

**Dr. Babasaheb Ambedkar Marathwada University,  
Aurangabad - 431 004**

**Department of Zoology**

**Choice Based Credit System [CBCS]**



**SYLLABUS**

**M.Sc. ZOOLOGY**

**(I, II, III and IV semester)**

**Dr. Babasaheb Ambedkar Marathwada University, Aurangabad**  
**Department of Zoology**  
**M. Sc. First Year (Semester – I)**

Course	Theory course					
	Paper code	Paper nomenclature	Credit	Work Load hrs		Max/Min Marks
				Per week	Per term	
Core Course	<b>ZOO-401</b>	Taxonomy and Animal Diversity	4	4	60	100/40
	<b>ZOO-402</b>	Ecology	4	4	60	100/40
	<b>ZOO-403</b>	Biochemistry	4	4	60	100/40
Elective Courses (ANY ONE)	<b>ZOO-421</b>	Helminthology - I	4	4	60	100/40
	<b>ZOO-422</b>	Protozoology – I	4	4	60	100/40
	<b>ZOO-423</b>	Entomology – I	4	4	60	100/40
	<b>ZOO-424</b>	Endocrinology - I	4	4	60	100/40
		<b>Total Credit</b>	<b>28</b>	<b>28</b>	<b>420</b>	<b>700</b>
Practical course						
Paper code	Practical	Credit	Work Load hrs		Max./Min Mark	
			Per week	per Term		
<b>ZOO -441</b>	Practical based on ZOO-401	2	4	60	50/20	
<b>ZOO-442</b>	Practical based on ZOO-402	2	4	60	50/20	
<b>ZOO-443</b>	Practical based on ZOO-403	2	4	60	50/20	
<b>ZOO-444</b>	Practical based on ZOO- 421	2	4	60	50/20	
<b>ZOO-445</b>	Practical based on ZOO-422	2	4	60	50/20	
<b>ZOO-446</b>	Practical based on ZOO-423	2	4	60	50/20	
<b>ZOO-447</b>	Practical based on ZOO-424	2	4	60	50/20	
	<b>Total Credit</b>	<b>14</b>	<b>28</b>	<b>420</b>	<b>350</b>	

## **CORE COURSES**

### **Paper NO. ZOO- 401**

### **Taxonomy and Animal diversity**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

**Course objective:**

1. To study fundamental aspects of taxonomy.
2. To study animal diversity.
3. To know the importance of taxonomy.
4. To know the importance animal diversity.

#### **Unit I**

**Principles and methods of taxonomy:**

1. Concepts of species-
  - 1.1. Essentialistic, Nominalistic concepts and Current status.
  - 1.2. Sub species and other infra specific categories.
  - 1.3. Ring species
  - 1.4. Biological mechanism of genetic incompatibility
2. Hierarchical taxa,
3. Biological nomenclature, International code, Cladistics and its application.
4. Classical and quantitative methods of taxonomy of animals.

#### **Unit II**

**Levels of structural organization:**

1. Unicellular, Colonial and Multicellular forms;
2. Levels of organization of tissues, organs and systems;
3. Phylum wise study of
  - 3.1 **Protozoa** : Sexual and asexual reproduction, Symbiotic and parasitic protozoan. Locomotory organs, their structure, ultrastructure. Ciliary movements.
  - 3.2 **Porifera** : Skeleton, Canal system.
  - 3.3 **Coelenterata** : Polymorphism in Coelenterata, Coral reefs and their formation, Metagenesis, Nematocysts- Types, structure and functions.
  - 3.4 **Platyhelminthes** : Parasitic adaptations,
  - 3.5 **Aschelminthes** : Parasitic adaptations in round worms,
  - 3.6 **Annelida** : Advent of coelum, Metamerism in Annelida, Annelida diversity.
  - 3.7 **Arthropoda**: Metamerism in Arthropoda, Crustacean larvae, Feeding and mouth parts of insects, Efficiency of Insects.
  - 3.8 **Mollusca** : Shell in mollusca, Torsion and Detorsion in mollusca, Foot in mollusca.
  - 3.9 **Echinodermata** : Water vascular system

#### **Unit III**

**Outline classification of animals :**

1. Important criteria used for classification in each taxon;
2. Classification of animals

3. Evolutionary relationships among taxa.
4. Class wise study of
  - 4.1. **Fishes** : Scales in fishes, Respiration in fishes, Migration in fishes.
  - 4.2. **Amphibia** : Parental care in Amphibia, Paedomorphosis.
  - 4.3. **Reptiles** : Rhynchocephalia- the living fossil. Skull characteristics of reptiles.
  - 4.4. **Birds** : Flying adaptations, Types of feathers, Flight muscles, Migration in birds.
  - 4.5. **Mammals** : Dentition, Histology of mammalian tissues.

#### Unit IV

##### Comparative functional anatomy of various systems of vertebrates

1. Integument and its derivatives,
2. Digestive system,
3. Respiratory system,
4. Circulatory system including heart and aortic arches;
5. Urinogenital system,
6. Brain and Sense organs (eye and ear).

##### Natural history of Indian subcontinent:

1. Major habitat types of the subcontinent, Geographic origins and migrations of species;
2. Continental drift and distribution of animals.
3. Major terrestrial biomes;
4. Theory of island biogeography;
5. Biogeographical zones of India,
6. Wild life of India.

#### Unit V

##### Organisms of health and agricultural importance:

1. Concept of pest
2. Classification of pest
  - 2.1. Agricultural pests- Sugar cane leaf hopper (*Pyrilla perpusiella*), Caster semilooper (*Achaeajana*) and Rice weevil (*Sitophilus oryzae*).
  - 2.2. Animal husbandry pest (Ticks, Mites, Tabanus, Stomoxys).
  - 2.3. Organisms of Public health importance (Malaria, Filariasis, Tuberculosis, Cholera and AIDS) their vectors, pathogens and prevention.
  - 2.4. Store grain pest
  - 2.5. Structural pest.

##### Recommended Books

1. Mayr and Ashock :Principles of systematic Zoology .
2. Simpson :Principle of animal taxonomy. Oxford IBH Pub. Company
3. M. Kato :The Biology of Biodiversity, Springer.
4. Biodiversity ,Academic press Washington - E.O.Wilson
5. Biodiversity Principles and conservation , Kumar and Aseja Agrobios Sidia
6. Biodiversity and Environment Agrawal Tiwari and Dubey
7. Principles of Environmental Biology PKJ Nair Himalaya Pub House Delhi.
8. E.O. Wilson: Biodiversity, Academic Press, Washington
9. Chatterjee K. D. (1969) -Parasitology (Protozoology and Helminthology)
10. Cheng T.C. (1964)-The Biology of animal parasites, Saunders International Student Edition.
11. The Invertebrates Vol II, McGraw Hill, New York.- Dawes B. (1946).
13. B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta

14. Applied Entomology 2nd edition, P. G Fenemore, Alka Prakash, Publisher : New Age International
15. “ Introduction to Insect Biology & Diversity” . Daly, H. V., J. T. Doyen & P.R. Ehrilch ( 1981) : International Student Edn. McGraw- Hill, Kogakusha, Japan.
16. Young, J.Z. :Life of Vertebrates. The Oxford University Press, London.
- 17.Parker and Haswell : Text book of Zoology vol. II
- 18.Goodrich.: Structure and Development of Vertebrates Vol.I and II.
- 19.Watermann, A.J. : Chordate Structure and Function, Mac Millan Co. New York.
- 20.Weichert C.K. : Anatomy of Chordates 4<sup>th</sup> edn. MC Graw Hill Books Co. New York.

## **Paper No. ZOO- 402**

### **ECOLOGY**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

**Course objective:**

1. To study fundamental aspects of ecosystems.
2. To study different ecosystems and biological diversity.
3. To know the importance of interactions among the species.
4. To know the importance of maintenance, conservation of ecosystems.
5. To get acquainted current trends in conservation biology, wildlife biology and management.

**Unit I Ecosystem:**

1. Structure and function;
2. Energy flow and energy pyramids.
3. Mineral cycling (Carbon, Nitrogen, Phosphorus);
4. Primary production and decomposition;
5. Structure and function of some Indian ecosystems:
  - 5.1. Terrestrial (forest, and
  - 5.2. Aquatic (fresh water,).

**Unit II Habitat and niche:**

1. Concept of habitat and niche;
2. Niche width and overlap;
3. Fundamental and realized niche;
4. Resource partitioning;
5. Character displacement.

**Ecological succession:**

1. Types;
2. Mechanisms;
3. Changes involved in succession;
4. Concept of climax

**Unit III .Species interactions:**

1. Types of interactions-
  - 1.1 Interspecific Interactions –
    - 1.1.1 Commensalism,
    - 1.1.2 Mutualism,
    - 1.1.3 Parasitism,
    - 1.1.4 Amensalism,
    - 1.1.5 Symbiosis
    - 1.1.6 Competition
  - 1.2 Intraspecific Interactions –
    2. Herbivory,
    3. Carnivory,
    4. Pollination,

**Community ecology:**

1. Nature of communities;
2. Community structure and attributes;
3. Edges and ecotones.

**Unit IV Population ecology:**

1. Characteristics of a population;
2. Population growth curves;
3. Population regulation;
4. Life history strategies (*r* and *K* selection);
5. Concept of meta population – demes and dispersal,
6. Interdemic extinctions,
7. Age structured populations.

**Unit V. Applied ecology:**

1. Environmental pollution;
2. Global environmental change;
3. Biodiversity
  - a. Concept of Biodiversity;
  - b. Patterns of Biodiversity;
  - c. Importance of Biodiversity;
  - d. Loss of Biodiversity;
  - e. Biodiversity Hotspots,
  - f. Endangered organisms,
  - g. Extinction and Red Data Book,
  - h. Biosphere reserves, National parks and Sanctuaries.
4. Status, monitoring and documentation;
5. Major drivers of biodiversity change;

**Conservation biology:**

1. Principles of conservation,
2. Major approaches to management- *in situ* and *ex-situ* conservation,
3. Indian case studies on conservation/management strategy
  - 3.1. Project Tiger,
  - 3.2. Project Elephant,
  - 3.3. Project Rhino,
  - 3.4. Biosphere reserves, National park and Sanctuaries.
4. Other recent developments in wild life management.

**Recommended Books**

1. Ecology -E.P.Odum
2. Limnology -P.S.Welch
3. Environment and Man -R.H. Wagher
4. Man fresh water ecology -T.T. Macan
5. Biodiversity, Academic press Washington - E.O.Wilson
6. Biodiversity Principles and conservation, Kumar and Aseja Agrobios Sidia
7. Biodiversity and Environment Agrawal Tiwari and Dubey
8. Principles of Environmental Biology PKJ Nair Himalaya Pub House Delhi.
9. E.O. Wilson: Biodiversity, Academic Press, Washington

## **Paper No. ZOO 403 BIOCHEMISTRY**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

**Course objective :**

1. To study fundamental aspects of Biochemistry.
2. To study different biological reaction mechanism.
3. To know the importance of metabolism.
4. To study the biochemical molecules and their interactions

**Unit I . Structure of atoms, molecules and chemical bonds and forces. Stabilizing interactions**

1. Van der Waals,
2. Electrostatic,
3. Hydrogen bonding (ex. water)
4. Hydrophobic interaction.

**Unit II. Composition, structure and function of biomolecules**

1. Carbohydrates,
2. Lipids,
3. Proteins,
4. Nucleic acids and
5. Vitamins.

**Principles of biophysical chemistry**

1. pH and pKa
2. buffer, (Henderson and Hasselbalch equation)
3. Reaction kinetics,
4. Colligative properties

**Unit III Principles of Bioenergetics**

1. Oxidative phosphorylation,
2. Coupled reaction,
3. Phosphoryl group transfer,
4. Biological energy transducers.

**Principles of catalysis,**

1. Enzymes and Enzyme kinetics (Michelis and menten equation, Competitive ,Uncompetitive , non-competitive inhibition, Allosteric enzymes)
2. Enzyme regulation,
3. Mechanism of enzyme catalysis ((Mechanism of enzyme action - binding of substrate and lowering of activation energy,ex.Chymotrypsin),
4. Isozymes.

**Unit IV Conformation of proteins**

1. Ramachandran plot,
2. Secondary( $\alpha$  and  $\beta$  sheet), tertiary and quaternary structure of proteins
3. Domains, motif and folds.

**Conformation of nucleic acids**



1. A- DNA,
2. B- DNA,
3. Z-DNA,
4. t-RNA,
5. micro-RNA.

**Stability of protein and nucleic acid structure**

- 1.1. Denaturation and renaturation of protein and DNA ,
- 1.2. Cot curve.

**Unit V. Metabolism of**

1. Carbohydrates (Anaerobic and Aerobic-Glycolysis, TCA Cycle Gluconeogenesis, PPP Pathway, Glycogen metabolism and its control
2. Lipids (Fatty acid and triacylglycerol breakdown,  $\beta$  oxidation,Cholesterol synthesis,Lipoproteins),
3. Amino acids(Transamination,Oxidative deamination of glutamate)
4. Nucleotides and
5. Vitamins.

**List of Books for Paper I : Biochemistry**

1. Principles of Biochemistry by Lehninger
2. Biochemistry by Vogt and Vogt.
3. Biochemistry by Zubey
4. Biochemistry by Stryer
5. Outline of biochemistry By Cohn and Stump
6. Physiological biochemistry By Harper

**Elective Courses**  
**Paper No. ZOO-421**  
**Helminthology- I**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

**Course Objectives**

This course is designed to teach students

1. The basic concepts of Helminthology.
2. Basic information of Cestodes & Trematodes.
3. The major types of important cestodes & Trematodes.
4. By studying this course students will develop the ability to collect, identify important cestodes and Trematodes, from locally available hosts.
5. To develop the experts in the field of Helminthology.

**Unit I Introduction, history and scope of Helminthology.**

1. General organization and Classification of Platyhelminthes up to order level.  
Cestodes (Cestodarians and Eucestodes), Trematodes (Monogenea, Aspidobothria and Digenea)
2. Functional anatomy of Reproductive system
  - a. Trematodes (Digeneans)
  - b. Cestodes (Pseudophyllideans & Cyclophyllideans).
  - c. Egg shell formation, chemistry of egg shell formation, factor influencing embryonation & hatching.

**Unit II :**

1. Intramolluscan stages and their effect on molluscan hosts, Effect on foot, haepatopancreas, Reproductive system and general metabolism.
2. Various types of Cercaria.
3. Different types of larvae in cestodes and their pathogenicity.
4. Holdfast organs with its adaptations in cestodes.

**Unit -III:**

1. Life cycle patterns of Digenetic Trematodes
  - a. Single intermediate host life cycle.
  - b. Two intermediate host life cycles
2. Life cycle patterns in Cestodes
  - a) No intermediate host life cycle
  - b) Single intermediate host life cycle
  - c) Two intermediate host life cycles.

**Unit -IV.:** Geographical distribution, habitat, morphology (Structure) , life cycle, pathogenicity, diagnosis, treatment & prevention of the following types

- a) **Monogenea:** *Polystoma integrimum*
- b) **Aspidobothria:** *Aspidogastar conchicola*
- c) **Digenea :** 1. *Pragonimus westermani* 2. *Fasciolopsis buski*
3. *Gastrodiccoides hominis*.

### Unit- V

Geographical distribution, habitat, morphology (Structure) , life cycle, pathogenicity, diagnosis, treatment and prevention of the following type.

#### **Cestode:-**

- 1) *Amphilina*
- 2) *Diphylidium caninum*
- 3) *Diphyllobothrium latum*
- 4) *Echinococcus granulosus*
- 5) *Taenia saginata*

### List of books

#### **TEXT BOOKS:**

1. Medical Parasitology by Markell, Voge and John, 8th ed. W.B. Saunders Co.
2. The Biology of animal parasites, Cheng T.C. (1964)-Saunders International Student Edition.
3. The Invertebrates Vol II, McGraw Hill, New York.- Dawes B. (1946).
4. Text book Medical Parasitology Jaypee Brothers, - Medical Publishers, New York. - Panikar C.K.J (1988)
5. The Parasitology of Trematodes Oliver and Boyd Ltd. Edinburgh - Smyth J.D (1977)
6. Parasitology (Protozoology and Helminthology) -Sood Pannik (1993) CBS Publication and Distribution, Delhi.
7. Human helminthology Manual for Clinical, Sanitarians Medical Zoologists – Faust, Emerest Caroll.
8. Systema Helminthum Vol. IV Monogenea and Aspidobothria - Yamaguti S. (1963) Inter- Science Publishers, London.
9. . Synopsis of Digenetic Trematodes of Vertebrates - Yamaguti S. (1971) Vol. I & II Keigaku Publishing Co., Tokyo, Japan.

#### **REFERENCE BOOKS.**

- 1) The Invertebrates Vol.II - Hyman L. H.
- 2) The Trematode - Dausese B
- 3) Text book of medical Parasitology - Dey
- 4) Text book of medical Parasitology - Sawitz
- 5) Parasitology - Nobel and Nobel
- 6) Structure of Nematode - Allen bird
- 7) An introduction to Nematodology - Chitwood
- 8) Organization and Biology of nematodes -Crool
- 9) Physiology of nematodes - Lee
- 10) Plant parasitic nematode - Parmonove
- 11) Principal of Nematodology - Throne
- 12) Plant Nematodology - Jenkins and Taylor
- 13) General Parasitology - Cheng
- 14) Clinical Parasitology - Craig Faust
- 15) Applied Parasitology - Hiware, Jadhav and Mohekar
- 16) Biochemistry of parasitism - Von Brand
- 17) Physiology of nematode parasite - Smith
- 18) Helminth, Arthropod and Protozoa of domesticated animal -Solbsy E.J.W
- 19) Laboratory methods of work with plant and soil nematodes -Southey
- 20) Soil and fresh water Nematodes - Goodey.
- 21) Practical exercise in Parasitology - Halton, Behave, Marshall.
- 22) Animal Nematodes from Indian Mammals - Nama, Shinde and Jadhav.

- 23) Parasitology (Protozoology and Helminthology) -Chatterjee K. D. (1969)
- 24) The Zoology of Tapeworm. - Wardle and Mcleod (1952)
- 25) The advances in the Zoology of tapeworm from Wardle and Mcleod (1952)
- 26) Systema Helminthum Vol. II Cestoda. - Satyu Yamaguti (1959)
- 27) The Physiology of Cestodes. - J.D Smyth
- 28) Vertebrate Nematodes - York and Mapelston
- 29) Plant Parasitic Nematodes, bionomics & control - Christie
- 30) Modern Parasitology - Cox
- 31) Essential Parasitology -Schimdit
- 32) Parasitism - Cameron
- 33) Animal Parasitism - Read
- 34) Parasitism and Symbiology - Read
- 35) Physiology of nematode parasites - Bee
- 36) Nematodes Parasites of domestic animal - Levine
- 37) Structure of Nematodes -Allen Bird
- 38) Medical Parasitology (Protozoology and Helminthological) - Chatterjeei K. D
- 39) Laboratory Methods for work with plant and soil Nematodes.-Southey
- 40) An Introduction to Parasitology - Chandler and Read

## Paper No. ZOO-422

### Protozoology- I

**Total no. of credits-** 4

**No. of periods per credit-** 15

**Total No. of periods** -60

**Evaluation:** External-80%, Internal-20%

#### **Course objective :**

This course is designed to teach students-

1. The basic concepts of protozoology.
2. To study systematics of Subkingdom Protozoa .
3. To study biological importance of free living Protozoa.
4. To study methodology of collection and identification of free living protozoa.
5. To study culture methods of free living protozoa.

#### **Unit – I**

1. Classification of Protozoa up to order level
2. Factors influencing Growth of Protozoa
  - i. Balanced growth.
  - ii. Non balanced growth

#### **Unit – II**

1. Ecology of free living Protozoa
  - i. Marine Protozoa
  - ii. Planktonic protozoa
  - iii. Soil protozoa
  - iv. Protozoan blooms

#### **Unit – III**

1. Nutrition in Protozoa
  - i. Methods of feeding
    - a. Filter feeding
    - b. Raptorial feeding
    - c. Diffusion feeding
  - ii. Digestion
  - iii. Nutritional requirements

#### **Unit – IV**

1. Metabolism in Protozoa
  - i. Carbohydrate and Respiratory metabolism
  - ii. Nitrogen metabolism
  - iii. Lipid metabolism
  - iv. Excretion and ionic regulation – Functioning of contractile vacuoles.

#### **Unit – V**

1. Heredity in Protozoa
  - i. Bi-parental reproduction
  - ii. Uni-parental reproduction
  - iii. Non-mendelian phenomena
  - iv. Mating types in ciliates

#### **Text Books:**

1. Aikawa and Sterling - Intracellular Parasitic Protzoa

2. Baker - Parasitic Protozoa
3. Chandler and Read - An introduction to Parasitology
4. Chatterjee - Parasitology
5. Thomas C. Cheng - General Parasitology
6. Corliss - The ciliate Protozoa
7. Dogiel - An Introduction to Protozoology
8. Faust, Russel and Jung - Clinical Parasitology
9. Hall - Protozoology
10. Hoare - Trypanosomes of mammals
11. Kudo - Protozoology
12. Levine - An introduction to Protozoan parasites of domestic animals and of man
13. Manwell - An Introduction to Protozoa
14. Richardson & Kendall - Veterinary Protozoology
15. Sleigh - Biology of Protozoa
16. Vickerman - The Protozoa
17. Ward & Whipple - Fresh water Biology
18. Wenyon - Protozoology Vol. I & II

**Reference Books:**

1. Calkins - Protozoa in Biological Research
2. Thomas C. Cheng - Research in Protozoology I-IV
3. Florkin and Scheer - Chemical Zoology Vol. -I
4. Hammond and Long - The Coccidia
5. Hutner and Lwaff - Biochemistry and Physiology of Protozoa Vol. I, II & III
6. John & John - How to know the Protozoa
7. Tayler & Baker - Cultivation of Parasites in Vitro

## **Paper No.-ZOO-423**

### **Entomology I**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

**Course Objective:-**

1. To develop a strong foundation in entomology, including understanding of the importance of insects to human society.
2. To familiarize the students with insects for their external and internal features,
3. To review important areas in insect biology such as morphology, physiology, ecology, behavior, genetics, phylogeny, ontogeny and population biology.
4. To develop a sufficient background for those students who wish to study more advanced entomological topics.

#### **Unit I**

1. Introduction to Entomology,
2. Insect morphology segmentation and tagmosis,
3. Head – Structure of definitive insect head,
4. Structure and types of antennae,
5. Structure and types of mouth parts,
6. Thorax-Segmentation, Wings- origin, structure , venation, Modifications,
7. Leg – General structure , types of legs.
8. Abdomen – Segmentation, Appendages.

#### **Unit II**

1. Integument, Cuticle- structure , molting, sclerotization,
2. Digestive system- Structure of alimentary canal and Associated digestive glands and physiology of digestion.
3. Respiratory system- Respiratory structures and mechanism of respiration in terrestrial and aquatic insects

#### **Unit III**

1. Circulatory system- Structure, Haemocoel, the dorsal vessel, accessory pulsatile organs, Haemolymph- chemical composition, Haemocytes- structure & types, mechanism of circulation
2. Excretory system- Structure of malpighian tubules, Physiology of Excretion and Osmoregulation

#### **Unit IV**

1. Nervous system- Central nervous system, Physiology and neurobiochemistry
2. Sense organs- Compound eyes, Chemoreceptor, Mechanoreceptors,
3. Effector organs- Sound producing organs, Light producing organs,

#### **Unit V**

1. Reproductive system- Male and female reproductive system, fertilization and Development,
2. Endocrine system- structure and mode of action of hormones in metamorphosis.
3. Ectohormones – Pheromones, sex pheromones, and defensive secretions

**References Books:-**

1. The insect structure and function, 4th Edition (2008). Chapman, R.F. Publisher- Cambridge University Press, London.
2. General Textbook Entomology, 10th Edn., (1977) Imms, A.D. Richard, O.W. & Davies, R.G. (Eds.) 1 : Chapman & Hall, London
3. General Entomology, 2nd edition (1973) Mani M.S. Oxford & IBH Publishing Company, Delhi.
4. Modern Entomology First edition: (1997) D.B. Tembhare, Himalay Publishing House Delhi
5. Principles of Insect Morphology, (1973). Snodgrass, R.E. Publisher – Tata McGraw Hill, Bombay.

**Additional Reference Books:-**

1. The Principles of Insect Physiology, 2nd edition (2007) Wigglesworth, V.B. Publisher – English Language Book Society and Methuen and Co. Ltd.
2. The Insects: Structure, Function and Biodiversity, (2004). Ambrose D.P. Publisher- Kalyani Publishers, New Delhi.
3. Introduction to Insect Biology & Diversity” Daly, H.V., J.T. Doyen & P.R. Ehrlich (1981): International Student Edn. McGraw- Hill, Kogakusha, Japan.
4. Insects: Textbook Entomology Evans. E. H. (1984) : Addison- Wesley, London.
5. Insects Physiology” Henning, W. (1981) : Wiley – Innerscience Publ., John Wiley & Sons, Chichester, England.
6. Journals and Internet resources.



## Paper No. ZOO-424

### Endocrinology I

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

**Course objectives:**

1. The elective paper in the subject endocrinology is designed to impart the basic information of the various endocrine glands/ tissue, so far identified in invertebrates.
2. The beginning of each unit enlightens the neuroendocrine system and their hormones.
3. The details of histology and physiological interaction of endocrine hormones and their regulation by environmental factors in invertebrates is the tenet of each unit.
4. The hands-on training to students in endocrine manipulations that are used in Aquaculture are incorporated in assigned practicals.

#### **Unit - I Endocrine mechanisms in Annelida**

1. Neuroendocrine system in Annelida.
2. Growth and regeneration in Polychaetes.
3. The control of epitoky and relationship between gametogenesis and epitoky.
4. Growth and reproduction in Oligochaetes.
5. Endocrine control of gametogenesis in Polychaetes.

#### **Unit - II Endocrine mechanisms in Mollusca**

1. Neurosecretion in Lamellibranches.
2. Hormones and reproduction in Gastropoda.
3. Hormones and reproduction in Cephalopoda.
4. Role of hormones in osmotic and ionic regulation in Gastropoda.

#### **Unit - III Endocrine mechanisms in Insecta**

1. Neuroendocrine system in Insecta.
2. Role of hormones in growth and metamorphosis in insects.
3. Moulting in adult insects and mode of action of developmental hormones in insects.
4. Reproductive system and endocrine control of oocyte development in insects

#### **Unit - IV Endocrine mechanisms in Crustacea**

1. Neuroendocrine system in Crustacea .
2. Moults cycle and role of hormones in moulting in crustaceans.
3. Sexual differentiation and role of hormones in gonadal activity in crustaceans.
4. Colour change and its hormonal control in crustaceans.

#### **Unit - V Neuroendocrine mechanisms in Echinodermata**

1. Histomorphology of radial nerve neurosecretory system in starfish.
2. Neurosecretory hormones and control of reproduction in echinoderma .
3. Hormone types and their chemical nature in echinoderms.

**Fundamental books:**

1. Highnam K. C. and Hill L : The Comparative Endocrinology of Invertebrates.
2. Adiyodi and Adiyodi : Reproductive Biology of Invertebrates Vol I &II
3. Laufer H. and Downer R.C.H. Endocrinology of selected Invertebrates Type

4. Boolootian R : Physiology of Echinodermata

**Reference books:**

Patil Meena: Neurobiology and Electrophysiology of Decapod Crustaceans

Lockwood, A.P.M : Aspects of Physiology of Crustacea.

Novak, U.J.A. : Insect Hormones

Rock stein M. : The Physiology of Insect Vol. I.

Wilbur, K.M. and Young, C.M. : Physiology of Mollusca. Vol. I and II

Mill, P.J. Physiology of Annelida

### **Practical Paper No. ZOO-441 Practicals based on ZOO-401(Taxonomy and Diversity of Animals)**

1. Museum specimen study of different groups of Invertebrates and Vertebrates.
2. Terrestrial ecosystem (Vegetation studies)- Abundance , Frequency , Density, Relative Diversity, Dominance , Raunkars biological spectrum , Index of Dominance etc.
3. Method of plankton collection, plankton identification and quantification from river or stream or lake water.
4. Methods of collection, preservation and identification of zooplankton.
5. Composition assessment of taxonomical diversity or biodiversity in habitat from local Grassland , Terrestrial and Wetland.
6. Composition assessment of taxonomic diversity/Biodiversity from different ecosystems.
  - a. Species diversity indices.
  - b. Relative density, Relative frequency and relative abundance of species.
7. Methods of collection, preservation and identification with keys from different groups of organisms like, Parasites, hosts, insects, birds and fishes etc.
8. Construction of taxonomic Key from the character in an animal group.
9. Visit to any biodiversity center /spots and submission of report.

### **Practical Paper No. ZOO-442 Practicals based on ZOO-402 (Ecology)**

1. Study of ecosystem biodiversity of local area.
2. Estimation of DO/ BOD
3. Estimation of hardness of water sample. (Total, Sodium and Potassium hardness.)
4. Estimation of Salinity /Nitrates and phosphates from a given water sample.
5. Biomass analysis in a given ecosystem.
6. Productivity estimation in given ecosystem (Primary and Secondary)
7. Study of efficiency of sampling method.
8. Study of air quality and aerobiology in given area.
9. Measuring ecotoxicity using a lettuce seed assay.
10. Estimation of various physical parameters of water (SSP, Turbidity, TDS etc).
11. Visit to any biodiversity center /National park/Sanctuary and submission of report.

### **Practical Paper No. ZOO-443 Practicals based on ZOO-403 (Biochemistry)**

1. Preparation of Acid and Alkali solutions and acid base titration
2. Preparation of Buffers of known pH, Buffering capacity.
3. Identification of Carbohydrates by Chemical tests.
4. Estimation of Amino acid (Tyrosine)
5. Estimation of Protein by Lowry's method.
6. Estimation of Carbohydrates by Anthrone reagent method. (Glycogen)
7. Separation of amino acids by paper chromatography.
8. Study of factors affecting enzyme activity (Substrate concentration, pH, Temperature and Inhibitors)
9. Isolation of Casein protein from the milk.
10. Determination of isoelectric pH of Caesin.

**Practical Paper No. ZOO-444 Practicals based on ZOO-421 (Helminthology I)**

- 1) Collection of trematodes and cestodes from various hosts
- 2) Preservation, staining and identification of collected trematode & cestodes, and preparation of their permanent slides (At least , 10 from cestodes & 10 from trematodes).
- 3) Study of different trematodes and cestodes from permanent slides (At least, 10 from cestodes & 10 from trematodes).
- 4) Examination of fecal samples for ova.
- 5) Collection and examination of molluscan hosts for larvae of trematodes.
- 6) Study the effect of helminth parasites (histopathology) on their host's tissue by microtechnique.

**Submission:** At least five permanent slides to be submitted at the time of practical examination

**Practical Paper No. ZOO-445 Practicals based on ZOO-422 (Protozoology-I )**

1. Collection, observation in living condition-fixation, staining and identification of protozoa from different habitats.
  - a. Marine Protozoa
  - b. Planktonic protozoa
  - c. Soil protozoa
2. Study of population density of ciliates in fresh water.
3. Study of ecological factors in relation to freshwater ciliates.
  - a. Oxygen
  - b. Carbon dioxide
  - c. pH
  - d. Oxidized organic matter
4. Study of cyclosis in *Paramecium*.
5. Study of contractile vacuole to observe excretion and osmoregulation.

**Practical Paper No. ZOO-446 Practicals based on ZOO-423 (Entomology I)**

1. Study, mounting and sketching of types of mouth parts, antennae, wings, legs and genitalia of various insects. (2 in two insects)
2. Dissections of Digestive system / Reproduction system / Nervous system of five available at least 3 insects.
3. The study and preparation of permanent slides of any five organs of at least 2 insects
4. Estimation of enzyme activities of Amylase, Invertase, Lipase & Protease in the alimentary canal/ midgut of cockroach.
5. Detection of uric acid as an end product of excretion in any terrestrial insect.
6. Study of types and Total count of haemocytes in haemolymph of any one insect.
7. Determination of role of insect hormones in the pupation of insect larvae by ligature technique.
8. Study of eggs, larvae and pupae/ nymph of any one insect.

**Practical Paper No. ZOO-447 Practicals based on ZOO-424 (Endocrinology-I)**

1. Histomorphological study of neuroendocrine system in various invertebrates (Annelida, Mollusca Arthropoda etc.) (at least 10 slides)
2. Dissection of nervous systems in different invertebrates (Leech, crab, cockroach, slug, snail).
3. Histological preparation of slides of neuroendocrine centers (at least 5)
4. Effect of brain removal on oxygen consumption in leech.
5. Effect of background on integument chromatophores of the freshwater prawn, *Caridina / Macrobrachium*.
6. Effect of eyestalk removal on oxygen consumption of freshwater crab / prawn.
7. Effect of eyestalk removal on blood glucose level in crab / prawn.
8. Effect of eyestalk removal on chromatophores in relation to background adaptation in *Caridina/Macrobrachium*

**Dr. Babasaheb Ambedkar Marathwada University, Aurangabad**  
**Department of Zoology**  
**M. Sc. Ist Year Semester – II**

Course	Theory course					
	Paper code	Paper nomenclature	Credit	Work Load hrs		Max/Min Marks
				Per week	Per term	
Core Course	<b>ZOO-411</b>	General Physiology Animal	4	4	60	100/40
	<b>ZOO-412</b>	Genetics	4	4	60	100/40
	<b>ZOO-413</b>	Cell Biology	4	4	60	100/40
Elective Courses (Any ONE)	<b>ZOO-431</b>	Helminthology – II	4	4	60	100/40
	<b>ZOO-432</b>	Protozoology – II	4	4	60	100/40
	<b>ZOO-433</b>	Entomology – II	4	4	60	100/40
	<b>ZOO-434</b>	Endocrinology - II	4	4	60	100/40
		<b>Total Credit</b>	<b>28</b>	<b>28</b>	<b>420</b>	<b>700</b>
Practical course						
Paper code	Practicals	Credits	Work Load hrs		Max./Min Mark	
			Per week	Per Term		
<b>ZOO-451</b>	Practical based on ZOO-411	2	4	60	50/20	
<b>ZOO-452</b>	Practical based on ZOO-412	2	4	60	50/20	
<b>ZOO-453</b>	Practical based on ZOO-413	2	4	60	50/20	
<b>ZOO-454</b>	Practical based on ZOO- 431	2	4	60	50/20	
<b>ZOO-455</b>	Practical based on ZOO-432	2	4	60	50/20	
<b>ZOO-456</b>	Practical based on ZOO-433	2	4	60	50/20	
<b>ZOO-457</b>	Practical based on ZOO-434	2	4	60	50/20	
<b>Total Credit</b>	<b>14</b>	<b>28</b>	<b>420</b>	<b>350</b>		

## Core Courses

### **Paper No. ZOO-411 General Animal Physiology**

**Total no. of credits-** 4

**No. of periods per credit-** 15

**Total No. of periods** -60

**Evaluation:** External-80%, Internal-20%

**Objectives :-**

The study of this course is essential to understand the physiological processes important in medical, Non-medical and veterinary sciences.

#### **Unit I Digestive system:**

1. Digestion
  - 1.1. Ingestion,
  - 1.2. Mechanical and Chemical breakdown of Food,(Digestion of Carbohydrates, Proteins and Fats, Enzymes involved)
  - 1.3. Absorption(Molecular basis absorption of Carbohydrate, Proteins and Fats) and
  - 1.4. Egestion,
  - 1.5. Hormones involved in Digestion
  - 1.6. Deviation in the animal world to above processes.(ex.Coprophagy,Cellulose digestion,Wax digestion)
2. Energy balance,
3. BMR.

#### **Blood and circulation:**

1. Blood corpuscles,
2. Haemopoiesis and formed elements,
3. Plasma function,
4. Blood volume and blood volume regulation,
5. Blood groups,
6. Haemoglobin,
7. Haemostasis.

#### **Unit II**

##### **Cardiovascular System:**

1. Comparative anatomy of heart structure,
2. Myogenic heart and Neurogenic heart
3. Cardiac cycle,
4. Heart as a pump.
5. ECG – its principle and significance,
6. Blood pressure,
7. Neural and chemical regulation of all above.
8. Heart ailments-Atherosclerosis, CHD

##### **Respiratory system:**

1. Comparison of respiration in different species, anatomical considerations,
2. Transport of gases –
  - 2.1. Oxygen-Hb dissociation curve

- 2.2. Factors affecting the std dissociation curve,
- 2.3. Bohr effect
3. Exchange of gases in lungs and transport of CO<sub>2</sub>,
4. Neural and chemical regulation of respiration.

**Unit III. Nervous system:**

1. Gross neuroanatomy of the brain and spinal cord,
2. Central and Peripheral nervous system,
3. Neuron Structure, Resting membrane potential.
4. Synaptic structure, Molecular mechanism of Synaptic transmission,
5. Neurotransmitters

**Sense organs:** Vision, hearing and tactile response.

**Muscle physiology**

1. Structure of Striated Muscle fiber and Sarcomere
2. Muscle contraction mechanism – at molecular level
3. Effects of exercise on muscles.

**Unit IV Excretory system:**

1. Comparative physiology of excretion.
2. Kidney.-Comparative Structure
3. Urine formation (Ammonotelic,Ureotelic and Uricotelic organisms),
4. Urine concentration (Countercurrent multiplier system)
5. Micturition,
6. Regulation of water balance,
7. Blood volume and blood pressure (Renin-Angiotensin system),
8. Electrolyte balance,
9. Acid-base balance.

**Thermoregulation:**

1. Comfort zone,
2. body temperature –
  - 1.1.Physical,
  - 1.2.Chemical,
  - 1.3.Neural regulation,
  - 1.4.Acclimatization.

**Stress and adaptation-**

1. High altitude physiology ,-
2. Space physiology
3. Underwater physiology

**Unit V Endocrinology and reproduction:**

1. Endocrine glands – Hypothalamus, Pituitary, Adrenal, Thyroid, Endocrine pancreas.
2. Basic mechanism of hormone action-
  - 2.1.Molecular mechanism of Peptide hormone action
  - 2.2.Molecular mechanism of Steroid hormone action
3. Reproductive processes and Glands involved in Reproduction.
4. Neuroendocrine regulation.
  - 4.1. Hypothalamo hypophyseal axis
  - 4.2. Hypothalamo hypophyseal gonadal axis.
5. Hormones and diseases;



**Books Recommended :**

1. Comparative Animal Physiology by Prosser C.L.
2. General and Comparative Physiology by Floren W.A.
3. General and Comparative Physiology by Hoar W. B.
4. Animal Physiology by Neilsen K.S.
5. General Physiology by Giese A.C.
6. Principles of Animal Physiology by Wilson J.A.
7. Animal Physiology by Gordon G.L.
8. Modern Physiology by Strang F.L.
9. Animal Physiology by Mohan and Arora
10. General Physiology by Guyton
11. Animal Physiology by William and Hoar
12. Molecular biology of the cell By Albert et al
13. Molecular biology of the Gene by Watson et al
14. Genes By Lewin
- 15: General Endocrinology by C. D. Turner
- 16 Endocrinology by Hadley , M. E.

## Paper No. ZOO-412 Genetics

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

**Course Objective :**

1. To study the hereditary biology
2. To study the mechanism involved in hereditary diseases and disorders.
3. To study the fundamental processes of life.

**Unit I Mendelian principles:**

1. Law of Dominance and its significance
2. Law of Segregation,
3. Law of Independent assortment,

**Concept of gene:**

1. Multiple alleles,
2. Pseudoallele,
3. Complementation tests.

**Extensions of Mendelian principles:**

1. Codominance,
2. Incomplete dominance,
3. Gene interactions (ex.Epistasis)
4. Pleiotropy,
5. Genomic imprinting,
6. Penetrance and expressivity,
7. Phenocopy,
8. Linkage and crossing over,
9. Sex linkage,
10. Sex limited and sex influenced characters.

**Unit II Gene mapping methods:**

1. Linkage maps,
2. Tetrad analysis,
3. Mapping with molecular markers,
4. Mapping by using somatic cell hybrids, Development of mapping population in plants.

**Extra chromosomal inheritance:**

1. Mitochondrial inheritance
2. Kappa particles.

**Microbial genetics:**

1. Methods of genetic transfers –
  - 1.1. Transformation,
  - 1.2. Conjugation,
  - 1.3. Transduction and
  - 1.4. Sex-duction,
2. Mapping genes by interrupted mating,
3. Fine structure analysis of genes.

**Unit III Human genetics:**

1. Pedigree analysis,
2. Lod score for linkage testing,
3. Karyotypes,
4. Genetic disorders.- Causes , Symptoms and treatment
  - 4.1. Sickle cell anemia
  - 4.2. Cystic fibrosis
  - 4.3. Phenylketoneuria
  - 4.4. Albinism
  - 4.5. Alkaptonuria
  - 4.6. Huntington's disease

**Quantitative genetics:**

1. Polygenic inheritance,
2. heritability and its measurements,
3. QTL mapping.

**Unit IV Mutation:**

1. Types of Mutation
2. Causes and detection,
3. Mutant types –
  - 3.1. Lethal,
  - 3.2. Conditional,
  - 3.3. Biochemical,
  - 3.4. Loss of function and gain of function,
  - 3.5. Germinal verses somatic mutants,
  - 3.6. Insertional mutagenesis.

**Unit V Structural and numerical alterations of chromosomes:**

1. Deletion,
2. Duplication,
3. Inversion,
4. Translocation,
5. Ploidy and their genetic implications.
6. Syndromes
  - 6.1 Turner's syndrome
  - 6.2. Klinefilter syndrome
  - 6.3 Down syndrome

**Recombination:**

1. Homologous and non-homologous recombination,
2. Transposition,
3. Site-specific recombination.

**Books recommended :**

1. Hartman and Surkind – Gene action
2. Hexter and Yost – The science of Genetics
3. Sinnot, Dunn and Dobzhansky- Principles of Genetics
4. Alberts B., Bray D., Lewis J., Rabt M., Robert K. and J. D.Watson. Molecular Biology of the Cell, Garland Publishing Inc. London.
5. Simmon, S. and Snustad: Principles of Genetics, 8th Edition, John Wiley and Sons Inc. N.Y.

6. Hartl D.L. and Jones E.W. Genetics: Analysis of gene and genome. Jones and Bartlett publishers . Boston
7. Tamarin R.H. Principles of Genetics. Wadsworth Publishing company ,Belmont, California.
8. Lewin Benjamin Genes VII Oxford University Press.
9. Winchester A.M. Genetics Oxford and IBH Publishing co New Delhi.
10. Genetics By Strichberger
11. Dobzhansky, Th.. Genetics and Origin of Species. 3rd Ed. Columbia Univ. Press. Dobzhansky, Th., F.J. Ayala, G.L. Stebbins and J.M. Valentine.
12. Futuyama, D.J. Evolution. Surjeet Publication, Delhi.
13. Jha, A.P. Genes and Evolution. John Wiley Publication, New Delhi.
14. Savage J.M Evolution. Amerind Publishing Co. New Delhi.
15. Varma and Agrawal – Evolution

## **Paper No. ZOO-413**

### **Cell Biology**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

#### **OBJECTIVE:**

1. To impart knowledge in evolving biological science at cellular level.
2. To impart understanding of the fundamental process governing life and information flow in cell
3. To inculcate interest in molecular cell biology research and creating human expertise.

#### **Unit I Membrane structure and function:**

1. Structure of membrane (Unit Membrane & Fluid Mosaic Model)
2. Membrane protein types.
3. Functions of membrane
  - 3.1. Diffusion and Osmosis,
  - 3.2. Passive transport
  - 3.3. Active transport : Primary and Secondary
  - 3.4. Exocytosis
  - 3.5. Endocytosis (Phagocytosis, Pinnocytosis and Receptor mediated endocytosis.)
4. Mechanism of Protein sorting
  - 1.1. For Secretory protein
  - 1.2. For Mitochondrial protein
5. Regulation of intracellular transport,
6. Electrical properties of membranes.
  - 5.1. General organization of neuron
  - 5.2. Molecular aspect of development of action potential and conduction

#### **Unit II Structural organization and function of intracellular organelles:**

- 1 Cell wall (Gram positive and Gram negative)
- 2 Nucleus:
- 3 Ribosomes (Subunits in prokaryotes & eukaryotes)
- 4 Mitochondria: (Oxidative phosphorylation and Chemiosmotic theory)
- 5 Golgi bodies,
- 6 Lysosomes,
- 7 Endoplasmic reticulum
- 8 Peroxisomes,
- 9 Structure & function of cytoskeleton and its role in motility. (Microfilaments, Microtubules, Intermediate filaments)

#### **Organization of genes and chromosomes:**

1. Structure of chromatin and chromosomes
  - 1.1. Nucleosome model
  - 1.2. Special type of Chromosomes
    - 1.2.1 Polytene chromosome
    - 1.2.2 Lampbrush chromosome
2. Unique and repetitive DNA
3. Heterochromatin
  - 3.1 Lyon hypothesis (X Chromosome inactivation)
  - 3.2 C Value paradox
4. Euchromatin,

#### **Unit III Cellular communication:**

1. General principles of cell communication,

2. Cell adhesion and roles of different adhesion molecules,
3. Gap junctions,
4. Extracellular matrix,
5. Integrins.

**Cell signaling:**

1. Hormones and their receptors-
  - 1.1. Nuclear receptors
  - 1.2. Membrane receptors (Enzyme linked receptors, Ion channel receptors),
  - 1.3. Miscellaneous receptors (Toll like receptors-TLR)
2. Signal Transduction
  - 2.1. G-protein mediated signaling pathway
  - 2.2. Cytokine receptor-STAT mediated signaling pathway
3. Regulation of signaling pathways.

**Unit IV Cell division and cell cycle:**

1. Mitosis and meiosis their regulation,
2. Steps in cell cycle (G<sub>0</sub>, G<sub>1</sub>, S, G<sub>2</sub> & M phases)
3. Control of cell cycle.(Regulation of CDK-cyclin activities and Molecular basis of cellular check points)

**Cancer:**

1. Cancer and the cell cycle,
2. Genetic rearrangements in progenitor cells,
3. Cancer causing genes-
  - 3.1 . Oncogenes,
  - 3.2 Tumor suppressor genes,
4. Virus-induced cancer,
5. Metastasis,
6. Interaction of cancer cells with normal cells,
7. Anticancer therapy and mechanism ;
8. Recent developments in anticancer treatments.

**Unit V Innate and adaptive immune system:**

**1. Innate immune system**

- 1.1. Overview, Features, Epithelial barrier. Neutrophil and Macrophage function.
- 1.2. Inflammation.
- 1.3. NK cell.
- 1.4. Cross-talk with Adaptive Immune system
2. Antigen Presentation
  - 2.1 Antigen ,Antigenicity and Epitopes
  - 2.2 APCs
  - 2.3 Dendritic cell
  - 2.4 MHC
3. Antigen Recognition
  - 3.1 T and B cell receptor
  - 3.2 Antibody molecules-Structure, types and functions
  - 3.3 Generation of Antibody diversity ( Antigen Receptor Diversity)
  - 3.4 Clonal selection and Expansion
4. Humoral and cell-mediated immune responses
5. Memory cells

**Text Books recommended:**

1. Molecular Cell Biology : Lodish et al
2. Molecular Cell Biology : J Darnell and others. Fifth Edition

3. Molecular biology of the cell -B. Alberts et al. Gartand publishing Inc. New York
4. Cell and Molecular Biology De robertis and De robertis :
5. Gene VIII -Benjamin Lewin
6. Cell Physiology - Giese A.C. :
7. Molecular biology of the Gene -Watson et al

## Elective Papers

### **Paper No. ZOO-431 Helminthology II**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

#### **Course Objectives**

This course is designed to teach students

1. The basic concepts of Helminthology.
2. Basics information & major types of important helminth parasites( Animal & plant Nematodes).
4. By studying this course students will develop the ability to collect, identify important Nematodes and Plant Nema from locally available hosts.
5. To prepare the experts in the field of Helminthology

#### **UNIT-I**

1. General organization of Animal nematodes.
2. Classification of Nematode up to family level.
3. Structure of lips and cephalic papillae.
4. Structure of stoma, its variations on esophagus and its associated glands.

#### **UNIT- II**

1. Feeding and nutrition's in Nematodes.
2. Essential foods, blood feeding by Hookworms and other nematodes.
3. Reproductive system in male, female, fertilization, development and hatching of eggs.
4. Moulting and Development in nematodes.

#### **UNIT –III**

1. Different life cycle patterns in Nematodes.
2. Morphology, life cycle, pathogenicity, control and prevention of following types.
  - a. *Strongyloides stercoralis*
  - b. *Wuchereria bancrofti*
  - c. *Trichenella spiralis*
  - d. *Trichuris trichura*

#### **UNIT-IV**

1. General organization and Outline classification of plant Nematodes.
2. Feeding habits and modifications in anterior region.
3. Reproductive systems.
4. Ecology of nematodes

#### **UNIT-V**

1. Symptoms of Nematode injuries to plants (above ground. below ground)
2. Controlling nemic diseases of plants (Cultural, biological, chemical, physical, legislative)
3. Life cycle studies of followings
  - a. Root knot Nematodes ( *Meloidogyne*)
  - b. Citrus Nematodes ( *Tylenchulus*)
  - c. Bud and leaf Nematodes ( *Aphelenchoides*)
  - d. Seed gall Nematodes ( *Anguina*)



### List of Text books

1. Medical Parasitology by Markell, Voge and John, 8<sup>th</sup>ed. W.B. Saunders Co.
2. The Biology of animal parasites, Cheng T.C. (1964)-Saunders International Student Edition.
3. The Invertebrates Vol II, McGraw Hill, New York.- Dawes B. (1946).
4. Text book Medical Parasitology Jaypee Brothers, - Medical Publishers, New York. - Panikar C.K.J (1988)
5. The Parasitology of Trematodes Oliver and Boyd Ltd. Edinburgh - Smyth J.D (1977)
6. Parasitology (Protozoology and Helminthology) -Sood Pamnik (1993) CBS Publication and Distrubution, Delhi.
7. Human helmintology Manual for Clinical, Sanitarians Medical Zoologists – Faust, Emerest Caroll.
8. Systema Helminthum Vol. IV Monogenea and Aspidobothria - Yamaguti S. (1963) Inter- Science Publishers, London.
9. Synopsis of Digenetic Trematodes of Vertebrates - Yamaguti S. (1971) Vol. I & II Keigaku Publishing Co., Tokyo, Japan.

### REFERENCE BOOKS.

1. The Invertebrates Vol.II - Hyman L. H.
2. The Trematode - Dausese B
3. Text book of medical Parasitology - Dey
4. Text book of medical Parasitology - Sawitz
5. Parasitology - Nobel and Nobel
6. Structure of Nematode - Allen bird
7. An introduction to Nematodology - Chitwood
8. Organization and Biology of nematodes -Crool
9. Physiology of nematodes - Lee
10. Plant parasitic nematode - Parmonove
11. Principal of Nematodology - Throne
12. Plant Nematodology - Jenkins and Taylor
13. General Parasitology - Cheng
14. Clinical Parasitology - Craig Faust
15. Applied Parasitology - Hiware, Jadhav and Mohekar
16. Biochemistry of parasitism - Von Brand
17. Physiology of nematode parasite - Smith
18. Helminth, Arthropod and Protozoa of domesticated animal -Solbsy E.J.W
19. Laboratory methods of work with plant and soil nematodes -Southey
20. Soil and fresh water Nematodes - Goodey.
21. Practical exercise in Parasitology - Halton, Behave, Marshall.
22. Animal Nematodes from Indian Mammals - Nama, Shinde and Jadhav.
23. Cestodes from Indian fishes - Baba Jadhav.
24. Parasitology (Protozoology and Helminthology) -Chatterjee K. D. (1969)
25. The Zoology of Tapeworm. - Wardle and Mcleod (1952)
26. The advances in the Zoology of tapeworm from Wardle and Mcleod (1952)
27. Systema Helminthum Vol. II Cestoda. - Satyu Yamaguti (1959)
28. The Physiology of Cestodes. - J.D Smyth
29. Vertebrate Nematodes - York and Mapelston
30. Plant Parasitic Nematodes, bionomics & control - Christie
31. Clinical Parasitology - Beaver, Jung & Cupp
32. An Introduction to Parasitology - Chandler and Read

33. Morden Parasitology - Cox
34. Essential Parasitology -Schmidt
35. Parasitism - Cameron
36. Animal Parasitism - Read
37. Parasitism and Symbiology - Read
38. Physiology of nematode parasites - Bee
39. Nematodes Parasites of domestic animal - Levine
40. Structure of Nematodes -Allen Bird
41. Medical Parasitology (Protozoology and Helminthological) - Chatterjeei K. D
42. Laboratory Methods for work with plant and soil Nematodes. - Southey

## Paper No. ZOO-432 Protozoology II

**Total no. of credits-** 4

**No. of periods per credit-** 15

**Total No. of periods** -60

**Evaluation:** External-80%, Internal-20%

### **Course objective :**

This course is designed to teach students -

1. To study systematics of Subkingdom Protozoa .
2. To study biological importance of parasitic Protozoa.
3. To study methodology of collection and identification of parasitic protozoa.

### **UNIT - I**

1. Factors influencing the distribution of protozoa.  
Oxygen, Carbon dioxide, pH , Light, Food , Nutrition
2. Immunity to protozoan parasite
  - i. Host reaction
  - ii. Innate and acquired defense mechanism
  - iii. Antigen of zooparasites
  - iv. Special manifestation of Antigen – Antibody reaction as related to protozoan parasites.

### **UNIT – II**

1. General organization and morphology of the parasitic flagellates occurring in digestive tract of man.
  - i. *Retartomonas intestinalis*
  - ii. *Chilomastix mesnili*
  - iii. *Giardia lamblia*
  - iv. *Trichomonas tenax*

### **UNIT – III**

1. General organization of the Microspora - Structure of the spore, life cycle of *Nosema*, Diseases caused by microspora in fishes and Arthropods.
2. General organization of the Myxospora – structure and development of the spore, Life cycle of *Myxobolus*, disease caused by Myxospora in fishes.

### **UNIT – IV**

1. General morphology, life cycle, transmission and pathology of parasitic Amoebae of man and domestic animals.
  - i. *Entamoeba histolytica* ii. *E. gingivalis* iii. *E. coli*

### **UNIT – V**

1. Structure and life cycle pattern of acephaline and cephaline Gregarines.
2. Coccidia of poultry with special reference to the structure, treatment and control.
3. Parasitism in ciliophora – structure, Life cycle, Pathogenesis and control of
  - i. *Balantidium coli*
  - ii. *Ichthiophtherius multifilis*

### **Text Books:**

1. Aikawa and Sterling - Intracellular Parasitic Protzoa
2. Baker - Prasic Protozoa
3. Chandler and Read - An introduction to Parasitology
4. Chatterjee - Parasitology
5. Thomas C. Cheng - General Parasitology
6. Corliss - The ciliate Protozoa
7. Dogiel - An Introduction to Protozoology
8. Faust, Russel and Jung - Clinical Parasitology
9. Hall - Protozoology

10. Hoare - Trypanosomes of mammals
11. Kudo - Protozoology
12. Levine - An introduction to Protozoan parasites of domestic animals and of man
13. Manwell - An Introduction to Protozoa
14. Richardson & Kendall - Veterinary Protozoology
15. Sleigh - Biology of Protozoa
16. Vickerman - The Protozoa
17. Ward & Whipple - Fresh water Biology
18. Wenyon - Protozoology Vol. I & II

**Reference Books:**

1. Calkins - Protozoa in Biological Research
2. Thomas C. Cheng - Research in Protozoology I-IV
3. Florkin and Scheer - Chemical Zoology Vol. -I
4. Hammond and Long - The Coccidia
5. Hutner and Lwaff - Biochemistry and Physiology of Protozoa Vol. I, II & III
6. John & John - How to know the Protozoa
7. Tayler & Baker - Cultivation of Parasites in Vitro

## **Paper No.ZOO-433**

### **Entomology II**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

**Course Objective:-**

1. To develop a strong foundation in entomology, including understanding of the importance of insects to human society.
2. To familiarize the students with identification of insect pests, vectors and their control methods.
3. To introduce the students with entomological cottage industry.
4. To develop a sufficient background for those students who wish to study more advanced entomological aspects

#### **Unit I Phylogeny and classification of insect**

1. Classification of Apterygota orders up to families. Thysanura and Collembola,
2. Classification of Pterygota orders up to families – Exopterygota-Odonata, Orthoptera, Mallophaga Anoplura, Isoptera, and Hemiptera
3. Classification of Pterygota orders up to families. Endopterygota-, Coleoptera, Hymenoptera, Neuroptera, Lepidoptera and Diptera,

#### **Unit II Insect as pest and Vectors**

1. Concept of pest; origin of pest; classification of pests;
2. Insect pests of Jowar, Cotton, Sugarcane, Soybean, Vegetables, Fruit Crops, Stored grains, structural pests
3. Insects as vectors of human pathogens and domestic animals,
4. Study of insect vectors like mosquito, bed bug, flea, body louse, rat flea etc.

#### **Unit III Principles of insect pest control**

1. Chemical control: mode of action of insecticide, merits and demerits of chemical control.
2. Modern trends in pest control
3. Biological control: Principles, procedure, Biological agents; success and limitations.
  - ii. Autocidal control – sterile male technique, genetic technique, the pheromonal technique
  - iii. Integrated pest management ( IPM ) Principles and application

#### **Unit IV Sericulture and Lac Culture**

1. Mulberry silkworm: life history, silk glands and silk production, silkworm diseases
2. Lac culture: Biology of lac insects, lac cultivation and economic importance of lac.

#### **Unit V Apiculture and Importance of insects**

1. Types of honey bees, life cycle, social organization and economic importance of honey, wax and apiary products.
2. Other important insect- Insects as pollinators, Insects in research, Butterfly farming, Insects in forensic entomology

#### **Text Books:**

1. Applied Entomology Vo1.1 2<sup>nd</sup> Edition, (1996) K.P. Srivastava Kalyani Publishers New Delhi.
2. Applied Entomology Vo1.2 2<sup>nd</sup> Edition, (1996) K.P. Srivastava Kalyani Publishers New Delhi.
3. Modern Entomology (2009) D.B. Tembhare, Himalaya Publishing House Delhi.

4. General and Applied Entomology. 2<sup>nd</sup> edition ( 2004). David , B.V. and
5. Ananthakrishnan, T.N. Publisher – Tata McGraw Hill, New Delhi.
6. General Entomology, 2<sup>nd</sup> edition ( 1973) Mani M.S. Oxford & IBH Publishing Company, New Delhi.
7. Applied zoology Dr. Waykar B.B. Prashant Publication jalgaon

**Reference Books:-**

1. Applied Entomology 2<sup>nd</sup> edition, P. G Fenemore, Alka Prakash, Publisher : New Age International
2. “ Introduction to Insect Biology & Diversity” . Daly, H. V., J. T. Doyen & P.R. Ehrlich ( 1981) : International Student Edn. McGraw- Hill, Kogakusha, Japan.
3. The Science of Entomology. 2<sup>nd</sup> edition (1982). Romoser, W.S. Publisher a. MacMillan, New York.
4. General and Applied Entomology ( 1998) Nayar KK and T. Ananat
5. A Text Book of Agricultural Entomology ( 2003) Hemsingh Pruthi

## **Paper No. ZOO-434**

### **Endocrinology II**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: m External-80%, Internal-20%**

**Course objectives:**

1. With enough background of the subject endocrinology in first semester, this elective paper is designed with many aspects of vertebrate endocrinology.
2. The morphology and histological structure of endocrine glands and their hormones attributed with various physiological functions in vertebrates.
3. The classes of hormones, synthesis and general mechanism of hormone action in vertebrates.

#### **Unit - I The vertebrate endocrine system**

1. Classes of hormones.
2. Hormone synthesis and control of hormone synthesis – a general concept..
3. General mechanisms of hormone action.
4. Termination of hormone action.

#### **Unit -II Hypothalamus and Pituitary gland**

1. Structure of Hypothalamus and hypophysiotropins and their functions in brief.
2. Control of Hypothalamo- hypophysial hormone secretion.
3. Histomorphology of pituitary gland, hormones and their functions .
4. Neurohypophysial hormones and their functions
5. Pars intermedia and role melanotropic hormones.

#### **Unit - III Reproductive Endocrinology**

1. Sex determination, differentiation of male and female gonads.
2. Development and differentiation of genital ducts.
3. Gonadal hormone synthesis.
4. Gonadal steroids and brain differentiation.

#### **Unit – IV Female Reproductive endocrinology.**

1. Anatomy of female reproductive system and histology of ovary, ovarian cycle and its hormonal control.
2. Ovarian steroid hormones and their physiological functions.
3. Menstrual cycle in primates and its hormonal basis.
4. Estrus cycle in rat and its hormonal basis.

#### **Unit - V Male Reproductive endocrinology ; Pregnancy, Parturition and Lactation mechanisms**

1. Anatomy of male reproductive system, histology of testis, spermatogenesis; hormones of testis and their functions.
2. Role of hypothalamic, pituitary and ovarian hormones in pregnancy in mammals
3. Hormonal mechanism in parturition in mammals.
4. Hormonal mechanism in lactation mammals.

#### **Books Recommended**

1. Hadley , M. E : Endocrinology. Pearson education ( Singapore )
2. C. D. Turner : General Endocrinology.
3. E. R. Martin : Endocrine Physiology Oxford University press
4. Gorbman A. and H.A. Bern : General and Comparative Endocrinology.
5. Bancroft, J.D. and Stevens A: Theory and practical histological techniques.
6. H. Laufer and R.C. H. Downer : Endocrinology of selected vertebrate types.

### **Practical Paper No. ZOO-451 Practical based on ZOO- 411 (General Animal Physiology)**

1. Qualitative survey of digestive enzymes in any vertebrate
2. Estimation of salivary amylase activity.
3. Determination of abnormal and normal constituents of urine.
4. Estimation of chloride form haemolymph/ urine of cow
5. Estimation of uric acid from serum
6. Total count of R.B.C from human blood
7. Differential count of W.B.C from human blood
8. Estimation of Haemoglobin and carrying capacity of blood.
9. Measurement of blood pressure
10. Hematin crystal formation.
11. Effect of temperature on the heart beat and Q10 measurement.
12. Effect of temperature on the rate of oxygen consumption
13. Measurement of respiratory quotients.

### **Practical Paper No.ZOO-452 Practicals based on ZOO-412 (Genetics)**

1. Problems on monohybrid and dihybrid ratio
2. Problems on modifications in dihybrid ratio
3. Determination of blood groups and suggestions on Medico legal problems regarding the parentage disputes using blood groups.
4. Culture of *Drosophila melanogaster* and study of its life cycle stages
5. Mutant studies in *Drosophila*.
6. Identification of blood group, a case study of multiple alleles.
7. Monohybrid cross and determination of monohybrid ratio in *Drosophila melanogaster*
8. Chromosome mounting – Onion roots, Chironomous larva – Giant Chromosomes
9. Mutant studies in *Drosophila*
10. Analysis of human Karyotype.

### **Practical Paper No. ZOO-453 Practicals based on ZOO- 413 (Cell Biology)**

1. Study of living microorganisms by phase contrast microscope.
2. Preparation of different cell types as hepatocytes/ parenchymal cells
3. Study of tumor and cancerous cell (Use permanent slides)
4. Induction of puff and study of puffing pattern in polytene chromosomes.
5. Mounting of mitotic stages from suitable material
6. Mounting of meiotic stages from suitable material
7. Preparation of Barr body
8. Study of mitochondria by vital staining technique.
9. Fulgen reaction- Staining of DNA.
10. Micronuclei test.



### **Practical Paper No. ZOO-454 Practicals based on ZOO-431(Helminthology II)**

1. Collections of Nematodes from locally available animals
2. Basic techniques of preservation and mounting of Nematodes
3. Identification of collected Nematodes
4. Fecal sample analysis for collection and identification of ova.
5. Study of permanent slides (At least 8).
6. Collection and identification of Phytonema.
7. Techniques of collection, fixation, mounting and preparation of permanent slides.
8. Submission of permanent slides at the time of examinations.

### **Practical Paper No. ZOO-455 Practicals based ZOO-432 (Protozoology II)**

1. Classification of parasitic protozoa.
2. Study of ciliates in alimentary canal of vertebrates and invertebrates.
3. Impregnation of ciliates with dry silver nitrate for study of kinetic structure.
4. Study of haemoflagellates from vertebrate blood.
5. Preparation of blood smear, staining and identification of staining of haemosporina.
6. Histopathology of host tissue caused by Apicomplexan parasites.
7. Examination of fecal sample of vertebrate host for oocyst of coccidia.
8. Collection of coccidian oocysts by centrifugation method.
9. Observation of oocysts for sporulation.
10. Study of different mosquito vectors of protozoan parasites.
11. Collection of Myxozoa from fishes.
12. Study of binary fission and conjugation in ciliates.

### **Practical Paper No. ZOO-456 Practicals based on ZOO-433 (Entomology- II)**

1. Collection, preservation, sketching, identification and classification of insects of following orders- Thysanura, Collembola, Odonata, Orthoptera, Mallophaga, Anopleura, Isoptera, Hemiptera, Coleoptera, Neuroptera, Hymenoptera, Lepidoptera, and Diptera and insects from Marathwada,
2. Identification damage symptoms, and management practices of pests of Jowar, Cotton, Sugarcane, soybean, Vegetables, Fruit Crops, Stored grains.
3. Collection and study of paratactic, Predatory, pollinator insects & biological control Agents, forensic insects
4. Study of insect vectors like mosquito, bed bug, flea, body louse, rat flea.
5. Study of silk worm adult, caterpillar, cocoon and types of silk worms.
6. Study of Indian species of honeybee and Study of life cycle of honeybee .
7. Field visit for demonstration of pest damage/ Sericulture farm / apiculture farm.

**Practical Paper No. ZOO-457 Practicals based on ZOO 434 (Endocrinology II)**

1. In situ demonstration of endocrine glands in rat.
2. Histological study of endocrine glands in different vertebrate representatives
3. Dissection of reproductive system in fish and rat
4. Study of estrous cycle in rat
5. Endocrine gland removal in rat- a) Orchidectomy b) Ovaryectomy  
c) Adrenalectomy d) Thyroidectomy
6. Effect of thyroxin on oxygen consumption in fish
7. Chromatophores and colour changes in fish  
( a ) Effect of back ground and ( b ) Effect of MSH injection.
8. Determination of cholesterol in the adrenal gland of rat.
9. Effect of insulin on blood glucose levels in fish / rat
10. Histological techniques : preparation of permanent slides for histological structure of endocrine glands of rat (at least 5 be submitted)

**Dr. Babasaheb Ambedkar Marathwada University, Aurangabad**  
**Department of Zoology**  
**M. Sc. Second year (Semester – III)**

Course	Theory course					
	Paper code	Paper nomenclature	Credit	Work Load hrs		Max/Min Marks
				Per week	Per term	
Core Course	<b>ZOO-501</b>	Evolution and Animal behavior	4	4	60	100/40
	<b>ZOO-502</b>	Quantitative biology	4	4	60	100/40
	<b>ZOO-503</b>	Fundamental processes	4	4	60	100/40
Elective Courses (ANY ONE)	<b>ZOO-521</b>	Fishery Science I	4	4	60	100/40
	<b>ZOO-522</b>	Animal Physiology-I { Invertebrate }	4	4	60	100/40
	<b>ZOO-523</b>	Molecular Biology- I	4	4	60	100/40
	<b>ZOO-524</b>	Applied Parasitology-I	4	4	60	100/40
*Service courses (ANY ONE)	<b>ZOO-581</b>	Pisciculture	4	4	60	100/40
	<b>ZOO-582</b>	Sericulture	4	4	60	100/40
	<b>ZOO-591</b>	Apiculture	4	4	60	100/40
	<b>ZOO-592</b>	Wild life & nature interpretation	4	4	60	100/40
	<b>ZOO-593</b>	Personality Development	4	4	60	100/40
		<b>Total Credit</b>	<b>48</b>	<b>48</b>	<b>720</b>	<b>1200</b>
Practical course						
Paper code	Practicals	Credits	Work Load hrs		Max./Min Mark	
			Per week	Per Term		
<b>ZOO-541</b>	Practicals based on ZOO-501 Evolution and Animal behavior	2	4	60	50/20	
<b>ZOO-542</b>	Practicals based on ZOO-502 Quantitative biology	2	4	60	50/20	
<b>ZOO-543</b>	Practicals based on ZOO-503 Fundamental processes	2	4	60	50/20	
<b>ZOO-544</b>	Practicals based on zoo-521 Fishery Science I	2	4	60	50/20	
<b>ZOO-545</b>	Practicals based on ZOO-522 Animal Physiology I	2	4	60	50/20	
<b>ZOO-546</b>	Practicals based on ZOO-523	2	4	60	50/20	
<b>ZOO-547</b>	Practicals based on ZOO-524	2	4	60	50/20	
	<b>Total Credit</b>	<b>14</b>	<b>28</b>	<b>420</b>	<b>350</b>	

## **Core Courses**

### **Paper No. ZOO 501 Evolution, Animal behaviour**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

#### **Course Objective :**

1. To study the Origin of various animal groups.
2. To study the mechanism involved in evolution.
3. To study the significance and pattern of evolution.
4. To study the behavioral mechanisms.

#### **Unit I Emergence of evolutionary thoughts:**

1. Lamarck's theory of evolution;
2. Darwin's theory of evolution –
  - 2.1. Concepts of variation
  - 2.2. Adaptation
  - 2.3. Struggle for existence
  - 2.4. Fitness and
  - 2.5. Natural selection;
3. Spontaneity of mutations;
4. The modern evolutionary synthesis.

#### **Unit II Origin of cells and unicellular evolution:**

1. Origin of basic biological molecules;
2. Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane;
3. Experiment of Miller (1953);
4. The first cell and Evolution of prokaryotes;
5. Origin of eukaryotic cells;
6. Evolution of
  - 7.1 Unicellular eukaryotes;
  - 7.2 Anaerobic metabolism,
  - 7.3 Photosynthesis and
  - 7.4 Aerobic metabolism.

#### **Unit III Paleontology and evolutionary history:**

1. The evolutionary time scale (eras, periods and epoch)
2. Major events in the evolutionary time scale
3. Origins of
  - 3.1. Unicellular and multicellular organisms and sex ;
  - 3.2. Major groups of animals (Amphibia, Reptilia, Birds and Mammals)
  - 3.3. Stages in primate evolution including Homo.

#### **Molecular Evolution:**

1. Concepts of natural evolution,

2. Molecular divergence and molecular clocks;
3. Origin of new genes and proteins; 4. Gene duplication and divergence.

**Unit IV The Mechanisms:**

1. Population genetics –
  - 1.1. Populations,
  - 1.2. Gene pool,
  - 1.3. Gene frequency;
2. Hardy-Weinberg law
3. Concepts and rate of change in gene frequency through
  - 3.1. Natural selection,
  - 3.2. Migration and
  - 3.3. Random genetic drift;
4. Adaptive radiation and modifications;
5. Isolating mechanisms;
6. Speciation – Allopatric, Sympatric and Parapatric ;
7. Convergent evolution;
8. Sexual selection;
9. Co-evolution.

**Unit V Brain, Behavior and Evolution:**

1. Kinship
2. Altruism and Kin selection
3. Reciprocal altruism;
4. Neural basis of -
  - 4.1. Learning,
  - 4.2. Memory,
  - 4.3. Cognition,
  - 4.4. Sleep and
  - 4.5. Arousal;
5. Biological rhythms, biological clock, tidal, seasonal and circadian rhythms
6. Development of behavior
7. Social communication;
8. Social dominance;
9. Parental care
10. Aggressive behavior;
11. Habitat selection and optimality in foraging;
12. Migration, Orientation and Navigation;

**Books recommended :**

1. Varma and Agrawal - Genetics and Evolution
2. Dobzhansky, Th.. Genetics and Origin of Species. 3rd Ed. Columbia Univ. Press.  
Dobzhansky, Th., F.J. Ayala, G.L. Stebbins and J.M. Valentine.
3. Futuyama, D.J. Evolution. Surjeet Publication, Delhi.
4. Jha, A.P. Genes and Evolution. John Wiley Publication, New Delhi.
5. Savage J.M Evolution. Amerind Publishing Co. New Delhi.
6. Varma and Agrawal - Evolution
7. Animal behavior and Evolutionary Approach by Alcock
8. Perspectives in animal behavior Goodenough , Wiley 1993
9. An introduction to animal behavior 5 th ed. Cambridge Univ Press. By Manning Dawkins.

## **Paper No. ZOO-502**

### **Quantitative Biology**

**Total no. of credits-** 4

**No. of periods per credit-** 15

**Total No. of periods -**60

**Evaluation: External-**80%, **Internal-**20%

**Objective:**

1. Mathematical and statistical approaches have played a fundamental role in understanding biological concepts.
2. It will enable students to be empowered to use such tools of greater significance.
3. The knowledge of computing and data mining is now a prerequisite for literacy in modern sciences.

**Unit I Statistical Methods**

1. Classification of Data,
2. Measures of central tendency
  - 2.1. Mean , Mode and Median, Geometric mean, Harmonic mean,
  - 2.2. Sample mean verses population mean
3. Measures of Dispersion,
  - 3.1. Absolute and Relative measures,
  - 3.2. Range and Interquartile range
  - 3.3. Absolute deviation and mean absolute deviation,
  - 3.4. Variance,

**Unit II Statistical Methods**

- 1. Standard deviation-** Sample std deviation and Population std deviation
  - 1.1. Coefficient of range and interquartile range,
  - 1.2. Coefficient of Mean deviation ,
  - 1.3. Coefficient of Std deviation and Coefficient of Variation
5. Frequency distribution
  - 1.4. Normal curve
  - 1.5. Standard deviation and standard error
  - 1.6. Sampling and t-test ,
  - 1.7. Student t-test,
  - 1.8. Chi Square test, Their importance and uses.
  - 1.9. Levels of significance;
  - 1.10. Regression and Correlation;

**Unit III Probability theory**

1. Probability distributions, and their properties.
2. Sampling distribution,
3. F-test (one-way & two-way F test).
4. Analysis of variance: One way and Two way.
5. Basic introduction to Multivariate statistics.

**Unit IV Computational methods**

1. Bioinformatics scope,
2. Tools and resources in bioinformatics.
3. Database,
4. Biological databases,
5. Data bases, types and information,

6. Nucleic acid and protein sequence databases;
7. Data mining methods for sequence analysis,
8. Web-based tools for sequence searches

**Unit V Computational methods**

9. Sequence retrieval,
10. Basic concepts and operational aspects
11. Phylogenetic analysis,
12. Clustal W and Blast application,
13. Construction of phylogenetic trees using molecular data.( Cytochrome, myoglobin etc.).
14. Predictive methods based on sequence data,
15. Genome information
16. Motif analysis and presentation.

**Recommended books:**

1. Introduction to mathematics for life scientists By Batschetelet , E. ,Springer –Verlag. Berlin
  2. Fundamentals of Ecological modeling by Jorgensen, S.E. , Elsevier, New York
  3. Ecological simulation primer by Swartzman, G.L., and S. P . Kalunzy, Macmillen , New York.
  4. Modeling in behavioral Ecology by Lendern, Chapman and Hal , London K.
  5. Biometry , by Sokal, R.R. and R.J.Rolf , Freeman, San Francisco
- Tentative Zoology Syllabus for PG Page 3
6. Statistical methods by Snedecor, G.W. and W.G. Cochran. Affiliated East West Press. New Delhi. (India Ed.)
  7. Sampling design and statistical methods for environmental biologist by Green , R.H. , John Wiley and Sons, New York.
  8. Mathematical Biology by Murray , J.D., Springer Verlag, Berlin.
  9. The Interpretation of Ecological Data. A Primer on classification and Ordination by Pielou, E.C.
  10. Introduction to Bioinformatics: A Theoretical and Practical Approach by Stephen A. Krawetz
  11. Bioinformatics and Genomes by Andrade

**Paper No. ZOO-503**  
**Fundamental Processes**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

**OBJECTIVE:**

1. To impart knowledge in evolving biological science at molecular level.
2. To impart understanding of the fundamental process governing life and information flow in cell.
3. To inculcate interest in molecular biology research and capacity building.

**Unit I Prokaryotic and Eukaryotic DNA replication, repair and recombination:**

1. Unit of replication, enzymes involved,
2. Replication origin and replication fork,
3. Fidelity of replication,
4. Extrachromosomal replicons,
5. DNA damage and repair mechanisms.

**Unit II Transcription (RNA synthesis and processing )**

1. Transcription regulation in Prokaryotes:
  - 1.1. RNA Pol subunit composition and
  - 1.2. DNA motif,
  - 1.3. Operon- Operons - inducible, repressible operons.
2. Transcription in Eukaryotes:
  - 2.1. RNA Pols subunit composition and
  - 2.2. DNA motif,
  - 2.3. Transcription factor and chain terminator.
  - 2.4. Promoters; enhancers, silencers.
3. Post transcriptional events:
  - 3.1. Splicing;
  - 3.2. Capping &
  - 3.3. Polyadenylation;
  - 3.4. Co-ordination of mRNA processing,
  - 3.5. rRNA & tRNA Processing;
  - 3.6. RNA editing,
4. Post-transcriptional control of gene regulation.

**Unit III Translation (Protein synthesis) and processing**

1. Genetic code,
2. Aminoacylation of tRNA,
3. tRNA-identity,
4. Aminoacyl tRNA synthetase,

**Prokaryotic Translation**

1. Initiation,
2. Elongation&
3. Termination.



**Unit IV Eukaryotic translation**

- 1.1. Ribosome,
- 1.2. Formation of initiation complex,
- 1.3. Initiation factors and their regulation,
- 1.4. Elongation and elongation factors,
- 1.5. Termination,
2. Translational proof-reading,
3. Translational inhibitors,
4. Co and post- translational modification of proteins.

**Unit V Control of gene expression at transcription and translation level**

1. Prokaryotic gene expression
  - 1.1. Operons and regulons, repression and activation of *Lac* operon.
2. Eukaryotic gene expression
3. Role of chromatin in regulating gene expression and gene silencing.

**Books recommended**

1. Hartman and Surkind – Gene action
2. Hexter and Yost – The science of Genetics
3. Sinnot, Dunn and Dobzhansky- Principles of Genetics
4. Alberts B., Bray D., Lewis J., Rabt M., Robert K. and J. D.Watson. Molecular Biology of the Cell, Garland Publishing Inc. London.
5. Simmon, S. and Snustad: Principles of Genetics, 8th Edition, John Wiley and Sons Inc. N.Y.
6. Hartl D.L. and Jones E.W. Genetics: Analysis of gene and genome. Jones and Bartlett publishers . Boston
7. Tamarin R.H. Principles of Genetics. Wadsworth Publishing company ,Belmont, California.
8. Lewin Benjamin Genes VII Oxford University Press.
9. Winchester A.M. Genetics Oxford and IBH Publishing co New Delhi.
10. Genetics By Strichberger
11. Dobzhansky, Th.. Genetics and Origin of Species. 3rd Ed. Columbia Univ. Press. Dobzhansky, Th., F.J. Ayala, G.L. Stebbins and J.M. Valentine.
12. Futuyama, D.J. Evolution. Surjeet Publication, Delhi.
13. Jha, A.P. Genes and Evolution. John Wiley Publication, New Delhi.
14. Savage J.M Evolution. Amerind Publishing Co. New Delhi.
15. Varma and Agrawal – Evolution

## **Elective Papers**

### **Paper No. ZOO- 521 Fishery Science-I**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

**Objectives:-**

1. To develop the scientific outlook and awareness in Inland water bodies and its great potential for fish and fish seed production.
2. To familiarize the students with phylogeny of fishes.
3. Application of the fishery science knowledge for the biological productivity of inland waters.
4. The commercial fish species exploitation by sharing ecological niches.

#### **Unit I**

General characters and classification of fresh and marine water fishes.  
Identification of larval stages of major carps.  
Identification of fishes up to species level,  
General characters of bony and cartilaginous fishes and phylogeny of fishes.

#### **Unit II**

Aquatic ecosystems-  
Fresh, brackish and marine water ecosystems.  
Productivity of ponds and its nutrient circulations.  
Identification of plankton, nekton and benthos.  
Role of plankton in fish culture.

#### **Unit III**

Culture techniques of major carps.  
Breeding techniques, Induced breeding bundh breeding, breeding in happa,  
Types of fish culture -Cage culture, Pen culture, Monoculture, Poly culture.  
Types of hatcheries, hatching happa, Chinese hatchery.  
Maintenance and management of hatcheries.  
Hybridization.

#### **Unit IV**

Types of fish ponds in fresh water fish culture.  
Layout and construction of ponds,  
Fertilization and management of various ponds.  
Fish diseases and their control measures,  
Setting up of home aquarium and maintenance of aquarium fishes.

#### **Unit V**

Major fisheries of India and Fishing methods  
Important Inland, cold water, Brackish , estuarine and marine fisheries of India,  
Conventional and non-conventional fishing methods.

Fishing crafts and gears.

Fish products and by-products and fish preservation.

Rigor mortis and post mortem changes, autolysis.

**Reference books**

1. Prosser & Brown- Comparative Physiology
2. Leninger- Principles of Biochemistry
3. Harper-. Physiological Chemistry
4. Pillay,T.V.R. & M.A. Dill.- Advances in Aquaculture. Fishing News (Books)Ltd., England, 1979.
5. Stickney, R.R. -Principles of Warm water Aquaculture. John Wiley & Sons Inc.,1979.
6. Boyd, C.E. -Water Quality Management for Pond Fish Culture. Elsevier Scientific Publishing Company, 1982.
7. Jhingran, V.G. -Fish and Fisheries of India. Hindustan Publishing Corporation India, 1982
8. Bardach, et. al. -Aquaculture – The Farming and Husbandry of Freshwater and Marine Organisms. John Wiley & Sons, NY, 1972.
8. Chondar, C.L. -Hypophysation of Indian major carps. Satish Book Enterprise,Agra, 1980.
9. Santhanam, R. et. al. -A Manual of Freshwater Aquaculture. Oxford & IBH Publishing Co. Pvt. Ltd., 1987.
10. Cheng, T.C. -The Biology of Animal Parasites. Saunders, Philadelphia, 1964.
11. Ribelin, W.E. & G. Miguki- The Pathology of Fishes. The Univ. of Wisconsin Press Ltd., Great Russel st., London, 1975.
12. Schauperclaus- Fish Diseases. Vol. I & II.
- 13.Douglas P Anderson - Text Book of Fish Immunology
14. Nandini Shetty- Immunology. Introductory Textbook.
15. Karunasagar, I. -Aquaculture and Biotechnology. Oxford-IBH Publishers, New Delhi,
17. Govindan, T.K. -Fish Processing Technology, Oxford-IBH, 1985.
18. Shang, Y.C. -Aquaculture Economic Analysis – An Introduction. 1990.
19. Nikolsky, G.V. -Ecology of Fishes. Academic Press, NY, 1963.
20. Howar, W.S. & D.J. Randal- Fish Physiology, Vols. 1–4, Academic Press, NY,1970.
22. Carl, B.E. Biology of Fishes- Saunders, 1979.
23. Turnor- Textbook of endocrinology
24. Day, F. -The fishes of India.

**Paper No. ZOO- 522**  
**Animal Physiology – I (Invertebrate Physiology)**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

**Objectives :- The study of this course is essential to understand the basic physiological processes in invertebrates and their use in medical, Non- medical and veterinary sciences.**

**Part –A: Physiology of Arthropods**

**Unit -I Crustacea**

1. Osmotic and ionic regulation, Mechanism of regulation, Hormonal control of osmoregulation.
2. Structure and functions of heart: significance of pericardial organs in heart beat, Blood sugars in crustacean and its hormonal control.
3. Types of reproduction, genetic sex determination, sex reversals, Factors affecting reproduction, Hormonal control of reproduction.

**Unit-II Insecta I**

1. Nutrition and choice of food, Functional morphology of alimentary canal and associated glands, Role of digestive enzymes.
2. Functional morphology of respiratory organs in insects, Physiology and factors affecting respiration.
3. Structure and functions of photoreceptors. Mechanoreceptors and chemoreceptors, Mechanism of reception.
4. Gametogenesis and factors affecting reproduction, Hormonal control of reproduction.
5. Types of metamorphosis in insects and Hormonal regulation of metamorphosis.

**Part – B: Physiology of Non-arthropods**

**Unit –III Annelida**

1. Digestive system, Transport of food through alimentary canal, Regulation of digestion.
2. Types of reproduction, sexual development and maturation, factors affecting reproduction.
3. Growth and regeneration in polychaeta and its hormonal regulation.

**Unit-IV Mollusca**

1. Osmotic equilibrium, osmotic and ionic regulation in freshwater and marine forms.
2. Respiratory organs, structural properties and functions of respiratory pigments,
3. Nitrogenous end products, Urine formation and excretion.
4. Reproduction pattern (Gonochorium, hermaphroditism, self - fertilization, parthenogenesis), Factors influencing reproduction, Hormonal control of reproduction. Sex reversal.

**Unit -V Echinodermata:-**

1. Coelomic fluids and coelomocytes.
2. Respiratory organs, Role of perivisceral coelomic fluid in respiration, Factors affecting respiration.
3. Types of reproduction, Breeding behavior, Factors influencing reproduction. Regeneration in echinoderms.

**Books Recommended**

1. Comparative Animal Physiology by Prosser C.L.
2. General and Comparative Physiology by– Florey W.A
3. General and Comparative Physiology by Hoar W.B.
4. Animal Physiology by Neilsen K.S.
5. Cell Physiology by Giese A.C.

6. General Physiology by Giese A.C.
7. A text Book of Biochemistry by West E.S. and Todd W.R.
8. Cell Biology by Ambrose and Fastly
9. Principle of Animal Physiology by Wilson J.A.
10. Neural and integrative Physiology by Prosser C.L.
11. Animal Physiology by Gordon G.S.
12. Modern Physiology– by Strang F.L.
13. Comparative Physiology of Animals by Hill R.W.
14. Medical Physiology by Guyton
15. Biological Rhythm by David S. and Saunders
16. Agrawal's text book of Biochemistry by A.P. Agrawal

**Paper No. ZOO-523**  
**Molecular Biology I**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

**COURSE OBJECTIVE:**

1. To impart knowledge in evolving biological science at molecular level.
2. To impart understanding of the fundamental process governing life and information flow
3. To inculcate interest in research molecular biology and creating human capacity for this region.

**UNIT I**

**1. Chemical components of nucleic acids**

**2. DNA structure**

- 2.1 Secondary structure,
- 2.2. Tertiary structure,
- 2.3. Supercoiling,
- 2.4. Unusual DNA structures –
- 2.5. DNA Motif
  - 2.5.1 Helix turn helix motif
  - 2.5.2. Leucine zipper motif
  - 2.5.3. Zinc finger motif
  - 2.5.4. Helix loop helix motif

**3. RNA structure,**

- 3.5. Secondary structure,
- 3.6. Types of RNA and their functions.
- 3.7. Small RNAs,
- 3.8. miRNA,
- 3.9. siRNA.

**4. RNA as catalyst: Ribozymes.**

**UNIT II**

**1. Bacterial (prokaryotic) DNA replication**

- 1.1. Origin of Replication,
- 1.2. Factors and enzymes involved in replication initiation, elongation and termination,
  - 1.2.1. Initiation complex,
  - 1.2.2. Elongation and
  - 1.2.3. termination of replication

**2. Extra-chromosomal and organelle DNA replication**

**3. Eukaryotic DNA replication,**

- 3.1. Replication origin,
- 3.2. Factors and enzymes in replication
- 3.3. Assembly of pre-replicative and replicative origin complexes,
- 3.4. Firing of replicative origin
- 3.5. Elongation (leading and lagging strand synthesis, replication of telomeric sequences
- 3.6. Proofreading

**4. DNA damage and genetic disorders.**

- 4.1. Repair systems, Excision repair in bacteria,
- 4.2. Nucleotide repair system pathway,

- 4.3. Base-excision repair pathway,
- 4.4. UV damage and Photo-reactivation or light repair pathway,
- 4.5. Error-prone repair,
- 4.6. Recombination repair system

### UNIT III

- 1.1. Transcription –**
- 1.2. In Prokaryotes: RNA synthesis,**
- 1.3. RNA polymerase,
- 1.4. Post-transcriptional processing of**
- 1.5. rRNA, tRNA and mRNA.
- 1.6. Transcription in Eukaryotes:**
- 1.7. RNA synthesis,
- 1.8. RNA polymerases,
- 1.9. Processing -**
- 1.10. Capping,
- 1.11. Poly-adenylation,
- 1.12. Splicing,
- 1.13. RNA Transport**
- 1.14. Translational machinery,**
- 1.15. RNA and protein components of ribosome,
- 1.16. tRNA synthetases and
- 1.17. tRNA charging**
- 1.18. Translation initiation in prokaryotes and eukaryotes**
- 1.19. Elongation - Ribosome translocation
- 1.20. Translation termination
- 1.21. Post-translational modifications and their significance**
- 1.22. Protein folding
- 1.23. Signal peptides, and localization**
- 1.24. Heat shock factors, chaperones and their roles in folding

### UNIT IV

- 1. Regulation of gene expression in viruses:**
- 1.1. Lysogeny vs lytic phase
- 2. Regulation of gene expression in prokaryotes:**
- 2.1. Operons,
- 2.2. Positive and negative control,
- 2.3. Inducible and repressible operons.
- 2.4. Gene expression control by RNA, Riboswitches
- 3. Regulation of gene expression in eukaryotes.**
- 3.1. At chromatin level, HATs and chromatin remodellers.
- 4. Regulation at transcription level,**
- 4.1. Cis- and trans-acting factors,
- 4.2. Transcription factors,
- 4.3. Enhancers and
- 4.4. Silencers.
- 5. Post –transcriptional regulation: alternate splicing**
- 6. Regulation of translation:**

### UNIT V

- 1. Basic Techniques of Molecular Biology**
- 1.1. Techniques for Gene Isolation

- 1.2. Genomic and cDNA libraries, Probe labeling and library screening approaches
- 1.3. PCR techniques – RT-PCR
- 1.4. Differential display and subtractive cloning
- 2. Basics of genome sequencing: Maxam-Gilbert and Sanger's di-deoxy sequencing**
- 3. Sequencing of genomes**

**Reference books:**

1. **Molecular Biology of the Gene**, 5th Edition (2004), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Publisher - Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.
2. **Molecular Biology**, 4th Edition (2007), Weaver R., Publisher-McGraw Hill Science.
3. **Molecular Biology of the Cell**, 4th Edition (2004), Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D. Publisher: Garland Publishing.
4. **Essential Cell Biology**, 2nd Edition (2003) Bruce Albert, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Publisher: Garland Publishing.
5. **Fundamentals of Molecular Biology**, (2009), Pal J.K. and Saroj Ghaskadbi, Publisher: Oxford University Press
6. **Genes X**, (2010), Benjamin Lewin, Publishers - Jones and Barlett Inc.
7. **Molecular biology**-De robertis and De robertis
8. **Genetics** -Strickberger



**Paper No. ZOO- 524**  
**Applied Parasitology- I**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

**Course Objectives:**

1. The basic and general concepts of Parasitology.
2. The major types of parasites of medical & veterinary importance
3. Basics of identification of common parasites of humans and animals.
4. To design and evaluate an intervention to control food and waterborne diseases.
5. Critically read and evaluate epidemiologic studies in the different disease
6. Critically read and evaluate epidemiologic studies in emerging disease and bioterrorism literature.
7. To prepare the experts in the field of Medical and veterinary Parasitology.

**UNIT-I**

1. Introduction to Parasitology
2. Inter-specific biological relationships phoresis, symbiosis, Commensalisms and parasitism.
3. Parasitism- Definition & concept
4. Origin and evolution of parasites.
5. Adaptation in parasites.

**UNIT-II**

1. Advantages and Disadvantages in parasitic life.
2. Types of Parasites.
3. Types of hosts- Definitive and intermediate, primary secondary specific host, Paratenic, Carrier, Susceptible, Resistant, Accidental, Vectors etc
4. Major taxa of parasites of medical & veterinary importance.
5. Factors influencing Parasitism; Influence of season, host age and other phonological factor on parasitic population (prevalence, intensity etc).

**UNIT-III**

1. Habitat and Environment of different parasites. Host parasite system
2. Host reaction to parasites, Pathogenecity of endo and ecto parasites.
3. General control measure of ecto and endo parasites. Chemical, Biological, Physical/ Mechanical, Culture and Legislative.
4. Economic importance of parasites, direct or indirect effect on human, animal, farm animals and agriculture, poultry and fisheries pathogenecity.

**UNIT-IV**

1. General organization of the parasitic Protozoa occurring in urinogenital tract and blood.
  - a. i) *Trichomonas vaginalis* ii) *Trichomonas foetus*
  - b. i) *Trypanosoma gambiense* ii) *Trypanosoma cruzi* iii) *Leshmania donovani*
  - iv) *Leshmania tropica*

## UNIT-V

### **Study of medically and veterinary important Parasitic Cestodes**

- i. Intestinal cestodes.
- ii. Tissue cestodes.

### **Study of medically and veterinary important Parasitic Trematodes**

- i. Trematodes infective in Metacercarial stage
- ii. Trematodes infective in Cercarial stage

## **List of books**

1. Infectious Disease Epidemiology: theory and practice. 2<sup>nd</sup> edition. Nelson & Williams (Eds.). 2007.
2. A good additional online text: Global Burden of Disease and Risk Factors. Disease Control Priorities Project. It is available at: <http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=gbd.TOC&depth=2>
3. Medical Parasitology by Markell, Voge and John, 8<sup>th</sup> ed. W.B. Saunders Co.
4. Reingold, A.L. Outbreak Investigations – A Perspective. Emerging Infectious Diseases 1998; 4(1): 21-27.
5. Jones, K.E., Patel, N.G., Levy, M.A., Storeygard, A., Balk, D., Gittleman, J.L. and P. Daszak. Global trends in emerging infectious diseases. Nature 2008; 451(21): 990-993.

## **Reference Books**

1. Text book of medical parasitology - Sawitz
2. Parasitology - Nobel and Nobel
3. An introduction to nematodology - Chitwood
4. Biology of nematode - Crool
5. Plant parasitic nematode - Parmonove
6. Principal of nematodology - Throne
7. Plant nematodology - Jenkin and Taylor
8. Clinical parasitology - Craig Faust
9. Applied parasitology - Hiware, Jadhav and Mohekar
10. Biochemistry of parasitisms - Von Brand
11. Physiology of cestode parasitology - Smith
12. Physiology of nematode parasite - Smith
13. Helminth, Arthropod and Protozoa of domesticated animal -Solbsy E.J.W
14. Laboratory methods of work with plant and soil nematodes -Southey
15. Soil and fresh water Nematodes - Goodey.
16. Chatterjee K. D. (1969) -Parasitology (Protozoology and Helminthology)
17. Cheng T.C. (1964)-The Biology of animal parasites, Saunders International Student Edition.
18. The Invertebrates Vol II, McGraw Hill, New York.- Dawes B. (1946).

## **Service Courses**

Service courses are comprising theory and practical/project work. Any one service course is to be adopted as per choice of student in third semester. The service Course is allotted to the students who have been admitted in the other Departments.

### **Paper No. ZOO- 581 Pisciculture**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

#### **Objectives**

21<sup>st</sup> century practice the culture of about 430 (97%) of the species. Given the long-term importance of agriculture, it is interesting to note that, to date only 0.0002 % of known animal species have been domesticated, compared with marine plant and animal species. Domesticating aquatic species involve fewer risks to humans than land animals, which took a large toll in human lives.

The farming of fish is the most common form of aquaculture. It involves raising fish commercially in tanks, ponds, or ocean enclosures, usually for food. A facility that releases juvenile fish into the wild for recreational fishing or to supplement a species natural numbers is generally referred to as a fish hatchery. Fish species raised by fish farms include carps, tilapia, catfish and cod.

In the region like Marathwada, pisciculture has not taken a key position as cash crop as agriculture product. Hence, very motto of this service course is to introduce pisciculture [fish culture] in this scenario as a theory cum practical course at post graduate level student in University. It will certainly attract the attention of youth which may lead to self employment. Such course will really help to transfer the technology from laboratory to land to gain real knowledge of fish culture.

**\* This service course is divided in to two parts consisting of two credits for theory and two credits for the practicals to provide the practical training to the students so that they can start the fish culture in their fields or train the others.**

#### **Theory component**

##### **Unit I**

1. Introduction to freshwater fishes
2. Survey of fish fauna of the river Godavari
3. Study of Fish food [ planktons]
4. Breeding of fishes

##### **Unit II**

1. Types of fish pond
2. Manuring and maintenance of fish pond
3. Collection of fish seed
4. Raring of fish

##### **Unit III**

1. Identification of fish diseases
2. Treatment of fish diseases
3. Marketing of fishes
4. Economics of fish culture

#### **Practicals or demonstration : 2 credits**

1. Collection of fishes from market for identification
2. Identification of freshwater fishes

3. Collection of fish seed
4. Packaging of seed for transportation
5. Preparation of fish pond [ model]
6. Application of fertilizer in pond
7. Maintenance of fish ponds
8. Identification of male and female fishes
9. Breeding techniques in fish
10. Observations of fertilized and non-fertilized eggs, fry, fingerlings and adult fish
11. Feeding of fishes[artificial and natural]
12. Observations of planktons as food of fish
13. Identification of fish diseases and their treatment
14. Fishing tools and techniques
15. Technique of fish marketing
16. Visit to any fish production unit

#### Reference books

1. Prosser & Brown- Comparative Physiology
2. Leninger- Principles of Biochemistry
3. Harper-. Physiological Chemistry
4. Pillay,T.V.R. & M.A. Dill.- Advances in Aquaculture. Fishing News (Books)Ltd., England, 1979.
5. Stickney, R.R. -Principles of Warm water Aquaculture. John Wiley & Sons Inc.,1979.
6. Boyd, C.E. -Water Quality Management for Pond Fish Culture. Elsevier Scientific Publishing Company, 1982.
7. Jhingran, V.G. -Fish and Fisheries of India. Hindustan Publishing Corporation India, 1982
8. Bardach, et. al. -Aquaculture – The Farming and Husbandry of Freshwater and Marine Organisms. John Wiley & Sons, NY, 1972.
8. Chondar, C.L. -Hypophysation of Indian major carps. Satish Book Enterprise,Agra, 1980.
9. Santhanam, R. et. al. -A Manual of Freshwater Aquaculture. Oxford & IBH Publishing Co. Pvt. Ltd., 1987.
10. Cheng, T.C. -The Biology of Animal Parasites. Saunders, Philadelphia, 1964.
11. Ribelin, W.E. & G. Miguki- The Pathology of Fishes. The Univ. of Wisconsin Press Ltd., Great Russel st., London, 1975.
12. Schaperclaus- Fish Diseases. Vol. I & II.
13. Douglas P Anderson - Text Book of Fish Immunology
14. Nandini Shetty- Immunology. Introductory Textbook.
15. Karunasagar, I. -Aquaculture and Biotechnology. Oxford-IBH Publishers, New Delhi,
17. Govindan, T.K. -Fish Processing Technology, Oxford-IBH, 1985.
18. Shang, Y.C. -Aquaculture Economic Analysis – An Introduction. 1990.
19. Nikolsky, G.V. -Ecology of Fishes. Academic Press, NY, 1963.
20. Howar, W.S. & D.J. Randal- Fish Physiology, Vols. 1–4, Academic Press, NY,1970.
22. Carl, B.E. Biology of Fishes- Saunders, 1979.
23. Turnor - Textbook of endocrinology
24. Day, F. -The fishes of India.

**Paper No. ZOO- 582**  
**Sericulture**

**Total no. of credits- 4 (Theory 03+ Practical 01)**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

**INTRODUCTION:**

India is agriculture-based country and majority of the population is from rural areas. They are totally dependent on agriculture. As sericulture is an agriculture-based industry it will help for the rural population to improve their economic status, and in turn the nation's too.

The Government of Maharashtra and the University Grants Commission through colleges and Universities has taken a step to give the job oriented courses / education in the new education policy. The sericulture is one of the subjects in that. This subject has immediate application of knowledge so it is essential to start and disseminate the knowledge of subject for the students to solve the problems of unemployment.

Sericulture consists mainly three parts:

1. Mulberry Cultivation
2. Silk Worm rearing
3. Post Cocoon Technology

Students from the rural area are well known to agriculture so they can easily get attracted and acquainted to this subject. It has got more job opportunities as well as self employment potentialities. India is producing 8% of total world Silk production and stood second in rank of silk producing countries. The total demand of the silk fabrics in the world is thousands of cores but India is providing just in hundred cores only so there are good chances and scope to improve the production and earn more foreign currencies. Ultimately it will help in improving the national economy.

**JOB OPPORTUNITIES**

1. Wage employment
2. Sericulture Operatives
3. Technical Assistant
4. Technical Demonstrator
5. Worker Teacher
6. Farm Assistant
7. Farm Master Roller and Supervisor
8. Rearing Supervisor

**SELF-EMPLOYMENT**

1. Sericulturist/Farmers
4. Chawki Rearer
5. Nursery Suppliers
7. Cocoon Marketing
8. Extension Worker Expert.

**OBJECTIVES**

1. Sericulture can provide a gainful remunerative occupation.
2. To prepare students to avail of employment potentials and opportunities in sericulture.
3. To popularize students for scientific and fundamental principals of various sericulture activities.
4. To expose the students directly to the field conditions for learning about the sericulture practically.
5. It enables students to improve their knowledge in sericulture through higher training.
6. To develop the habits of working in field.
7. Appreciate and honour the work of those who are engaged in farming.

8. To improve the economical status of the weaker and backward sections of society.
9. To develop the ability and income by adopting the technologies of the subject.
10. To earn foreign exchange.
11. Employment generating capacity through subject sericulture.
12. Minimize the Migration of people from rural to urban area in search of job.
13. Avoid pollution, as afforestation is unavoidable part of sericulture industry.
14. Help to transfer wealth from higher section of society to weaker section.

**\* This service course is divided in to two parts consisting of three credits for theory and one credit for the practicals to provide the practical training to the students so that they can start the culture of silk worms in their fields or train the others.**

## **THEORY PAPER**

### **Unit I**

Introduction to Sericulture, Different types of silk worms.  
Importance, Scope and objectives of Sericulture industry.

### **Unit II**

Mulberry Cultivation:  
- Selection and preparation of land.  
- Selection and preparation of cuttings of Mulberry variety.  
- Role of climatic factors in growth of Mulberry.  
- Plantation methods.  
- Inputs requirement and management of Mulberry.  
- Mulberry diseases and pest management.

### **Unit III**

Silk Worm Rearing:  
- Prerequisite for Silk Worm rearing.  
- Disinfections.  
- Methods of rearing and importance of Silk Worm races.  
- Incubation and black boxing.  
- Brushing, feeding, spacing, bed cleaning, mounting, spinning, harvesting and marketing.  
- Role of environmental factors in rearing.

### **Unit IV**

Diseases and pest management of Mulberry and Mulberry silk worm.  
A. Diseases of Mulberry –  
i) Foliar diseases – Causal agent, Symptoms, Prevention and control measures.  
ii) Root rot disease – Causal agent, Symptoms, Prevention and control measures.  
iii) Root knot disease.  
C. Common pests of Mulberry – Nature and extent of damage, Prevention and control.  
  
D. Disease of Silkworm and their classification.  
i. Pebrine, fungal, viral and bacterial diseases (causative agent, symptoms, prevention and control).  
ii. Pest of Silkworm. (Uzi Fly and Dermestid beetle)

## **SERICULTURE PRACTICALS**

1. Study of different types of Silk Worms: (i) Mulberry, (ii) Tassar, (iii) Eri (iv) Muga.
2. Study of Mulberry varieties.
3. Preparation of cuttings and Nursery bed.

4. Methods of leaf harvesting and pruning with their importance / advantages and disadvantages.
5. Study of diseases and pests of Mulberry.
6. Disinfection, Incubation and Black boxing.
7. Brushing.
8. Calculation of hatching percentage.
9. Rearing of chawki and late age silk worms.
10. Mounting methods and study of montages.
11. Harvesting and Marketing of cocoons.
12. Study of diseases and pests of Silk Worms.
13. Field visit (compulsory).

**Recommended Books:**

1. Manuals on Sericulture, FAO Agricultural Service Bulletins of United Nations
2. Hand book of Silkworm Rearing by Tazim Fuji Publishing Co. Ltd. Tokyo, Japan
3. Hand book of Practical Sericulture by Ullal and Narsimhanna, CSB, Bangalore
5. Appropriate Techniques on Sericulture by Jolly S. Manfert, CSB, Bangalore.
6. Text book on Tropical Sericulture by Japan Cooperative Volunteers, Tokyo.
7. CCRTI Bulletins, CSB, Bangalore
8. Principles of Agronomy by V.T. Subbaiah Mudaliar
9. Irrigation - Theory and Practice by A.M. Michael
10. Hand Book on Agriculture, ICAR, New Delhi.
11. Land and Soil by Rayachaudhri
12. Agro-cottage Industry Sericulture by Hiware C.J. Daya Publishing House New Delhi
13. Imms text book of Entomology
14. Economic Entomology of South India by Ramakrishna Iyyar
15. Sulabh Reshim Nirmithi (Marathi) by Hiware Chandrashekhar, Continental publications, Pune.

**JOURNALS**

1. Indian Silk, CSB, Bangalore.
2. Indian Journal of Sericulture, CSB, Bangalore.
3. Annadata, Eenadu Publications, Hyderabad.

## Paper No. ZOO-591 Apiculture (Bee keeping)

Total no. of credits- 4 (Theory 02+ Practical 02)

No. of periods per credit- 15

Total No. of periods -60

Evaluation: External-80%, Internal-20%

### Background of the course

Apiculture (Apis- honey bee, culture- to rear) is one of the most important branch of a applied biology and deals with the rearing of honey bees in order to obtain honey , wax and also for the increase in crop production by their efficient service of cross pollination. Now a day's beekeeping is an ideal agro-based subsidiary enterprise providing s supplementary / major income to the people in rural areas. Bee keeping in India has been taken up as a subsidiary source of income by rural people and as a hobby by newcomers. This subsidiary activity can provide the much needed employment to the rural people as it employs more than 2.50 lakh people under the purview of KVIC alone. In recent years, a number of techniques have been developed for increasing the productivity of certain agricultural crops through cross-pollination by honeybees. Considering the importance of bees in pollination, Himachal Pradesh has taken the lead in rearing in renting *Apis cerana* colonies to orchards for the pollination of apple crops. This programme has created great awareness among orchardists about the importance of honeybee pollination. Many of our Indian oilseed crops like mustard, sunflowers, safflower, pulses like tur, beans, forage legumes, vegetable like pumpkins, cucumber, radish, cabbage, snake gourd, bitter guard (Bhopla), ridge gourd, carrot, cauliflower and onion; fruits like melons, orange, sweet lime, lemon, pomegranate, guava, apples, and other crops like cotton, coffee, cardamom require cross pollination via honey bees to affect fruit or seed setting and also for improving the quality of seed and fruit. The central bee Research Institute, Pune has taken up experiments on the effect of the bee pollination in various crops. The result are as follows –mustard 131%, Sunflower 511%, Niger 112%, Safflower 675%,Linseed 232%, Onion 178%, Carrot 500%, Radish 700%, Brinjal 125%, fruits 90%,Coffee 83%.

Objective of the course:

- 1) To provide direction of higher education towards social utility (benefit)
- 2) To equip the students with latest technologies in emerging area.
- 3) To extend the knowledge from laboratory to field
- 4) To provide the skills and job oriented techniques to the students.
- 5) To achieve the goal of the College /University/National Policy.
- 6) To provide eco-friendly techniques.

**\* This service course is divided in to two parts consisting of two credits for theory and two credits for the practicals to provide the practical training to the students so that they can start the apiculture in their fields or train the others.**

### Theory component

#### Unit I

##### Introduction of Modern bee keeping

- 1.1. Importance of beekeeping
- 1.2. Scope of beekeeping
- 1.3. Bee species
- 1.4. Cast differentiation, Colony organization
- 1.5. Division of labor in honeybee
- 1.6. Life cycle of honeybee and nuptial flight

#### Unit II

##### Scientific bee keeping

##### 2.1 Beekeeping equipments

- 2.1.1 Equipments for improving efficiency of honeybees
- 2.1.2 Equipments for improving efficiency of bee's keepers
- 2.1.3. Equipments for improving hygienic conditions
- 2.2. Methods of Swarm capturing
  - 2.2.1. Capturing a Swarm from a tree branch
  - 2.2.2. Capturing a Swarm from Ground
- 2.3. Inspection and Handling the Colony



- 2.4. Hiving by dividing an established colony.
- 2.5. Establishment, Seasonal Management of apiary and inspection of bee colonies.

### Unit III

#### Apiculture in Agriculture

- 3.1. Bee plants and floral calendar- Importance and qualities of good bee flora.
- 3.2. Pollination, Need of bee pollination
- 3.4. Management of honeybees for pollination.
- 3.5. Migratory beekeeping
- 3.6. Honeybee products
  - 3.6.1. Honey- Its constituents, methods of collection and uses.
  - 3.6.2. Importance of other bee products to mankind
    - a) Pollen –Method of collection, constituents, uses.
    - b) Royal jelly- Method of collection, constituents, uses.
    - c) Propolis - Method of collection, constituents, uses.
    - d) Bee wax- Method of collection, constituents, uses.
    - e) Bee venom- Method of collection, constituents, uses.

#### 3.7. Problems of beekeeping industries,

Natural Climate Condition, natural enemies, pest and diseases,  
human activities and Apiary and Hive Hygiene

#### Practicals

- 1) Study of external morphology of honeybee
- 2) Study of Indian species of honeybee
- 3) Study of life cycle of honeybee
- 4) Study of architecture of honey comb
- 5) Study of diseases, pests, parasites and predators of the honeybee
- 6) Study of bee keeping equipments and their uses
- 7) Study of artificial bee breeding technique
- 8) Visit to an apiary to study bee-crop relationship and management practices of honeybees for pollination
- 9) Chemical analysis of honey- test for pure honey
- 10) Maintenance of honeybee colony (Compulsory Rearing of live colony) in University campus.

#### Books

- 1) Introduction to disease of bee –Bailey, L
- 2) World of honeybee –Butter C. G.
- 3) Beekeeping in India –Sardar Sing (ICAR)
- 4) The Principle of Insect Physiology-Wigglesworth, V.S.
- 5) Applied Zoology- B. B. Waykar, A. Y. Mahajan, B. C. More . (Prashant Publication Jalgaon)
- 6) D.K.Belsare Beekeeping for livelihood

## **Paper No. ZOO- 592 Wild life and Nature interpretation**

**Total no. of credits- 4 (Theory 02+ Practical 02)**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

**Objectives:**

- **Students will learn to appreciate the beauty of nature, Conservation of Nature and Wildlife.**
- **To create the human resource to spread the awareness of nature and wild life conservation among the people.**
- **Capacity building for nature lovers as forest tour guide or Nature interpreter.**

**\* This service course is divided in to two parts consisting of two credits for theory and two credits for the practicals to provide the practical training to the students. The students will have to bring their own camera.**

### **Theory component**

#### **Unit I**

- Introduction to Forests, Forest ecology- basics
- Composition and Structure of Forest.
- Succession
- Studies on Animal Ecology and Ecosystem
- Vegetation Studies , Animal abundance , Predator prey relationship

#### **Unit II**

- Census techniques , Wildlife signs and evidences for monitoring .
- Introduction of Endangered animals from Fishes, Amphibians, Reptiles , Birds and Mammals
- Introduction of Endangered plants. -Wild life trade and sensitization against this trade

#### **Unit III**

- Camera , Equipment & Accessories
- Photographic Nature & Wildlife / Lighting Conditions
- Micro Specimen Demonstration / Camouflaging & the Waiting Game
- Digital SLR Camera basics

#### **Unit IV**

- A. Telephoto photography I
  - a. Technique, Walk & Stalk method
- B. Telephoto photography II
  - Captive animals (Zoos & rehab centers), Places to capture wilderness
- C. Macro photography
  - Light and image magnification theory, Focusing close-ups, Equipment for close-ups
  - Flash with close up equipment, The butterfly special

#### **Practicals:**

1. Estimation of Relative abundance of Ungulates using track plot method
2. Estimation of Relative abundance of Birds using line transect method
3. Field visits and visits to any zoological park
4. Exercises on wildlife population parameters and census methods for various species.
5. Workshop on Wildlife Photography Techniques
6. Observations and collection of study material

7. Conservation Practices, Tour - Field tour designed to examine wildlife conservation and biology issues in a variety of ecological situations in any biogeographic zone of India

**Recommended Books**

1. The master guide for Wildlife photographers -Bill Silliker
2. Lonely planet Photography- Andy Rouse
3. The Essential Wildlife Photography Manual -Chris Weston
4. Essential Wild life Photography -Richard Du Toit
5. The new complete guide to Wild life Photography -Joe McDonald
6. Digital Wildlife Photography -Chris Weston
7. How to photograph animal in the wild- Leonard Lee Rue
8. The art of wildlife photography – Fritz Polking
9. Natural visions : Creative tips for Wildlife Photography – Heather Angel
10. Man and Nature – George Perkins Marsh , David Lowenthal
11. Nature : The other earthlings - James Shreeve
12. Handbook of nature study – Anna Botsford Comstock
13. Nature's services : Societal dependence on natural ecosystems – Gretchen C. Daily
14. The rights of Nature : A history of environmental ethics- Roderick Nash

**Paper No. ZOO- 593**  
**Personality Development**

**Total no. of credits- 4 (Theory 03+ Practical 01)**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

Course Objectives: To enhance the skills and abilities of students according to the need of business culture.

**Unit I**

**Healthy Environment** – Creating Healthy Environment,  
Role of individual, Cultural effect, Stress Management.

**Unit II**

Value Additions- Excellence in Knowledge,  
Convincing ability, Reading skills, Grasping power, Effective listening.

**Unit III**

**Physical Appearance-** Formal Dressing, Body Movement,  
Limitations, Gesture, Posture.

**Unit IV**

**Communication-** Communication, Significance of Communication,  
Types, Language Command, Mother Tongue Influence, Practices for adjusting mother Tongue influence,  
Learning from Environment.

**Unit V**

**Public Speaking** – Understanding Audience, Stage Courage,  
Handling Question's and Answer's Sessions. Need, Group Discussion objectives, Avoiding Factors,  
Energy, Use of Knowledge, and Motivation to Group Members.

**Unit VI**

**Etiquettes and Manners** – Email Etiquettes, Elevator,  
Communication, Control on Habits.

**References:**

- 1 You Can Win – Shiv Khera – Macmillan Books – 2003 Revised Edition
2. 7 Habits of Highly effective people – Stephen Covey
3. Business Communication ? Asha Kaul
4. Business Communication - M. Balasubramanyam Topic 2 and 3
5. John Collin, "Perfect Presentation", Video Arts MARSHAL
6. Jenny Rogers "Effective Interviews", Video Arts MARSHAL
7. Raman Sharma, " Technical Communications", OXFORD

### **Practical Paper No. ZOO-541 Practicals based on ZOO 501 (Evolution , Animal behavior)**

1. Practical based on Hardy- Weinberg law
2. Lederberg expt
3. Courtship behavior in drossphila
4. Wing beat and Song produced
5. Duration intervals of courtship songs (wing buzzing etc)
6. Reading behavior of praying mantis.
7. Schooling behavior of Fishes.
8. Field visit to an Animal Husbandry centre.
9. Visit to NCCS,NCL, NIV ,NARI Pune.

### **Practical Paper No. ZOO-542 Practicals based on ZOO-502 (Quantitative biology)**

1. Process the data using suitable computer software for calculating mean, median, mode , Calculation of Average, Variance, Frequency distribution, Standard deviation,T test & depict in the data in the form of Graphical representation.
2. Study of databases on the internet.
3. Study of sequence retrieval procedure.
4. Homology searches using BLAST.
5. Alignment of Sequence information using different tools like Clustal X,Clustal W MUSCLE, T-COFFE
6. Phylogenetic tree building method using distance and character base,MEGA, DnaSP

### **Practical Paper No. ZOO-543 Practicals based on ZOO-503 (Fundamental Processes)**

1. Cleaning , washing and drying of glassware.
2. Glassware Sterilization techniques.
3. Extraction of DNA from Animal /plant/bacteria.
4. Study of Structure of DNA molecule with the help of paper model.
5. Estimation of DNA by Diphenyl amine method
6. Estimation of RNA by Orcinol method
7. Study of *E.coli* growth curve.
8. Amplification of DNA by PCR.(Thermocycler)

### **Practical Paper No. ZOO-544 Practical based on ZOO-521 (Fishery Science-I)**

1. Identification of fishes up species level with suitable examples from each class
2. Analysis of water : Turbidity, pH, Dissolved oxygen, Carbon dioxide, Alkalinity, Chlorinity
3. Identification of plankton, nekton and benthos
4. Fishing crafts and gears, hatching happa.
5. Identification fish parasites.
6. Identification of food fishes (at least twenty)
7. Visit to fish breeding centre.

**Practical Paper No. ZOO-545 Practicals based on ZOO-52 (Animal Physiology– I)**

1. Effect of salinity on blood chloride content of crab.
2. Effect of temperature on heart beat. Q<sub>10</sub> measurements in bivalve/ crabs.
3. Estimation of glycogen from hepatopancreas and gonad of crab/ bivalve.
4. Estimation of protein from hepatopancreas and gonad of crab/ bivalve.
5. Estimation of lipid from hepatopancreas and gonad of crab/ bivalve.
6. Estimation of cholesterol from hepatopancreas and gonad of crab/ bivalve.
7. Oxygen consumption in relation to sex and size / temperature of crab/leech/bivalve
8. Histological study of different receptors in crab, snail, cockroach and bivalve.
- 9 Histological study of gametogenic stages in crab, cockroach and bivalve.
10. Acid phosphatase activity in hepatopancreas of crab/ bivalve .
11. Alkaline phosphatase activity in hepatopancreas of crab/ bivalve .
12. Estimation of ascorbic acid from hepatopancreas and gonad of crab/ bivalve .
13. Chromatophores in crustaceans and effect of background on colour change.

**Practical Paper No. ZOO-546 Practicals based on ZOO-523 (Molecular biology-I)**

1. Extraction of genomic DNA from plant/bacteria/yeast/tissue/whole blood.
2. Determination of Molecular size of DNA
3. Restriction digestion of DNA.
4. Determination of molecular weight of different DNA fragments by running a standard marker on agarose gel electrophoresis.
5. Demonstration of plastids in the gel by gel electrophoresis.
6. To isolate and clearing of the DNA fragment of interest from the agarose gel.
7. To perform transformation of DNA into bacterial cells.
8. To separate immunological proteins (Alpha, beta and gamma) from serum by sodium dodecyl sulphate polyacrylamide gel electrophoresis.(SDS-PAGE)

**Practical Paper ZOO-547 Practicals based on ZOO-524: Applied Parasitology- I**

1. Study of different types of animal associations with suitable examples.
2. Study of different Hold fast organs in Helminthes.
3. Study of different types of parasites, vectors etc.
4. Histopathology of host tissue caused by parasites ex. Cestode/ Trematode any host tissue, to study host parasites relation.
5. Study of different/ important ecto/ endoparasites of poultry, fish, animal & human.
6. Collection, fixative, preservation of metacercaria from fish
7. Collection, fixative, preservation of Cestodes, trematodes from locally available hosts.
8. Study of flagellates in alimentary canal and urinogenital tract of vertebrates and invertebrates.
9. Study of haemoflagellates from vertebrate blood.
10. Preparation of blood smear, staining and identification of haemosporina.
11. Study of different mosquito vectors of protozoan parasites.
12. Submission of permanent slides at the time of examination.

**Dr. Babasaheb Ambedkar Marathwada University, Aurangabad**  
**Department of Zoology**  
**M. Sc. Second year (Semester – IV)**

Course	Theory course					
	Paper code	Paper nomenclature	Credit	Work Load hrs		Max/Min Marks
				Per week	Per term	
Core Course	<b>ZOO-511</b>	Developmental Biology	4	4	60	100/40
	<b>ZOO-512</b>	Methods in Biology	4	4	60	100/40
	<b>ZOO-513</b>	Applied Zoology	4	4	60	100/40
Elective Courses (Any ONE)	<b>ZOO-531</b>	Fishery Science –II	4	4	60	100/40
	<b>ZOO-532</b>	Animal Physiology – II (Vertebrates)	4	4	60	100/40
	<b>ZOO-533</b>	Molecular Biology - II	4	4	60	100/40
	<b>ZOO-534</b>	Applied Parasitology – II	4	4	60	100/40
		Total Credit	28	28	420	700
Practical course						
Paper code	Practicals	Credits	Work Load hrs		Max./Min Mark	
			Per week	Per Term		
<b>ZOO-551</b>	Practical based on ZOO-511	2	4	60	50/20	
<b>ZOO-552</b>	Practical based on ZOO-512	2	4	60	50/20	
<b>ZOO-553</b>	Practical based on ZOO-513	2	4	60	50/20	
<b>ZOO-554</b>	Practical based on ZOO- 531	2	4	60	50/20	
<b>ZOO-555</b>	Practical based on ZOO-532	2	4	60	50/20	
<b>ZOO-556</b>	Practical based on ZOO-533	2	4	60	50/20	
<b>ZOO-557</b>	Practical based on ZOO-534	2	4	60	50/20	
<b>* ZOO- 561</b>	Project work	4	4	120	100/40	
	<b>Total Credit</b>	<b>18</b>	<b>32</b>	<b>540</b>	<b>450</b>	

\* ZOO-561 is a Project work. It shall start in 3<sup>rd</sup> semester after allocation of guide/supervisor and all students will submit it in 4<sup>th</sup> semester.

## Core Courses

### **Paper No. ZOO 511 Developmental Biology**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

#### **OBJECTIVE:**

1. To impart knowledge in evolving biological science with respect to Developmental biology.
2. To impart understanding of the fundamental process governing development of life.
3. To inculcate interest research in developmental biology and creating manpower for this region.

#### **Unit I.Gametogenesis, fertilization and early development:**

1. Production of gametes-
  - 1.1. Spermatogenesis in mammals, structure of sperm,
  - 1.2. Oogenesis in mammals, Structure of egg and types.
2. Cell surface molecules in sperm-egg recognition in animals;

#### **Unit II Zygote formation**

- 1.1.Capacitation
- 1.2.Prevention to polyspermy (Fast block and slow block)
- 1.3.Acrosome reaction
- 1.4.Activation of Egg metabolism
2. Cleavage and patterns of embryonic cleavage
3. Blastula formation and fate map of blastula
4. Gastrulation and formation of 3 germ layers in animals (Ex. Frog and Chick)

#### **Unit III Basic concepts of development:**

1. Potency,
2. Commitment,
3. Specification,
4. Induction,
5. Competence,
6. Determination and differentiation;
7. Morphogenetic gradients;
8. Cell fate and cell lineages;
9. Stem cells;
10. Genomic equivalence and the Cytoplasmic determinants;
11. Imprinting; mutants and transgenics in analysis of development.

#### **Unit IV Morphogenesis and organogenesis in animals:**

1. Cell aggregation and differentiation in *Dictyostelium*;
2. Axes and pattern formation in *Drosophila*,
  - 2.1. Segmentation genes,
  - 2.2. Homeotic genes
3. Amphibia and chick; organogenesis – vulva formation in *Caenorhabditis elegans*;
4. Axis formation in Amphibians
  - 4.1. Spemann's Organizer experiment(Primary embryonic induction)
  - 4.2. Functions of organizer
5. Nuclear transplantation experiments of Briggs and King and Gurdon in the frog.



6. Nuclear transplantation and cloning in mammals.
7. The concept of totipotency Embryonic stem cells
8. Eye lens induction, limb development and regeneration in vertebrates;
9. Differentiation of neurons,
10. Post embryonic development-
  - 10.1. Larval formation,
  - 10.2. Metamorphosis;
  - 10.3. Environmental regulation of normal development;
11. Sex determination.

**Unit V Programmed cell death, aging and senescence.**

1. Apoptosis
2. Senescence
3. Theories of aging-
  - 3.1. Programmed theories (ex. Programmed senescence theory, Telomeric theory,) and
  - 3.2. Error theories (ex. Free radical theory)

**Text books**

1. Developmental Biology by Gilbert Scott
2. Molecular biology of the cell By Albert et al
3. Molecular biology of the Gene by Watson et al
4. Principle of Development by Wolpert
5. Genes VIII/ IX By Benjamin Lewin
6. Developmental Biology by Balinsky
7. Developmental Biology by Berril
8. Developmental Biology by Waddington
9. Readings are also assigned from journals and from Internet resources such as Medline( [Http://www.ncbi.nlm.nih.gov/entrez/quey.fcgi](http://www.ncbi.nlm.nih.gov/entrez/quey.fcgi)) and bio Med Net ( <http://www.bmn.com/>) Wikipedia etc.

## **Paper No. ZOO-512**

### **Methods in Biology**

**Total no. of credits-** 4

**No. of periods per credit-** 16

**Total No. of periods** -60

**Evaluation:** External-80%, Internal-20%

**Course objective :**

1. To study the biochemical molecules and their interactions
2. To study the principle and functioning of instruments used for biological study

**Unit I Microscopic techniques:**

1. Visualization of cells and subcellular components by light microscopy,
2. Resolving powers of different microscopes,
3. Microscopy of living cells,
4. Scanning and transmission microscopes,
5. Different fixation and staining techniques for EM

**Unit II Histochemical and immunotechniques:**

1. Antibody generation,
2. Detection of molecules using ELISA, RIA,
3. Western blot,
4. Immunoprecipitation,
5. Flowcytometry and immunofluorescence microscopy, Detection of molecules in living cells,
6. *in situ* localization by techniques such as FISH and GISH.
7. Chromosome painting.

**Biophysical methods:**

1. Analysis of biomolecules using
  - 1.1. UV/visible,
  - 1.2. Fluorescence,
  - 1.3. Circular dichroism,
  - 1.4. NMR and
  - 1.5. ESR spectroscopy,
2. Structure determination using
  - 2.1. X-ray diffraction and
  - 2.2. NMR;

**Radiolabeling techniques:**

- 1.1. Properties of different types of radioisotopes normally used in biology,
- 1.2. Their detection and measurement
- 1.3. Incorporation of radioisotopes in biological tissues and cells,

**Unit III Recombinant DNA methods:**

1. Isolation and purification of RNA , DNA (genomic and plasmid) and proteins,
2. Different separation methods;
3. Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis,
4. Isoelectric focusing gels;
5. Molecular cloning of DNA or RNA fragments in eukaryotic systems;
6. Expression of recombinant proteins using bacterial, animal and plant vectors;
7. Isolation of specific nucleic acid sequences;
8. Generation of genomic and cDNA libraries in plasmid, phage, cosmid
9. In vitro mutagenesis and deletion techniques,
10. Gene knock out in eukaryotic organisms;

**Unit IV Molecular biology methods:**

1. DNA sequencing methods,
2. Protein sequencing methods,
3. Detection of post-translation modification of proteins;
4. RFLP,
5. RAPD and
6. AFLP techniques

**Unit V Electrophysiological methods:**

1. Single neuron recording,
2. Patch-clamp recording,
3. Brain activity recording,
4. Lesion and stimulation of brain,
5. Pharmacological testing,
6. PET,
7. MRI,
8. fMRI,
9. CAT

**Methods in field biology:** Methods of estimating population density of animals

**List of Books :**

1. Instrumentation and Techniques by Chatwal and Chatwal
2. Biophysical chemistry by Upadhyaya and Upadhyaya.
3. Principles of Biochemistry by Lehninger
4. Harper's Biochemistry.
5. Molecular biology of Gene. By Watson.
6. Molecular cell biology by Lodish.
7. Biochemistry by Voets and Voets
8. Hand book of molecular and cellular methods in biology by Leland J Cseke et al.

## **Paper No. ZOO 513 Applied Zoology**

**Total no. of credits- 4**

**No. of periods per credit- 16**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

### **Course objective :**

1. To study the applied aspects of zoology.
2. To study the principle and functioning of new technologies used in Zoology.

### **Unit I . Microbial fermentation and production of small and macro molecules.**

Application of immunological principles (vaccines, diagnostics).

Edible vaccines

Tissue and cell culture methods for plants and animals.

#### **Tissue engineering**

1. Principle
2. Objective
3. Method –
  - 3.1. Scaffold properties
  - 3.2. Scaffold guided tissue regeneration

### **Unit II Recombinant DNA technology;**

1. Plasmid, cosmid, artificial chromosomes as vectors,
2. DNA cloning and whole animal cloning (Principles and methods).
3. Animal Cloning.

#### **Stem cells:**

3. Sources and types
4. Induced pluripotent stem cells (iPSCs)
5. Use of stem cells in human welfare,

#### **Assisted reproductive technologies**

6. In vitro fertilization and embryo transfer,
7. ICSI
8. GIFT

### **Unit III Transgenics**

1. Transgenic animals-Methodology and applications.
2. Transgenic plants - Methodology and applications.
3. Health and ethical considerations for transgenic organisms.
4. Molecular approaches to diagnosis and Strain identification.

### **Unit IV Advanced Technologies**

1. Ribozyme display technology
2. Human genome project,
3. Genomics and Proteomics.
4. Its application in Health (Gene therapy) and Agriculture

### **Unit V Bioresources and uses of biodiversity.**

1. Biodiversity and food security
2. Biodiversity and pharmacy research
3. Breeding in plants and animals, including marker – assisted selection.
4. Bioremediation and phytoremediation.
5. Bio-nano technology- Principles and applications.
6. Biosensors and Biomimetics

**Books recommended**

1. Biomimicry By Dora Lee, Margot Thompson
2. Bionics by Judith Jango-Cohen
3. Biometrics by Yoseph Bar-Cohen.
4. Biometrics by Mehmet Sarikaya et al.
5. Design in Nature by C. Mattek.
6. Bionanotechnology :Lessons from Nature.by David S. Goodsell
7. Bionanotechnology : A revolution in food,biomedical and health sciences by Debashish Bagchi and others. John Wiley Publications.
8. Bioresources and Human environment by Reena Mehanka
9. Tissue engineering : Principles and practices by John P. Fisher et al.
10. Tissue engineering : From cell biology to artificial organs by Will W. Minuth.
11. Molecular biotechnology by Bernard R. Glick.
12. Technology, Transgenics and Practical Moral code by Dennis Cooley, Springerpublications.
13. Assisted Reproductive technology : Accomplishment and new Horizon edited by Christopher J De Jonge and Christopher L.R. Barret by Cambridge University Press.
14. Stem Cells by Eapen Cherian Jaypee brothers medical publishers.

**Elective papers**  
**Paper No. ZOO- 531**  
**Fishery Science-II**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

**Objectives**

1. To provide knowledge to the students about the recent trends and techniques of hybridization and induced breeding.
2. To study the role of endocrine glands and their role in reproductive fish biology.
3. To study processing, storage and preservation of pituitary gland in fishes.
4. To study the adaptations, migration, feeding etc. in fishes.
5. To study the lateral line system and its role in fishes.
6. To study the fish behavior and physiological aspects.

**Unit I**

Digestive system and physiology of digestion, Structure of Heart, Blood vascular and peripheral circulatory system.

Structure of kidney, ionic balance and osmoregulation and Physiology of excretion in fishes.

Reproductive system and physiology of reproduction, embryological development in fishes.

Respiratory organs, physiology of respiration, Swim bladder and Weberian ossicle ,

Central Nervous system [CNS] and cranial system, Structure of Eye and image formation in fishes,

**Unit II**

Coloration in fishes, physiology of coloration,

Types of migration, hill stream and deep sea adaptations,

Bioluminescence and physiology of light production in fishes.

Venom and venomous glands, electric organ in fishes.

**Unit III**

Food and feeding habits, Age and growth study, factors affecting growth.

Types of scales, fins, girdles in fishes,

Lateral line system and its role in fish life, sensory organs in fishes, parental care in fishes.

**Unit IV**

Structure and function Endocrine glands.

**Pituitary gland**, hormones of adenohypophysis and neurohypophysis, stainable and nonstainable fibers.

**Adrenal gland**, adrenocortico-steroids, corpuscles of stannius, adrenal medullary hormones, pituitary-adrenal axis

**Urohypophysis**, role of urotensin I and II

**Thyroid gland**. Thyroid hormone synthesis, thyrotrophic hormones and their functions,

**Pancreas**. pancreatic hormone, structure and their role in glucose metabolism, homeostasis

**Unit V**

Hormones and control mechanisms

General classification of hormones, principles, nature and functions of hormones, hormone receptors

Sex hormones, Types of sex steroids and their biosynthesis pathway.

Prolactin cells and its hormones, functions, role of prolactin in osmoregulation and melanogenesis

calcium regulation in fishes.

Gonadotropin releasing hormones [ GnRh], role of gonadotrophins , biochemical nature , hormonal control of reproductive behavior. role of sex hormones in sex differentiation,

**Text Books :**

1. Prosser & Brown- Comparative Physiology
2. Leninger- Principles of Biochemistry
3. Harper-. Physiological Chemistry
4. Pillay,T.V.R. & M.A. Dill.- Advances in Aquaculture. Fishing News (Books)Ltd., England, 1979.
5. Stickney, R.R. -Principles of Warm water Aquaculture. John Wiley & Sons Inc.,1979.
6. Boyd, C.E. -Water Quality Management for Pond Fish Culture. Elsevier Scientific Publishing Company, 1982.
7. Jhingran, V.G. -Fish and Fisheries of India. Hindustan Publishing Corporation India, 1982
8. Bardach, et. al. -Aquaculture – The Farming and Husbandry of Freshwater and Marine Organisms. John Wiley & Sons, NY, 1972.
8. Chondar, C.L. -Hypophysation of Indian major carps. Satish Book Enterprise,Agra, 1980.
9. Santhanam, R. et. al. -A Manual of Freshwater Aquaculture. Oxford & IBH Publishing Co. Pvt. Ltd., 1987.
10. Cheng, T.C. -The Biology of Animal Parasites. Saunders, Philadelphia, 1964.
11. Ribelin, W.E. & G. Miguki- The Pathology of Fishes. The Univ. of Wisconsin Press Ltd., Great Russel st., London, 1975.
12. Schaperclaus- Fish Diseases. Vol. I & II.
13. Douglas P Anderson - Text Book of Fish Immunology
14. Nandini Shetty- Immunology. Introductory Textbook.
15. Karunasagar, I. -Aquaculture and Biotechnology. Oxford-IBH Publishers, New Delhi,
17. Govindan, T.K. -Fish Processing Technology, Oxford-IBH, 1985.
18. Shang, Y.C. -Aquaculture Economic Analysis – An Introduction. 1990.
19. Nikolsky, G.V. -Ecology of Fishes. Academic Press, NY, 1963.
20. Howar, W.S. & D.J. Randal- Fish Physiology, Vols. 1–4, Academic Press, NY,1970.
22. Carl, B.E. Biology of Fishes- Saunders, 1979.
23. Turnor- Textbook of endocrinology
24. Day, F. -The fishes of India.

**Paper No. ZOO- 532**  
**Animal Physiology – II (Vertebrate Physiology)**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

**Objectives**

The course includes the basic mechanisms involved in the various physiological processes studied in animal, veterinary and medical sciences.

**Unit – I**

1. Colloidal properties of cell; the cell as a polyphasic colloidal system.
2. Active transport, principles and mechanisms involved in transport (a) Endocytosis-Pinocytosis, Phagocytosis, phagotrophy and autophagy (b) Exocytosis

**Unit - II**

1. Cell growth: Measurement of cell growth and regulations of growth; cell growth in tumors.
2. Bioluminescent organs in different vertebrates. Physical properties of bioluminescence; chemistry of light production and functional significance of bioluminescence.

**Unit – III**

1. Structure of myofibrils; protein molecules in myofibrils; mechanism of muscle contraction, force and shortening velocity, role of calcium in cross bridge attachment.
2. Nerve cell and their classification; how resting potential is maintained; origin and development of action potential; synapses and theories of synaptic transmission.

**Unit – IV**

1. Osmotic balance and ionic regulation in different vertebrates; role of hormones in osmoregulation
2. Nitrogenous excretory products: their detoxification, formation of ammonia, ornithine cycle, Ammonia toxicity and detoxification. Role of aldosterone, ADH hormone and rennin-angiotensin system in renal physiology.
3. Physiology of respiration: Structure of organs of respiration in air and water. Respiratory pigments and Chemistry of oxygen transport. Factors affecting respiration, Role of thyroid hormones in basal metabolic rate.

**Unit – V**

1. Sex determination and differentiation and differentiation of gonads in mammals.
2. Leydig's cells, morphology, differentiation and its regulation.
3. Spermatogenesis, Composition and formation of semen.
4. Ovarian follicular growth and differentiation. Oogenesis, vitellogenesis, ovulation and ovum transport in mammals.
5. Hormonal mechanisms of implantation, pregnancy, parturition and lactation in mammals.

**Books Recommended:-**

1. Eckert N Animal physiology by David Randall
2. Comparative Animal Physiology by Prosser C.L.
3. General and Comparative Physiology by– Florey W.A
4. General and Comparative Physiology by Hoar W.B.
5. Animal Physiology by Neilsen K.S.
6. Cell Physiology by Giese A.C.
7. General Physiology by Giese A.C.
8. A text Book of Biochemistry by West E.S. and Todd W.R.
9. Cell Biology by Ambrose and Fastly



10. Principle of Animal Physiology by Wilson J.A.
11. Animal Physiology by Gordon G.S.
12. Modern Physiology– by Strang F.L.
13. Comparative Physiology of Animals by Hill R.W.
14. Medical Physiology by Guyton
- 15: General Endocrinology C. D. Turner
16. Endocrinology. Hadley , M. E. Pearson education ( Singapore )

## **Paper No. ZOO-533**

### **Molecular Biology II**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External-80%, Internal-20%**

#### **COURSE OBJECTIVE:**

1. To impart knowledge in evolving biological science at molecular level.
2. To impart understanding of the fundamental process governing life and information flow
3. To inculcate interest in research molecular biology and creating human capacity for this region.

#### **Unit I**

1. Gene and heredity , concept of heredity, DNA as the Genetic material; Transformation Experiment, DNA as a transforming Principle Avery , Mcleod and Mc Carty Experiment), Blender Experiment ( Hershey and Chase Experiment). RNA as genetic material in some viruses, Property of genetic materials

#### **Unit II**

**Chromatin:**Structure , Genetic code , Genome evolution

**DNA damage and repair:** DNA damages, Different DNA repair systems:

Nucleotide excision repair, Base excision repair, mismatch repair, recombination repair, Double strand break repair, transcriptional coupled repair, Photo sensitive repair, SOS response

#### **Unit III**

**Recombination:**

Homologous and site specific recombination, Models for homologous recombination: The Holliday model, ,Proteins involved in recombination: RecA, RuvA,B,C, Site specific recombination Gene conversion

#### **Unit IV**

**Mobile DNA elements:**

**Discovery of transposons,** Transposable elements in bacteria, IS elements, Composite transposons, **Process of transposition** replicative, non-replicative transposons, Mu transposition, Controlling elements in Tn A and Tn 10 transposition, SINES and LINES. Retroviruses and retrotransposon

#### **Unit V**

**Genome organization:** C value paradox and genome size, Cot curves, repetitive and nonrepetitive

DNA sequence, Cot  $\frac{1}{2}$  and Rot  $\frac{1}{2}$  values, Pseudogenes ,Gene families, Gene clusters, Super-families.

#### **Reference books:**

1. Molecular Biology of the Gene, 5th Edition (2004), James D. Watson, Tania Baker,

- Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Publisher - Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.
2. Molecular Biology, 4th Edition (2007), Weaver R., Publisher-McGraw Hill Science.
  3. Molecular Biology of the Cell, 4th Edition (2004), Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D. Publisher: Garland Publishing.
  4. Essential Cell Biology, 2nd Edition (2003) Bruce Albert, Dennis Bray, Karen Hopkin, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Publisher: Garland Publishing.
  5. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Publisher: Oxford University Press
  7. Genes X, (2010), Benjamin Lewin, Publishers - Jones and Barlett Inc.
  8. Molecular biology-De robertis and De robertis
  9. Genetics –Strickberger

**Paper No. ZOO- 534**  
**Applied Parasitology- II**

**Total no. of credits- 4**

**No. of periods per credit- 15**

**Total No. of periods -60**

**Evaluation: External 80%, Internal 20%**

**Course objectives:**

1. The basic and general concepts of Parasitology.
2. The major types of parasites of medical & veterinary importance.
3. Basics of identification of common parasites of humans and animals.
4. To design and evaluate an intervention to control food and waterborne diseases.
5. Critically read and evaluate epidemiologic studies in the different disease.
6. Critically read and evaluate epidemiologic studies in emerging disease and bioterrorism literature.
7. To prepare the experts in the field of Medical and veterinary Parasitology.

**UNIT I**

1. Parasite and global public health.
2. Global burden of infectious diseases.
3. Biology, epidemiology and control of waterborne and food borne parasites
4. Ecological changes & emerging diseases.
5. General pattern of parasitic transmission.
6. Parasitic zoonosis.
7. Bioterrorism threats

**UNIT II**

1. Introduction to Immunology of Parasitic infections.
2. Natural & acquired immunity.
3. Host Specificity.
4. Factors affecting cellular & humoral immune responses.
5. Immunopathological consequences of parasitic infections.
6. Immunity against external and internal parasites.
7. General principles of immunization and Hypersensitivity reactions.
8. Strategies in designing parasitic vaccines.
9. Limitations in preparation of vaccines against parasites.
10. Immunodiagnosis.

**UNIT III**

1. Parasitism in phylum Apicomplexa
  - a. Special features of Apicomplexa
  - b. Life cycle and pathogenicity of malarial parasites and control of malaria.
  - c. Study of coccidian parasites in vertebrates.
  - d. Study of class Piroplasma to special reference to *Theileria* and *Babesia*.

**UNIT-IV**

- A. Study of medically and veterinary important Parasitic Nematodes.**
  - a. Intestinal nematodes infective in egg stage.

- b. Intestinal nematodes infective in larval stage.
- c. Blood & tissue dwelling nematodes.

#### **UNIT-V**

Morphology life history, diseases/ harm caused and the control of following-

- a) Parasitic Acanthocephala and Annelida (Any one example each)
- b) Parasitic Siphonoptera, Anupleura, Mallophaga
- c) Parasitic Diptera
- d) Parasitic Hemiptera and Pentastomidea
- e) Parasitic Crustacean and Acarids (any one example).

#### **List of books:**

1. Infectious Disease Epidemiology: theory and practice. 2<sup>nd</sup> edition. Nelson & Williams (Eds.). 2007.
2. A good additional online text: Global Burden of Disease and Risk Factors. Disease Control Priorities Project. It is available at: <http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=gbd.TOC&depth=2>
3. Medical Parasitology by Markell, Voge and John, 8<sup>th</sup> ed. W.B. Saunders Co.
4. Reingold, A.L. Outbreak Investigations : A Perspective. Emerging Infectious Diseases 1998; 4(1): 21-27.
5. Jones, K.E., Patel, N.G., Levy, M.A., Storeygard, A., Balk, D., Gittleman, J.L. and P. Daszak. Global trends in emerging infectious diseases. Nature 2008; 451(21): 990-993.

#### **Reference Books**

1. Text book of medical parasitology - Sawitz
2. Parasitology - Nobel and Nobel
3. An introduction to nematodology - Chitwood
4. Biology of nematode - Crool
5. Plant parasitic nematode - Parmonove
6. Principal of nematodology - Throne
7. Plant nematodology - Jenkin and Taylor
8. Clinical parasitology - Craig Faust
9. Applied parasitology - Hiware, Jadhav and Mohekar
10. Biochemistry of parasitisms - Von Brand
11. Physiology of cestode parasitology - Smith
12. Physiology of nematode parasite - Smith
13. Helminth, Arthropod and Protozoa of domesticated animal -Solbsy E.J.W
14. Laboratory methods of work with plant and soil nematodes -Southey
15. Soil and fresh water Nematodes - Goodey.
16. Chatterjee K. D. (1969) -Parasitology (Protozoology and Helminthology)
17. Cheng T.C. (1964)-The Biology of animal parasites, Saunders International Student Edition.
18. The Invertebrates Vol II, McGraw Hill, New York.- Dawes B. (1946).
19. Text book Medical Parasitology of Jaypee Brothers, - Panikar C.K.J (1988) Medical Publishers, New York.
20. The Parasitology of Trematodes Oliver and Boyd Ltd. Edinburgh - Smyth J.D (1977)
21. Systema helminthum Vol. IV Monogenea and Aspidobothria - Yamaguti S. (1963) Inter- Science Publishers, London.

22. The advances in the Zoology of tapeworm from - 1970- Wardle and Mcleod
23. Systema Helmentum Vol. II Cestoda - Satyu Yamaguti (1959)
24. The Physiology of Cestodes. - J.D Smyth
25. Plant Parasitic Nematodes, bionomics & control - Cristie
26. Parasitic Protozoa - Baker
27. Clinical Parasitology - Beaver, Jung & Cupp
28. An Introduction to Parasitology - Chandler and Read
29. An Introduction to Protozoology - Dogiel
30. Protozoology - Hall
31. Protozoology - Kudo
32. Essential Parasitology -Scmidt
33. Animal Parasitism - Read
34. Bio- Chemistry and physiology of protozoa -Hutner and Lwoff II Ed. Vols I and II
35. Prozoan Parasites of domestic animals and man - Levine
36. Structure of Nematodes - Bird

**Practical Paper No. ZOO-551 Practicals based on ZOO 511( Developmental Biology)**

1. Whole mount of different types of Sperms
2. Study of sperm count by Neubauer's Chamber.
3. Types of eggs and cleavage patterns
4. Study of morphogenetic movements during development
5. Stages of development in frog.
6. Studies of whole mount of chick development : 16, 18, 24, 33, 36, 48, 72, 98 hours
7. Developmental stages of pond snail, *Lymnaea*
8. Mounting of chick embryo and determination of its age.
9. Studies of cell death in Chick embryo
10. Regeneration in *Planaria/ Hydra*

**Practical Paper No. ZOO-552 Practicals based on ZOO-512 (Methods in Biology)**

1. Cell fractionation.
2. Detection of protein by ELISA.
3. Separation of amino acids by paper chromatography.
4. Determination of isoelectric pH of Casein
5. Working principle of : Colorimeter, Spectrophotometer, Centrifuge machines, Electrophoresis, Column chromatography etc.
6. Isolation and purification of Plasmid DNA from bacteria.
7. Measurement of Cell diameters
8. Histochemical staining of Glycogen/Lipids.
9. Protein estimation by UV Spectrophotometer.
10. Study of ECG and its characters.
11. Study of working principle and Amplification of DNA using PCR.

**Practical Paper No. ZOO-553 Practicals based on ZOO - 513 (Applied Zoology)**

1. Embryonic stem cell culture.
2. Study of working principle of Glucometer and its use in glucose estimation.
3. Field visit to an Animal Husbandry centre.
4. Haemoagglutination reaction.
5. Karyotype preparation from WBC.
6. Isolation of plasmid DNA
7. Cell culture by hanging drop method.
8. Visit to NCCS, NCL, NIV, NARI Pune.

**Practical Paper No. ZOO-554 : Practicals based on ZOO-531 (Fishery science II)**

1. Quantitative determination of glycogen, proteins and fats
2. Dissections (Any bony fish)- Digestive, reproductive, Brain, Pituitary gland and Cranial nerves.
3. Methods of food analysis with different feeding habits
4. Study of different maturity stages and fecundity in fishes
5. Determination of growth in fish by scale or otolith method
6. Determination of GSI&PI
7. Histological preparation different glands and tissues.
8. Visiting CIFE, CIFA, FSI and CIFT etc.,
9. Fieldwork : Visit to fish production unit

**Practical Paper No. ZOO-555 Practicals based on ZOO-532( Animal physiology- II)**

1. Denaturation and coagulation of egg albumen.
2. Isoelectric point of casein.
3. Effect of temperature on heart beat of fish, Q10 measurement.
4. Effect of drugs on respiration of fish.
6. Estimation of chloride from urine of cow.
8. Estimation of uric acid from rectum / blood of lizard / birds.
9. Determination of clotting time of blood.
10. Differential count of WBC from blood of human
11. Effect of drugs on rate of heart beat
12. Demonstration of Adrenalectomy and ovariectomy in rat.

**Practical Paper No. ZOO-556 Practicals based on ZOO-533 (Molecular biology II)**

1. Transformation of DNA in Bacteria
2. Gene expression by Gal- X
3. Detection/ Determination of Auxotroph mutants
4. Chromatin digestion with Micrococcal nuclease
5. Isolation of DNA from animal/plant/bacterial cells by using kits
6. Restriction digestion of DNA using nucleases.
7. DNA amplification using PCR
8. Molecular weight determination using Column Chromatography and PAGE.
9. Isolation of plasmids from bacteria

**Practical Paper No. ZOO-557 Practicals based on ZOO-534 (Applied Parasitology II)**

1. Study of prevalence & intensity of parasites from locally available hosts.
2. Demonstrate / study the effect of season/ phonological factors as the prevalence and intensity of parasites.
3. Separation of immunological protein (alpha, beta and gamma) by paper or gel electrophoresis.
4. Estimation of antigen and antibodies in samples by quantitative precipitation assay.
5. Examination of faecal sample of sheep, goat and chicken.
6. Histopathology of Caeca of chicken to study different stages of schizonts.
7. To collect coccidian oocysts of sheep, goats and chicken by centrifugation method.
8. Techniques for collection, Fixation, preservation, staining and identification of different nematodes from different/ various hosts.
9. Examination of faecal sample for different helminthes ova and their identification.
10. Collection, preservation and identification of veterinary & medically important Annelids, Acanthocephalans and arthropods.
11. Study of different types of mouth parts of vectors.
12. Visit to veterinary & medical Parasitology /Pathology laboratory and study of food and waterborne parasites.
13. Submission of permanent slides at the time of examination.

**ZOO-561 Project work started in IIIrd sem to be completed in IV th sem**