan Metz & W.J.
24. The molecular basic of membrane function: Yodyrdan.
25. Molecular Biology of Gene: W. Son.
26. The Chromosomes: White.
27. The Nuclear Envelope, Its ultra structure & functional Significance: Wisctinitzers, S.
28. Tissue Culture methods & Application: Kruse, P. F. Jr. Academic Press, M. KS Pattersron, New York, San Francisco, London, 1973.
29. Tissue culture technique:2<sup>nd</sup> Ed. Cameron G. Academic press, N. Y.
30. Laboratory Techniquesin Biology & Medicine, Earle W.R
31. An Introduction to cell and tissue culture: Free, W. F. Burgess, Minneapolis.
32. Genes VI: Lwein, Benjamin(1997), Oxford University press, New York
33. Genetics: 3<sup>rd</sup> Ed., Stansfield W.D.(1991), Schaum's outline series, McGraw Hill Inc. New York.
34. Genetics in Medicine: Thompson M. W., Mcinnes RR& HF. Willard (1991),W. D. Saunders Co. Philadelphia.
35. A first course in Recombinant DNA Technology: Micklos D.A & G.A Freyer (1990), Cold Spring Harbor Lab. Press.
36. Scientific American Books: Watson, J.D., Gilman, M. Witnowski,I.& M. Zoller (1992), Distributed by W. H. Freeman & Co., New York.

37. Genetics, Weaver: RF. & P.W. Hedrick,(1989), Wnc Brown Publishers, Dubuque, TOWA (USA).
38. Gene Regulation: A Eukaryotic Perspective, Latchrnan, Davin (1990), Un win Hyman, London.
39. Gene Cloning: Brown.
40. Biotechonolgy: Higgins.
41. Essentials of Cytology: C.B. Powar (1996), Himalaya Pub. House, Bombay.
42. Cell Biology: David E. Sadava (1993), Jones & Bartlett Pub. Boston (London).
43. Biotechnology: Current Progress, Paul, N. Cherernisenoff & L.M. Ferrante (1991), A technomic Pub. Co., Lancaster, U.S.A
44. Microbial Genetics, David Freifelder (1987), NAROSA Pub. House, (India).
45. Molecular Biology: David Freifelder (1987), NAROSA Pub. House, Delhi, India
46. Molecular Cell Biology, Lodish *et. al.*, (2007), W.H. Freeman and Company, New York, USA.
47. Molecular Biology of the cell, Alberts *et. al.*, (2008), Graceland Science, Taylor & Francis Group, New York, USA.
48. Cell Physiology Source Book: A Molecular approach, Sperelakis, (2001), Academic Press, New York, USA.
49. Principles of Genome Analysis and Genomics, Primrose, S.B. and Twyman R.M., (7<sup>th</sup> Ed., 2006), Blackwell Publishing Company, Malden, USA
50. Genomes 3, Brown, T. A., Garland Science Publishing, London, UK.
51. Bioinformatics: sequence and Genome Analysis, Mount, D.W., Cold Spring Harbor Laboratory Press, New York, USA.

## **Semester –IV**

### **Paper XIV, Special Group-Fresh water Zoology-III**

#### **Aquatic Biology**

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

- 3.1 Plankton: Definition and classification. Diurnal and vertical movement of plankton.
- 3.2 Collection and preservation of plankton. Qualitative and quantitative study, importance of plankton.
- 3.3 Periphyton: Definition and composition, Types & Qualitative study of Periphyton
- 3.4 Quantitative study of Periphyton & its importance.

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

- 4.1 Nekton: Definition and composition, Study of various forms of nekton from aquatic ecosystem.
- 4.2 Bottom material: Sedimentations, Sediments in lakes and rivers.
- 4.3 Benthos: Definition and collection of benthos. Qualitative and quantitative study.
- 4.4 Importance of benthic organisms with reference to water quality and aquatic pollution.



### **Unit-III**

- 1.1 Definition of Aquatic pollution, types & sources of pollutants.
- 1.2 Heavy metal and pesticide residues from agriculture fields & control measures.
- 1.3 Pollution processes in aquatic ecosystem: dispersion, degradation, accumulation, biomagnificance, transformation, movement and recycling.
- 1.4 Eutrophication

### **Unit-IV**

- 2.1 Methods of assessment of pollutional status.
- 2.2 Biological indicators of pollution.
- 2.3 Drinking water treatment and Disposal of sewage.
- 2.4 Aquatic toxicology: Toxicants, toxicity concentration response relation and Bioassay study

### **Semester –IV**

#### **Paper XV, Special Group-Fresh water Zoology-IV**

#### **Inland Fisheries**

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

- 1.1 Inland fisheries resources - riverine, reservoir and lacustrine fisheries.
- 1.2 Fresh water fish culture and management techniques.
- 1.3 Basic experimental designs useful in aquaculture
- 1.4 Population dynamics of fish and stock assessment models.

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

- 2.1 Induced breeding of fish by hypophysation technique.
- 2.2 Bundh breeding of fish and use of natural & synthetic hormones in breeding.
- 2.3 Glass jar hatchery and Chinese hatchery systems for seed production
- 2.4 Nutritional requirement of carps and supplementary feeding.

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

- 3.1 Culture of air breathing fish and cage culture.
- 3.2 Mixed farming of fishes and culture of giant fresh water prawn.
- 3.3 Integrated fish farming with agriculture and live stock.
- 3.4 Culture of fresh water mussel for pearls.

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

- 4.1 Fisheries extension and Co-operative societies.
- 4.2 Biochemical composition and economic importance of fishes.
- 4.3 Fish spoilage & preservation methods, and HACCP in processing industry.
- 4.4 Time series analysis and its significance.

### **Semester-IV, Practical-VII, Special Group- Fresh water Zoology**

#### **Section: A**

- 1 Qualitative study of fresh water zooplankton.
- 2 Quantitative analysis of zooplankton.

- 3 Study of fresh water periphyton.
- 4 Study of fresh water benthic organisms with the help of already available permanent slides/ ICT tools/ charts/ models / photographs etc.
- 5 Study of LC<sub>50</sub> value of toxicant to aquatic organism by provided data.
- 6 Methodology of oxygen consumption rate of aquatic organisms.
- 7 Camera lucida drawings of zooplankton.
- 8 Study of ecological set up.

**Section: B**

- 1 Feed formulation by square method.
- 2 Estimation of Maximum sustainable yield (MSY) using surplus production model.
- 3 Study of preparation of pituitary extract with the help of ICT tools/ charts/ models / photographs etc.
- 4 Identification of aquatic weeds, insects and weed fishes with the help of already available permanent slides/ ICT tools/ charts/ models / photographs etc.
- 5 Gram staining of bacteria.
- 6 Estimation of protein (Source of blood: Local recognized pathology laboratory)
- 7 Determination of acid value or free fatty acids (FFAs) in fish oil.
- 8 Identification of egg, spawn, fry & fingerlings of carps with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
- 9 Estimation of trend by using given data with the help of time series analysis.
- 10 Visit to a fish farm for studying the culture and breeding activities.

**Distribution of marks**

	<b>Marks</b>
1. Quantitative estimation of zooplankton / Oxygen consumption rate by provided data	15
2. Comment on ecological setup / Preparation of artificial feed	10
3. Estimation of MSY / Estimation of protein/ Time series analysis.	10
4. Determination of acid value/ Gram staining of bacteria	10
5. Identification of spots with the help of photos (1 to10).	30
6. Camera lucida drawing.	05
7. Practical record and submission of photos	10
8. Viva – voce	10

**Total marks**

100

• **Project work**

100

(80 marks project evaluation including viva + 20 marks Internal assessment)

• **Suggested Readings**

1. A textbook of fishery science and Indian fisheries- S. B. L. Srivastava
2. Fish and fisheries – Kamleshwar Pandey and J. P Shukala

3. A textbook of fish biology and fisheries – S.S. Khanna and H. R. Singh
4. A text book of fish biology and Indian fisheries- R.P. Parihar
5. General and Applied Ichthyology- S.K.Gupta and P.C.Gupta
6. An introduction to fishes- S. S. Khanna.
7. Fish processing technology – T. K. Govindon.
8. Hand book of breeding of major carps by pituitary hormones – S. L. Chonder.
9. Aquaculture – T. V. R. Pillay.
10. Diseases of cultivable freshwater fishes and their control – N. M. Chokraborty.
11. Fish and fisheries in India - V. G. Jhingran.
12. Indian fishes (Identification of Indian Teleosts) – T. A. Qureshi.
13. Introduction to tropical fish assessment per share, Erik Ursine and Siberian C. Verma.
14. Fish population dynamics – M. Devaraj.

#### **Semester –IV**

#### **Paper XIV, Special Group-Aquaculture-III**

#### **Aquaculture and Management**

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

- 1.1 Preparation of pond: Liming and manuring.
- 1.2 Prestocking management of Nursery, Rearing and stocking ponds.
- 1.3 Control of aquatic weeds, predatory fishes, weed fishes and insects.
- 1.4 Post stocking management – stocking density, carrying capacity, enhancement of carrying capacity.

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

- 2.1 Nutritional requirements of culturable carps. Supplementary feeding. Artificial feed. Use of growth promoting hormones.
- 2.2 Transport of live fish seed, Brood fish and food fish.
- 2.3 Effect of dams on fisheries.
- 2.4 Development of reservoir fisheries in India.

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

- 3.1 Different systems of aquaculture, Monosex culture, cage culture and pen culture.
- 3.2 Polyculture of Indian and Exotic carps.
- 3.3 Culture of air breathing fishes.
- 3.4 Integrated aquaculture: fish-cum-poultry and fish-cum-paddy.

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

- 4.1 Integrated fish farming: fish-cum-duck and fish-cum-pig
- 4.2 Sewage fed fish culture.
- 4.3 Cold water fish culture in India.
- 4.4 Extensive, Intensive, Semi-intensive and super- intensive culture.

#### **Semester-IV**

#### **Paper XV, Special Group-Aquaculture-IV**

## **Fish Pathology and Fish Genetics**

### **Unit-I**

- 1.1 Biochemical composition of raw fish.
- 1.2 Nutritional value of raw and preserved fish.
- 1.3 Fish preservation objective and principles..
- 1.4 Methods of fish preservation.

### **Unit-II**

- 2.1 Fish decomposition, rigor mortis and fish spoilage.
- 2.2 Poisoning, Toxicity and allergies from fish as food.
- 2.3 Effect of water pollution on fishes.
- 2.4 Fish products and byproducts.

### **Unit-III**

- 3.1 Fungal, bacterial, protozoan diseases of farm fish.
- 3.2 Nutritional diseases of fish.
- 3.3 Worm and crustacean diseases of farm fish.
- 3.4 Diseases caused by aquatic pollutants.

### **Unit-IV**

- 4.1 Fish genetic resources and its application in fisheries management.
- 4.2 Hybridization, transgenic fish.
- 4.3 Gene banking and application of genetic engineering in aquaculture.
- 4.4 Cryopreservation of gametes.

## **Semester –IV Practical-VII, Special Group- Aquaculture**

- 1 Study of feeding habits of herbivorous, carnivorous and omnivorous fish by gut content analysis with the help of ICT tools/ charts/ models / photographs etc.
- 2 Identification of egg, spawn, fry and fingerlings of Indian carps with the help of already available specimens, permanent slides/ ICT tools/ charts/ models/ photographs etc.
- 3 Preparation of artificial fish feed.
- 4 Anatomical observations, demonstration and detailed explanation of the reproductive system of carps with the help of ICT tools/ models/ charts/ photographs etc.
- 5 Identification and classification of palaemonoid prawns, crabs, bivalves, larvivorous and aquarium fishes using fishes available in the local fish market or with the help of already available specimens, permanent slides ICT tools/ charts/ models/ photographs etc.
- 6 Short term bioassay and determination of LC50 for fish exposed to pollutant using provided data.
- 7 Study of pathological changes in gills, liver, kidney and intestine of fish exposed to heavy metals or pesticides with the help of already available permanent slides ICT tools/ charts/ models/ photographs etc.
- 8 Biochemical estimation of proteins, lipids, glycogen, DNA and cholesterol (Source of Blood/ Tissue: Local recognized fish markets).

- 9 Preparation of bacteriological media and determination of bacterial plate count for skin and gut.
- 10 Gram staining of bacteria.
- 11 Visit to a fish market and collection of fish landing data.

<b>Distribution of marks</b>	<b>Marks</b>
1. Analysis of gut content / preparation of artificial fish feed	15
2. Study of pathological changes in gills, liver, kidney and intestine	10
3. Biochemical estimation / determination of bacterial plate count.	10
4. Gram staining	05
5. Identification of spots (1 to10)	30
6. Anatomical observation	10
7. Practical record & submission	10
8. Viva – voce	10
	-----
	80
<b>Internal Assessment</b>	20
	-----
<b>Total marks</b>	100

- **Project work** 100  
(80 marks project evaluation including viva + 20 marks Internal assessment)

- **Suggested Readings**

1. A textbook of fishery science and Indian fisheries- S. B. L. Srivastava
2. Fish and fisheries – Kamleshwar Pandey and J. P Shukala
3. A textbook of fish biology and fisheries – S.S. Khanna and H. R. Singh
4. A text book of fish biology and Indian fisheries- R.P. Parihar
5. General and Applied Ichthyology- S.K.Gupta and P.C.Gupta
6. An introduction to fishes- S. S. Khanna.
7. Fish processing technology – T. K. Govindon.
8. Hand book of breeding of major carps by pituitary hormones – S. L. Chonder.
9. Aquaculture – T. V. R. Pillay.
10. Diseases of cultivable freshwater fishes and their control – N. M. Chokraborty.
11. Fish and fisheries in India - V. G. Jhingran.
12. Indian fishes (Identification of Indian Teleosts) – T. A. Qureshi.
13. Introduction to tropical fish assessment per share, Erik Ursine and Siberian C. Verma.
14. Fish population dynamics – M. Devaraj.

**Semester –IV**

**Paper-XIV, Special Group-Environmental Biology-III**

## **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-XV, Special Group-Environmental Biology-IV**

#### **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-III, Practical-VII, Special Group-Environmental Biology**

- 1 Bioassay test- toxicity evaluation of heavy metals/pesticides using snail/fish as test animals, determination of LC50 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.





20. Treatise on Limnology: Hutchinson, G.E., (1967), John Willy Pub. New York.
21. Methods of Soil Analysis: De, S. K. (1962), Narayan Pub. House, Allahabad.
22. Fish & Fishes of India: Jhingran, V. G. (1985)
23. **Aquatic Pollution:** Edward A. (2000) Laws. 3rd edition. **John Wiley and Sons**, New York.
24. A Manual of Fresh Water Ecology: Santhanam, R., Velayntan, P. & Jagathesan, G. (1989), Daya Pub. House, Delhi.
25. Limnology: Welch, P. S. (1957), McGrall & Hill Co. New York.
26. **Air Pollution: Perkins, H.C.,** (1974) McGraw-Hill, New York.

## **Semester-IV**

### **Paper-XIV, Special Group-Sericulture-III**

#### **Silkworm Genetics, Breeding and Seed Technology**

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

- 1.1 Hereditary traits of egg, larva, cocoon, pupa and adult, characters and effect of environment on them.
- 1.2 Genetics of cocoon colours, linkage maps and inheritance of cocoon colour, environment influence and hormone control.
- 1.3 Inheritance of voltinism, moultinism, environment influence and hormone control.
- 1.4 Sex Determination in *B. mori*: Sex determination, sex linked, sex limited traits and their special significance in sericulture.

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

- 2.1 Breeding of Silkworm: Pre-requisites, aims and objectives, variability in breeds.
- 2.2 Methods of Breeding: Line breeding, cross breeding and mutation breeding, tropical and temperate races.
- 2.3 Silkworm breeding in India - its problems, advantages and disadvantages.
- 2.4 Heterosis, utilization of heterosis in sericulture.

##### **Unit II**

- 3.1 Selection, preservation and incubation of seed cocoons.
- 3.2 Grainage and basic equipments.
- 3.3 Management of grainage.
- 3.4 Silkworm Egg Production: Moth emergence, mating, egg laying (DFLs) and mother moth examination.

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

- 4.1 Disinfection and preservation of eggs.
- 4.2 Transportation and maintenance of eggs.
- 4.3 Artificial hatching (Acid treatment) of uni and biovoltine eggs.
- 4.4 Embryonic development, inhibition of embryonic development.

## **Semester-IV**

### **Paper-XV, Special Group-Sericulture-IV**

#### **Rearing of silkworm and Silk Technology**

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

- 1.1 Silkworm rearing, principles of silkworm rearing.
- 1.2 Types of rearing houses.
- 1.3 Rearing equipments.
- 1.4 Disinfection of rearing house and appliances.

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

- 2.1 Rearing Methods: Early age rearing (chowki rearing) and late age rearing.
- 2.2 Environmental conditions for silkworm rearing, Precautions for rearing.
- 2.3 Mounting, spinning and harvesting of cocoons.
- 2.4 Cocoon sorting, transportation of cocoons.

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

- 3.1 Grading of cocoons, stifling/ drying, storage and preservation of cocoon, deflossing.
- 3.2 Boiling of Cocoon: Appliances, methods of boiling and processing of cocoon for reeling.
- 3.3 Reeling appliances and methods of reeling.
- 3.4 Silk Reeling Operations: Re-reeling, silk testing and skeining of silk yarn, preparation and preservation of silk yarn, Process of winding, process of doubling, process of twisting, stifling of twisted yarn, process of reeling.

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

- 4.1 Silk weaving, bleaching and dyeing of twisted yarn.
- 4.2 Warping unit and process of warping. Bobbin filling machine and process of filling, weaving machine, process of weaving, testing and storage of silk fabric.
- 4.3 Marketing of Silk: Indian market, international market, foreign exchange earning.
- 4.4 Silk industry in various states of India, role of silk industry in Indian economy.

#### **Semester-IV, Practical VII-Special Group- Sericulture**

- 1 Characterization of silkworm breeds/ races with the help of specimens/ ICT tools/ charts/ models/ photographs etc.
- 2 Cytological technique- Study of temporary preparation of the following with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.: i) Determination of somatic chromosome number of mulberry ii) Mitotic and meiotic chromosomes - preparation of the root tip, and iii) chromosomes of silkworm.
- 3 Study of rearing appliances and rearing of silkworm (100 dfls).
- 4 Disinfection - Type of sprayers and methods of their use.
- 5 Emergence of moths, selection of moths, pairing and de-pairing, oviposition, preservation of male moth.

- 6 DFL preparation (Card and Loose eggs) Cold and hot acid treatment methods.
- 7 Study of mounting of different embryonic stages of silkworm with the help of already available permanent slides/ ICT tools/ charts/ models/ photographs etc.
- 8 Rearing of silkworm and harvesting of cocoons.
- 9 Determination of good and defective cocoons and their percentage based on appearance and weight.
- 10 Determination of shell ratio, percentage and estimation of renditta.
- 11 Single cocoon reeling - Determination of average filament length and denier (size).
- 12 Reeling technique - Single cocoon reeling (Approuvet), charka reeling, cottage basin, filature (multi end).
- 13 Field work and study tour - Study tour and visit to sericulture centers.

<b>Distribution of Marks:</b>	<b>Marks</b>
1. Identification and comment on the spots (1-5)	15
2. Demonstration of meiotic and mitotic chromosomes in Mulberry plant	15
3. Demonstration of reeling and production of yarn	15
4. Determination of shell ratio, percentage and estimation of renditta	15
5. Determination of average filament length and denier	10
6. Mounting of embryonic stages of silkworm	10
7. Practical record	10
8. Viva voce	10
	-----
<b>Total marks</b>	<b>100</b>
• <b>Project work</b>	<b>100</b>
(80 marks project evaluation including viva + 20 marks Internal assessment)	

• **Suggested Readings**

1. Handbook of Practical Sericulture: Ullal, S.R. and Narasimhanna, M.N. (1987), Central Silk Board Publication, Bangalore.
2. Text Book of Tropical Sericulture: (1975), Publ., Japan Overseas Corporation Volunteers.
3. FAO Manual on Sericulture: Anonymous (1972), Vol. I - IV.
4. An Introduction to Sericulture: Ganga, G. and Chetty S.J. (1997), 2<sup>nd</sup> Edition, Oxford and IBH Publishing Co. Ltd., New Delhi.
5. Principles of Sericulture: Hisao Aruga, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Modern Entomology: Tembhare, D.B. (1997), Himalaya Publishing House, Bombay.
7. General T.B. of Entomology: Imms, A.D. (1961), Edn. 9, Rev. by O.W. Richards and R.G. Davis.

8. A Text Book of Insect Morphology Physiology and Endocrinology: Tembhare, D.B. (1984), S. Chand and Co. New Delhi.
9. Mulberry Cultivation: (1988) FAO Pub. by Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
10. Text Book of Soil Science: Biswas, T.D. and Mukherjee, S.K. (1997), Tata McGraw-Hill Pub., New Delhi.
11. Nutrient Deficiency Management in Mulberry: S. Chakrabarti *et al* (1997), Pub. by CSR&TI, Mysore.
12. The Nature and Properties of Soils: Nyle C. Brady (1984) Mac Millan Pub. Co. Inc.
13. Sericulture and Rural Development: G. Sandhya Rani (1988), Discovery Publishing House, New Delhi.
14. Sericulture Society and Economy: Hanumappa, H.G. (1993), Himalaya Publishing House, New Delhi.
15. Economics of Sericulture and Silk Industry in India: Ramana D.V. (1987), Deep and Deep Publishers, New Delhi.
16. An Introduction to Extension Education: Supe, S.V.
17. Silk Production, Processing and Marketing: Nanavaty, M.N., Economics of Sericulture under Irrigated and Rainfed Conditions (1982) M.S. Jolly, CSR & TI Mysore.
18. An analysis of Demand and Supply Prospectus for High Quality Raw Silk: Naik, G. and Babu, K.R. (1991) Centre for Management in Agriculture, Ahemadabad.
19. Tasar Culture: Joly, M.S., Sen, S.K. and Absan, M.M. (1974), CSTRI, Ranchi.
20. Ericulture in India: Sarkar, D.C. (1988), CSB Bangalore.
21. Handbook of Muga Culture: Thangavelu, K. *et al.* (1988), CSB Publication, Bangalore.
22. Muga Culture: Choudhary, S.N.
23. Ericulture: Choudhary, S.N.
24. Agricultural Pests of India: Atwal, A.S. (1986), South East Asia, Kalyani Publishers.
25. Agricultural Entomology and Pest Control: Pradhan, S. (1983), Pub. by ICAR, New Delhi.
26. Silkworm Diseases (1988): FAO Pub. by Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi.
27. Handbook of Pests and Diseases of Mulberry and Silkworm: (1990) Pub. by UNESCAP, Bangkok, Thailand.
28. Silkworm Genetics Illustrated: Yokoyama, T. (1964), Academic Press, London.
29. Silkworm Biology, Genetics and Breeding: Sarkar, D.D. (1998), Vikas Publication, New Delhi.
30. Principles and Techniques of Silkworm Breeding: (1993) United Nations, New York.
31. Silkworm Breeding: Reddy, G.S. (1998), Pub. by Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi.
32. Plant Breeding for Drought Resistance in Water Deficits and Plant Growth: Hurd, (1976) T.T. Kozlowaki, Academic Press New York.

33. Cytology and Cytogenetics: Swanson, C.P. (1975), Prentice Hall, New Jersey.
34. Diseases and Pests of Mulberry and their Control: (1991) Pub. by Director, CSR&TI, Mysore.
35. Silkworm Rearing and Diseases of Silkworm: (1956) Pub. by Director of Ptg. Sta. & Pub. Govt. Press, Bangalore.
36. Silkworm Rearing: Wupang Chun and Chen Da-Chung (1988), Pub. by FAO Rome.
37. Handbook of Silkworm Rearing: Anonymous (1972), Agriculture and Technical Manual - 1, Fuzi Pub. Co. Ltd., Tokyo, Japan.
38. Silkworm Rearing (Translated from Japanese): (1977), Oxford & IBH Pub. Co. Pvt. Ltd.
39. Manual on Silkworm Egg Production: Narasimhanna, M.N. (1988), CSB Publishing, Bangalore.
40. A Guide for Bivoltine Sericulture: Sengupta, K. (1989), Director, CSR&TI, Mysore.
41. Sericulture Training Manual: (1990), FAO, Rome.
42. A Treatise on the Acid Treatment of Silkworm Eggs: Biram, N.M. *et al.* (1990) Pub. by CSR&TI, Mysore.
43. New Technology of Silkworm Rearing: Krishnaswamy, S. (1986), Reprinted by CSB, Bangalore.
44. The Silkworm: An Important Laboratory Tool: Tazima, Y. (1978), Kodansha Ltd., Tokyo.
45. Silk Dyeing, Printing and Finishing: Gubrajani, M.L. (1986), New Delhi.
46. The Development of Indian Silk: Sinha, H., Oxford and IBH Publishing Co. Ltd. New Delhi.
47. Silk Reeling: Huang Gao Rui (1998), Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
48. Silk Production and Weaving in India: Ghosh, C.C.
49. Sericulture and Silk Industry: Tripurari Sharma.
50. Silk Industry - Problem and Prospects: Ajas, A. and Lawpper, H.

#### **Semester –IV**

#### **Paper-XVI, Foundation II, Applied Zoology**

#### **Unit I: Human diseases and Disorders**

- 1.1 Blood groups, blood transfusion
- 1.2 Heart failure: Cause, symptoms, precaution and remedy
- 1.3 Stress related disorders- Hypertension and Diabetes: cause, symptoms, precaution and remedy
- 1.4 Parasitic diseases: Malaria, Dengue, Swine flu

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

- 2.1 Sericulture: Life cycle and rearing of mulberry and non mulberry (tasar) silkworm and production of silk and its economic importance
- 2.2 Apiculture: culture of honey bees, bee products and its economic importance, Dance language of honeybee
- 2.3 Lac culture
- 2.4 Biological pest management

### **Unit III: Fisheries**

- 3.1 Management of fish ponds, Breeding of fishes, Integrated fish farming
- 3.2 Prawn culture and Pearl culture
- 3.3 Fish products and byproducts, fish preservation
- 3.4 Fabrication and setting up of aquarium, its maintenance and aquarium fishes

### **Unit IV: Reproductive biology**

- 4.1 Introduction to development of human embryo
- 4.2 Estrous and menstrual cycle
- 4.3 Introduction to contraceptives, In-vitro fertilization (IVF) and its significance
- 4.4 Infertility in male and female: Causes and remedy

## **Semester –IV, Paper-XVI, 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

## **Semester –IV, Paper-XVI, Foundation II, Applied Fresh Water Fisheries**

### **Unit – I**

- 1.1 Pre and post stocking management of pond.
- 1.2 Predators and their eradication.
- 1.3 Aquatic weeds and their control.
- 1.4 Manuring and liming of pond

### **Unit – II**

- 2.1 Composite fish farming.
- 2.2 General outline of integrated fish farming.
- 2.3 Sewage fed fisheries.
- 2.4 Prawn culture.

### **Unit – III**

- 3.1 Role of co-operative societies in fish marketing.
- 3.2 Introduction to fisheries economics
- 3.3 Economics of fish seed & fish production.
- 3.4 Fisheries extension services.

### **Unit- IV**

- 4.1 Fresh water pearl culture.
- 4.2 Cage and Pen culture.
- 4.3 Setting up of aquarium and its maintenance.
- 4.4 General outline of fish diseases

## **Semester –IV, Paper-XVI, Foundation II, Applied Human Physiology**

### **Unit 1- Circulation**

- 1.1. Structure of Heart and its function
- 1.2. Cardiac cycle, ECG and blood pressure
- 1.3. Blood groups, blood transfusion
- 1.4. Heart failure; Trade milk test (TMT); Angioplasty and Angiography

### **Unit 2- Brain**

- 2.1 Structure of human brain
- 2.2 Sense organ- Eye
- 2.3 Sense organ- Ear
- 2.4 Disorders of nervous system- Alzheimer's and Parkinson's disease

### **Unit 3- Reproduction**

- 3.1 Reproductive organs and its function- Ovary and testis
- 3.2 Menstrual cycle, pregnancy, menopause and andropause
- 3.3 Role of placentas
- 3.4 Parturition and lactation

### **Unit 4- Reproduction**

- 4.1 Contraceptive methods in male and female- Barrier methods, natural methods, oral contraceptives and IUCD
- 4.2 Polycystic ovary syndrome; Breast cancer

- 4.3 Prostate cancer; Impotency
- 4.4 IVF; Surrogacy

### **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.

#### **Fresh water Zoology**

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. (1987) . 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 compemendum of aquaculture technologies: Sinha, V.R. P.(1993). Oxford and JBH publication Co. New Delhi.

### **Human 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
- 16 A textbook of in vitro fertilization and assisted reproduction edited by P.R. Brinsden and P. A. Rainsbur Jaypee brothers 1992.
- 17 Advances in Reproductive Physiology, Vol. 1 to 6: McLaren, (1968). Logos Press Ltd., London.
- 18 Advances in Reproductive Toxicology eds. S. C. Joshi and A. S. Ansari Pointer publishers. Andrology. 2<sup>nd</sup> Edition Male Reproductive health and dysfunction (Eds. E. Nieschlag & H.M. Behre) 2000
- 19 Biochemistry of Mammalian Reproduction: Zanveld, L.J.D. & R.T. Chatterton (1982). John Wiley & sons, New York. The Ovary. Vol. I, II & III: Zuckerman, S, (1962). Academic Press, London.
- 20 Biology of Gestation: Assalye, N.S. (1968). Academic Press, London.
- 21 Biology of ovarian follicles in mammals (1985). S. S. Guraya Springer-Verlag.
- 22 Comparative cellular and molecular biology of testis in vertebrates (Trends in endocrine, paracrine and autocrine regulation of structure of functions) (2001) S.S. Guraya, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, Calcutta
- 23 Comparative Endocrinology and Reproduction. Eds. K.P. Joy, A. Krishna and C. Haldar, Narosa Publishing House (1998).
- 24 Contraceptive Technology Past, Present and Future: Das. R.P. (1989). N.I.H.F.W. New Delhi.
- 25 Control of ovulation: Crighton, D.B., Haynes, N.B. Foxcroft, G.R. & G.E. Lamming (1978). Butterworths, London
- 26 Encyclopedia of Reproduction Vol. I, II, III, IV eds. Ernst Knobil and J.D. Neill (1998).
- 27 Endocrinology and metabolism. 4<sup>th</sup> edition 2001. Philip Felig & Lawrence A. Frohmon McGraw Hill Inc. Medical Publishing Division.
- 28 Endocrinology. Vol. 1 to 3: L.J. Degroot et al. (1989). W.B. Saunders Co. Philadelphia.
- 29 General Endocrinology: Turner, C.D. & J.T. Bagnara (1990) W.B. Saunders Co., & Toppan Co., Philadelphia, London & Tokyo.
- 30 Hormonal Control of Lactation: Cowie, A.T. Forryth, I.A. and I. Hart (1980). Springer-Verlag, Berlin & New York
- 31 Mammalian Oviduct: Hafez, E.S., and R.J. Blandu. The University of Chicago Press, Chicago, London.
- 32 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.
- 33 Ovarian Cycle of Mammals: Perry, J.S. Oliver and Boyd, Edinburgh.
34. Patterns of Reproduction: Asdell, S.A. (1964). Constable and Co. London.
35. Physiology of Lactation: Smith, Vearch, Constable & Co., London.
36. Postgraduate Reproductive endocrinology. 4<sup>th</sup> Edition. 1997. R. Rajan Jaypee brothers. Medical Publishers (P) Ltd.

37. Practice of fertility control, Choudhary S. K. Churchill and Livingstone.
38. Progress in Reproductive Biology, Vol. 4. The pineal and reproduction: Reiter, R.J. Series Ed. P.O. Hubinant, Karger, Basel. Paris, London (latest edition).
39. Reproduction in Mammals Series: 1 to 6: Austin, C.R. and R. V. Short (1984 & 1994),  
Cambridge University Press, Cambridge.
40. Reproductive Endocrinology: Ref. No. 1, Vol. 3 Hormones in Reproduction.
41. Seasonal Patterns of Stress, immune function and disease R.J. Nelson, G.E. Demas, S.L. Klein, L.J. Kriegsfeld. 2002. Cambridge Univ. Press.
42. Shaw's textbook of Gynaecology eds. V. G. Padubidri and S. N. Daftary. 2000.
43. The Biology of Blastocyst: Blandau, R.J. (1971). The University of Chicago Press, Chicago & London.
44. The Prostaglandins Vol. I & II: Ramwell, P.W. (1974). Preum Press, New York and London.
45. The Testis Vol. 1 to 4: Jhonson, A.D. and W. R., Gomes.
46. Vertebrate Foetal Membrances: Mossman, H.W. (1989). Rutgress Press Ltd.
47. 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**  
**Core (Subject Centric)- II**  
**Paper- XVI 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. & Mellow, 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, Barends 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.

## **Question paper pattern: Guidelines to paper setters**

The theory question papers comprises of **four** questions. All questions are compulsory and carry equal marks.

- Q. 1. One long answer question from Unit-I  
OR  
Two short notes from Unit-I
- Q. 2. One long answer question from Unit-II  
OR  
Two short notes from Unit-II
- Q. 3. One long answer question from Unit-III  
OR  
Two short notes from Unit-III
- Q. 4. One long answer question from Unit-IV  
OR  
Two short notes from Unit-IV