

**Learning Outcome based Curriculum Framework (LOCF)**

**For**

**Choice Based Credit System (CBCS)**

**Syllabus**

**B.Sc. (Program) in Zoology**

**w.e.f. Academic Session 2020-21**



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## Preamble

In the evolving biological paradigm in modern times; subject Zoology is important to understand living beings at morphological, cellular, molecular, interactive and evolutionary levels. The syllabus has been customized to understand inner working of living beings by comparing various systems within invertebrates and vertebrates i.e., from a single cell protozoan to multicellular humans, and to develop a comprehensive understanding and appreciation of the differences through ICT tools and well-designed hands-on practical exposures along with the field work. Apart from this, syllabus on Zoology will enhance quality of critical thinking, analytical and scientific reasoning, reflective thinking, information and digital literacy, and problem-solving capacity of students.

## SCHEME OF SYLLABUS

*(As per Learning Outcomes-based Curriculum Framework)*

SEMESTER	Core Course (4 in ZOOLOGY)	Ability Enhancement Courses AEC (2)	Skill Enhancement Courses SEC (4)	Discipline Specific Elective DSE (4)
I	CC Zoology-1(1) (Systematics and Diversity of Life- Protists to Chordates)	Environmental Science		
II	CC Zoology-1(2) (Comparative Anatomy & Physiology of Nonchordates)	English Communication		
III	CC Zoology-1(3) (Fundamentals of Comparative Anatomy & Physiology of Chordates)		SEC-1 Essentials of Bee keeping	
IV	CC Zoology-1(4) (Cyto-genetics, Biochemistry, Immunology, Evolutionary Biology)		SEC-2 Essentials of Sericulture	
V			SEC-3 Public Health and Hygiene	DSEC-1(1) Fundamentals of Genetic Engineering and Biotechnology/ DSEC-1(1) Basics of Livestock Management and Animal Husbandry
VI			SEC-4 Insect Pest, Vector Biology and Management	DSEC-1(2) Introduction to Wild Life Conservation and Management DSEC-1(2) Physiology of mammals

<b>ASSIGNMENTS OF DIFFERENT SEMESTERS</b>							
Semester	COURSE DETAILS	PPT PRESTN.	PROJECT REPORT	FIELD REPORT	EXCURSION	LAB/FARM VISIT	ALBUM/VIDEO DOCUMENTARY
I	CC-1(1)	√		√	√		√ (Album)
II	CC-1(2)	√					√ (Video)
III	CC-1(3)	√	√				
	SEC-1						
IV	CC-1(4)	√					
	SEC-2						
V	DSEC-1(1)	√					
	DSEC-1(1)	√					
	SEC-3						
VI	DSEC-1(2)	√		√	√		
	DSEC-1(2)	√					
	SEC-4						

### **Guidelines for Individual/ Team Projects and Field Reports**

The aim of the individual/ team project/s is to develop an aptitude for research in Zoology and to inculcate proficiency to identify appropriate research topic and presentation. The topics of biological interest and significance can be selected for the project. Project is to be done by a group not exceeding 5 students. The project report should be submitted on typed A4 paper, 12 Font, 1.5 Space in spirally bound form and duly attested by the supervising teacher and the Head of the Department on the day of practical examination before a board of two Examiners for End Semester. The viva-voce based on the project is conducted individually. Project topic once chosen shall not be repeated by any later batches of students. The project report may have the following sections: 1. Preliminary (Title page, declaration, certificate of the supervising teacher, content etc.) 2. Introduction with relevant literature review and objective 3. Materials and Methods 4. Result 5. Discussion 6. Conclusion / Summary 7. References.

### **Field Study/ Study tour**

Students have to visit one research institute and one wild life sanctuary / museum / zoo. Scientifically prepared hand-written study tour report along with photographs of candidate at the places of visit must be submitted by each student for End Semester on the day of the examination of project.

### **Video presentation**

Students have to develop a short film (2-5 min duration) based on relevant animal/topic given solely by themselves along with voice command/floating comments. It will help them to be competent in video documentation of a matter also a career prospect too.

# C O N T E N T S

Sl. No.	Seme sters	COURSE DETAILS	COURSE CODE	COURSE NAME	Th/ Pr	Page No.
1.	I	CC-1(1)	BSCPZOOC101	SYSTEMATICS & DIVERSITY OF LIFE : PROTISTS TO CHORDATES	TH	5
2.					PR	6
3.	II	CC-1(2)	BSCPZOOC201	COMPARATIVE ANATOMY & PHYSIOLOGY OF NONCHORDATES	TH	8
4.					PR	9
5.	III	CC-1(3)	BSCPZOOC301	FUNDAMENTALS OF COMPARATIVE ANATOMY & PHYSIOLOGY OF CHORDATES	TH	11
6.					PR	12
7.		SEC-1	BSCPZOOSE301	ESSENTIALS OF BEEKEEPING	TH	14
8.	IV	CC-1(4)	BSCPZOOC401	CYTO-GENETICS, BIOCHEMISTRY, IMMUNOLOGY, EVOLUTIONARY BIOLOGY	TH	16
9.					PR	17
10.		SEC-2	BSCPZOOSE401	ESSENTIALS OF SERICULTURE	TH	18
11.	V	DSEC-1(1)	BSCPZOODSE501	FUNDAMENTALS OF GENETIC ENGINEERING & BIOTECHNOLOGY	TH	20
12.					PR	21
13.		DSEC-1(1)	BSCPZOODSE502	BASICS OF LIVESTOCK MANAGEMENT & ANIMAL HUSBANDRY	TH	22
14.					PR	23
15.		SEC-3	BSCPZOOSE501	PUBLIC HEALTH AND HYGIENE	TH	24
16.	VI	DSEC-1(2)	BSCPZOODSE601	INTRODUCTION TO WILDLIFE CONSERVATION AND MANAGEMENT	TH	26
17.					PR	27
18.		DSEC-1(2)	BSCPZOODSE602	PHYSIOLOGY OF MAMMALS	TH	29
19.					PR	30
20.		SEC-4	BSCPZOOSE601	INSECT PEST, VECTOR BIOLOGY AND MANAGEMENT	TH	31

# SEMESTER – I (PROGRAM)

**Course Name: Systematics & Diversity of Life - Protists to Chordates**  
**Course Code: BSCPZOOOC101**

Course Type: Core (Theoretical & Practical)	Course Details: CC-1(1)			L-T-P: 4-0-4	
Credit: 6	Full Marks: <b>100</b>	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		<b>30</b>	<b>10</b>	<b>20</b>	<b>40</b>

**About the course :**

The course is a walk for the Bachelor's entrant through the amazing diversity of living forms from simple to complex one. It enlightens how each group of organisms arose and how did they establish themselves in the environment with their special characteristics. It also deals with the differences and similarities between organisms on the basis of their morphology and anatomy which led to their grouping into taxa and clades.

**Learning outcomes :**

*After successfully completing this course, the students will be able to :*

- Develop understanding on the diversity of life with regard to protists, non chordates and chordates.
- Group animals on the basis of their morphological characteristics/ structures.
- Develop critical understanding how animals changed from a primitive cell to a collection of simple cells to form a complex body plan.
- Examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic/ cladistics tree.
- Understand how morphological change due to change in environment helps drive evolution over a long period of time.
- The project assignment will also give them a flavour of research to find the process involved in studying biodiversity and taxonomy besides improving their writing skills. It will further enable the students to think and interpret individually due to different animal species chosen.

## **THEORY**

**Unit I: Principles and practice of taxonomy**

**(13 Lectures)**

1. Basic idea of Systematics and taxonomy.
2. Binomial Nomenclature and utility of scientific names.
3. Classification: morphological and evolutionary (molecular): Artificial, Natural and phylogenetic concept.
4. Relationship of taxa: phylogenetics and cladistics with special reference to paraphyly, monophyly, apomorphy, plesiomorphy and phenoplasticity.

**Unit II: Diversity in Protists and acelomate Metazoa**

**(13 Lectures)**

1. Structure and diversity in Protists (classification up to Phylum).
2. Origin of Metazoans: diploblastic and triploblastic organization; symmetries; body cavities; protostomes and deuterostomes.
3. Porifera: Characters and classification of up to classes).
4. Cnidarians: Special features; polymorphism and division of labour; coral reef forming cnidarians, types & significance, classification up to classes.
5. Basic characteristics, classification of Platyhelminthes up to classes.

**UNIT III: Diversity in pseudocoelomate and coelomate Non chordates**

(13 Lectures)

1. Classification of Nematoda up to classes.
2. Classification of Arthropoda up to classes.
3. Basic organization and diversity (classification up to classes) in Annelids.
4. Basic organization and diversity (classification up to classes) in Molluscs.
5. Basic organization and classification (up to classes) of Echinoderms; their affinity to Chordates.

**Note:** Classification to be followed from Ruppert and Barnes Invertebrate Zoology VI edition, except for Protozoa (American Association of Protozoologist ref: Levine 1980) and Porifera (Brusca and Brusca 2002; IV edition. Invertebrate Zoology)

**UNIT IV: Diversity in Protostomes and Chordates**

(13 Lectures)

1. Chordates– Primitive Chordates and their affinities.
2. Characters and affinities of Hemichordates, Urochordates and Cephalochordates.
3. Advent of vertebrates: Cyclostomes, their evolutionary status and affinities.
4. Basic organization and diversity (classification up to sub-classes) of fishes, their evolutionary transitions from Water to Land invasion- Early Tetrapodes.
5. Amphibians diversity (classification up to living orders) and adaptability to dual mode of life.
6. Classification of reptiles up to living orders ; the avian ancestors.
7. Birds : classification up to sub-class, Adaptation from terrestrial to aerial mode of life.
8. Characteristics and classification of mammalian groups (up to orders) with special reference to primates.

**Note:** Classification from Young, J. Z. (1981) to be followed except for classification fishes. For Pisces classification scheme to be followed from Nelson, J. S. (2006).

**PRACTICAL**

1. **Study** of animals through slides and museum specimens/photographs in the laboratory with their classification, biogeography and diagnostic features (**record book**). Animals to be included for the study are as follows:

a. Non-chordates :	b. Chordates :
i. <b>Protista:</b> Euglena, Amoeba, Paramecium.	i. <b>Protochordata:</b> Balanoglossus, Branchiostoma, Ascidia.
ii. <b>Porifera:</b> Euspongia, Scypha.	ii. <b>Fishes:</b> Scoliodon, Torpedo, Mystus vitattatus, Catla, Exocoetus, Hippocampus,
iii. <b>Cnidaria:</b> Obelia, Physalia, Porpita, Aurelia, Tubipora, Sea Anemone, Pennatula, Fungia.	iii. <b>Amphibia:</b> Ichthyophis, Necturus, Bufo, Rachophorous
iv. <b>Platyhelminthes:</b> Fasciola hepatica, Taenia solium.	iv. <b>Reptiles:</b> Chelone, Calotes, Chamaeleon, Draco, Bungarus, Vipera, Naja.
v. <b>Nematoda:</b> Ascaris.	v. <b>Birds:</b> Psittacula, Pycnonotus.
vi. <b>Annelida:</b> Aphrodite, Sabella, Chaetopterus, Pheretima.	vi. <b>Mammals:</b> Sorex, Pteropus, Funambulus.
vii. <b>Arthropoda:</b> Carcinoscorpius, Macrobrachium, Balanus, Julius, Periplaneta, Peripatus.	
viii. <b>Mollusca:</b> Chiton, Pila, Pinctada, Sepia.	
ix. <b>Echinodermata:</b> Astropecten, Cucumaria and Antedon.	

2. **Excursion:** Study of animals in nature during a survey of a National Park or Forest area or any local biodiversity rich area.
3. **Collection** of five species or presentation through photographic plates (preferably invertebrates, insects) belonging to a clade. A project report to be submitted based on their generic identification,

description and illustration with a note on their locality. Also, the assessment of their relationship by constructing a cladogram using characters and character states.

4. **Comparison** of two species of birds belonging to same genus (Interspecific difference).
5. **Comparison and weighting** of characters of two birds belonging to same family but dissimilar genera.
6. **Group discussion or Seminar presentation** on following topics:

<b>Pool of Topics for Group discussion or Seminar presentation :</b>			
1. Tree of Life. 2. Polymorphism. 3. Freshwater sponges. 4. Parasitic adaptations.	5. Molecular systematics vs Traditional taxonomy. 6. Phenoplasticity and its relevance. 7. Reliability of taxonomic characters.	8. Coral reefs and their role in ecosystem generation. 9. Molluscs of industrial value. 10. Molecular system of classification.	

#### **Format for conducting CA and ESE practical examination :**

<b>CA (30 marks)</b>	<b>ESE (20 marks)</b>
<ol style="list-style-type: none"> <li>1. Assessment based on practical topics (class test)-<b>10</b></li> <li>2. PPT/Poster preparation, presentation and write up submission-<b>3+4+3=10</b></li> <li>3. Attendance and Participation in class-<b>5</b></li> <li>4. Practical skills, laboratory reports, etc-<b>5</b></li> </ol>	<ol style="list-style-type: none"> <li>1. Identification - 4 items (2 non-chordate, 2 chordate)- [Sc. Name, systematic position (3 taxa), generic characters, habit &amp; habitat, <math>0.5+0.5+1+0.5=2.5</math> (<b>2.5x4=10</b>)]</li> <li>2. Cladogram construction based on provided data (Item no 3) -<b>3</b></li> <li>3. Field Report (Item no 2) -<b>3</b></li> <li>3. LNB (Laboratory Note Book) -<b>2</b></li> <li>4. Viva -<b>2</b></li> </ol>

#### **NOTE :**

- *CA can be done multiple times even by more than one teacher. An average will be taken for marks capturing.*
- *Study of specimen should include-Scientific name, common name, Taxa as per theory syllabus, Habit (Nutritional, ecological, Reproductive, special habit if any) and Habitat (Distribution, endemic / cosmopolitan/sporadic, climatic type), Conservation status (if available), Generic character only, economic importance (if any).*
- *LNB should be prepared (item 1 & 3) in inter-leaf practical note book with date & Teacher's sign.*
- *Album should be prepared on item 4 & 5.*
- *Project report (Presentation mandatory), Field report, Write-up, etc to be prepared separately.*
- *A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.*

#### **Recommended readings :**

1. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VII Edition. Thompson Brooks Cole (International Edition)
2. Barnes, R.S.K., Callow, P., Olive, P. J. W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition.
4. Young, J. Z. (1981). The Life of Vertebrates. III Edition. Oxford university press.
5. Pough H. Vertebrate life, VIII Edition, Pearson International.
6. Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.
7. Hall B.K. and Hallgrímsson B. (2008), Strickberger's Evolution. 4<sup>th</sup> Edition. Jones and Bartlett Publishers Inc.
8. Nelson, J. S. (2006). Fishes of the World, Wiley.
9. Lomolino, M. V. et al (2010) Biogeography, 4<sup>th</sup> Edition, Sinauer Associates.
10. Verma, A (2017) Principles of animal taxonomy, 1<sup>st</sup> Ed, Narosa.

## SEMESTER – II (PROGRAM)

**Course Name: Comparative Anatomy & Physiology of Nonchordates**  
**Course Code: BSCPZOO201**

<b>Course Type: Core (Theoretical &amp; Practical)</b>		<b>Course Details: CC-1(2)</b>			<b>L-T-P: 4-0-4</b>	
<b>Credit: 6</b>		<b>CA Marks</b>			<b>ESE Marks</b>	
		<b>Full Marks:</b>	<b>Practical</b>	<b>Theoretical</b>	<b>Practical</b>	<b>Theoretical</b>
		<b>100</b>	<b>30</b>	<b>10</b>	<b>20</b>	<b>40</b>

**About the course :**

The course makes a detailed comparison of the anatomy of the different taxa of non-chordates. It also highlights how in the taxonomic hierarchy, there is an increase in the complexity of structure and function. The course thus gives an overview of the intricate life processes and adaptive radiations in nonchordates.

**Learning outcomes :**

*After successfully completing this course, the students will be able to :*

- Develop an understanding of the characters used to classify besides being able to differentiate the organisms belonging to different taxa.
- Acquire knowledge of the coordinated functioning of complex human body machine. Have hands on experience of materials demonstrating the diversity of protists and non-chordates.
- Understand the relative position of individual organs and associated structures through dissection of the invertebrate representatives.
- Realize that very similar physiological mechanisms are used in very diverse organisms.
- Get a flavor of research by working on project besides improving their writing skills. It will further enable the students to think and interpret individually.
- Undertake research in any aspect of animal physiology in future.

## **THEORY**

- UNIT I: Diversity of Tegument and Digestive system** **(13 Lectures)**
1. Coelom development and diversity.
  2. Cell membrane in protists.
  3. Tegument in non-chordates (Helminthes, Annelida, Arthropoda, Echinodermata).
  4. Nutrition and feeding modes in protists.
  5. Evolutionary changes in digestive system, feeding mechanism (from food vacuoles to complex digestive organs) in major phyla of non-chordates.

**UNIT II: Diversity of Locomotory, Respiratory, Circulatory and Excretory systems** **(13 Lectures)**

1. Diversity of locomotory organs in protists and non-chordates [Cilia & Flagella, Pseudopodia, tentacle, seta, parapodia, wing, tube feet].
2. Modes of locomotion [swimming, looping, gliding, creeping, flying, etc].
3. Structure and diversity of skeletal elements in protists and major non-chordate phyla (Spicule, Spongin, Coral, Exoskeleton, Shell, ossicle/pedicellariae).
4. Diversity of respiratory organs (skin, trachea, gill, book lung, book gill, ctenidia, pulmonary sac, papillae, etc),
5. Modes of respiration and Respiratory pigments in major non-chordate phyla.

6. Circulation and the diversity of circulatory system in major non-chordate phyla
7. Excretion (protists): endocytosis, exocytosis.
8. Excretion and diversity of excretory organs in major non-chordate phyla.

**UNIT III: Diversity of Nervous and Reproductive systems****(13 Lectures)**

1. Nervous system with special reference to diversity in brain and nerve chord in major non-chordate phyla.
2. Neuroendocrine systems, pheromones in different classes of arthropods.
3. Sense organs: mechanoreceptors: photoreceptors, chemoreceptors, thigmoreceptors, rheoreceptors and proprioceptors in major non-chordate phyla.
4. Diversity of the reproductive organs and accessory sex organs (in different classes of annelids and arthropods).
5. Modes of reproduction- asexual and sexual reproduction in major non-chordate phyla
6. Metamorphosis: Types, hormonal role and significance.
7. Diversity of larval forms in non-chordates (*Trochophore, Zoa, Veliger, Bipinnaria, Brachiolaria*).

**UNIT IV: Evolution and characteristics of important Non Chordate taxa****(13 Lectures)**

1. Affinities of living fossils: *Limulus* and *Peripatus*.
2. Evolution of Parasitism, Parasitic adaptations and life cycle patterns in parasites belonging to different taxa- A generalized study
3. Invertebrate model organisms (*Planaria, Ascaris, Pheretima, Palaemon, Pila, Asterias*) and their importance.
4. Types of canal systems in sponges and their significance.
5. Torsion and detorsion in *Mollusca*.
6. Components and functions of water vascular system in echinoderms.

**PRACTICAL**

1. Study of **slides or models or photographs** of specimens of
  - i. Protozoans of agricultural importance (*Bodo, Naegleria, Hyalosphenia, Oxytricha, Vampyrella*).
  - ii. Coral-reef forming Cnidarians (*Gorgonia, Fungia, Tubipora, Heliopora, Alcyonium*)
  - iii. Plant parasitic nematodes (*Meloidogyne, Radopholus*)
  - iv. Nematodes used as models in experimental biological research-*Caenorhabditis elegans*
2. Dissection of ***Periplaneta*** to expose- (a) Digestive, (b) Nervous and (c) Reproductive system.
3. Dissection of ***Palaemon*** to expose- Appendages and Statocyst (mount).
4. Dissection of ***Pila*** to expose the Digestive system and mount Radula.
5. Study of **larval forms**: *Ephyra, Planula, Trochophore, Zoa, Metazoea, Veliger, Bipinnaria, Echinopluteus*.
6. Some **videos to develop** understanding on the animals of different taxa.
7. Group discussion or **Seminar presentation** (Given Below):

**Pool of Topics for Group discussion or Seminar presentation :**

1. Tree of Life.	7. Living fossils.
2. Connecting links	8. Polymorphism.
3. Parthenogenesis in animals.	9. Water regulation in marine animals
4. Helminth infection in human.	10. Parasitic adaptations.
5. Zoonotic diseases	11. Evolution of terrestrial animals.
6. Locomotory organs in non-chordates	12. Respiratory organs in non-chordates

### **Format for conducting CA and ESE practical examination :**

<b>CA (30 marks)</b>	<b>ESE (20 marks)</b>
1. Assessment based on practical topics (class test)- <b>10</b> 2. PPT/Poster preparation, presentation and write up submission- <b>3+4+3=10</b> 3. Attendance and Participation in class- <b>5</b> 4. Practical skills, laboratory reports, etc- <b>5</b>	1. Dissection- (Sl no 2, 3, 4); Dissection-4, Display-1, Drawing-1.5, Labelling-1.5. ( <b>8</b> ) 2. Mounting (Sl no 2 and 3)- Preparation-2, Drawing-1, Labelling-1. ( <b>4</b> ) 3. Identification (Sl no 1 and 5, 1 item from each gr )- Sc. Name-0.5, Characters-1, Habit & habitat-0.5, ( $2 \times 2 = 4$ ) 4. LNB - <b>2</b> 5. Viva- <b>2</b>

**NOTE :**

- *Study of specimen should include-Scientific name, Habit and Habitat, Diagnostics feature, importance/values if any.*
- *Identification could be done by using card printed with photograph/drawing/data/preserved specimen/permanent slide.*
- *CA can be done multiple times even by more than one teacher. An average will be taken for marks capturing.*
- *LNB should be prepared in inter-leaf practical note book with date & Teacher's sign.*
- *A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.*

***Recommended readings***

1. Barrington, E J W. (1967) Invertebrate structure and function, Nelson, London.
2. Barnes, R. D. (1968) Invertebrate Zoology, 2nd Ed. Saunders, Philadelphia.
3. Hyman, L H. (1940-67). The Invertebrates, Vol. I-VI. McGraw-Hill, New York.
4. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002) The Invertebrates: A New Synthesis. III Edition. Blackwell Science.
5. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
6. Marshall, A.J and Williams, W.D. (1995) Text book of Zoology-Invertebrates. VII Ed., Vol. I, A.L.T.B.S. Publishers.

## SEMESTER – III (PROGRAM)

**Course Name: Fundamentals of Comparative Anatomy & Physiology of Chordates**  
**Course Code: BSCPZOOOC301**

Course Type: Core <b>(Theoretical &amp; Practical)</b>		Course Details: CC-1 (3)			L-T-P: 4-0-4		
Credit: <b>6</b>		Full Marks:		CA Marks		ESE Marks	
		Practical		Theoretical	Practical	Theoretical	
		<b>100</b>		<b>30</b>	<b>10</b>	<b>20</b>	<b>40</b>

**About the course :**

The course offers insight into the physiology of chordates while giving an account of their anatomy. This course also explores vertebrate morphology with the aims of understanding major events in the history of vertebrate evolution and integrating the morphology of vertebrates with their ecology, behaviour and physiological adaptation in diverse habitats. Thermal relations encountered in endo- and ectothermic animals will be explained. Selective pressures that shape to different physiological phenotypes will also be addressed in the course.

**Learning outcomes :**

*After successfully completing this course, the students will be able to :*

- Develop an understanding of the evolution of vertebrates thus integrating structure, function and development.
- Have an overview of the evolutionary concepts including homology and homoplasy, and detailed discussions of major organ systems.
- Understand how cells, tissues, and organisms function at different levels. The course content also provides the basis of understanding their abnormal function in animal and human diseases and new methods for treating those diseases.
- Develop an understanding of the related disciplines, such as cell biology, neurophysiology, pharmacology, biochemistry etc.
- Get a flavor of research besides improving their writing skills and making them well versed with the current trends. It will further enable the students to think and interpret individually due to different aspects chosen.
- Undertake research in any aspect of animal physiology in future.

### **THEORY**

**UNIT-I: Structure and function of integument, skeletal and muscular systems (11 Lectures)**

1. **Integumentary system** (Comparative Anatomy and functional significance): Integument from fishes to mammals: Scales of fishes and reptiles, Feather of birds, Epidermal glands from fish to mammals. Horn, hoof, claw, nail, hair.
2. **Skeletal system** (Comparative Anatomy and functional significance): Axial and appendicular skeleton from fishes (bony) to mammals. Pelvic and pectoral girdles from fishes (bony) to mammals.
3. **Muscular system:** Types of muscles from fishes to mammals, Properties of skeletal muscle. Physiology of skeletal muscle contraction.

**UNIT-II: Structure and function of digestive, circulatory and endocrine systems (13 Lectures)**

1. **Digestive system-** Dentition in mammals. General Structure and diversity of alimentary canal and digestive glands in vertebrates. Physiology of ruminating stomach. Physiology of digestion with special reference to enzymes involved in vertebrates. Biological significance of nutrients- carbohydrates, proteins, fats, vitamins and minerals.

2. **Circulatory system:** Evolution of aortic arches and their significance. Structure and evolution of heart in vertebrates. Functional anatomy of human heart w.r.t. junctional tissues and valves, cardiac cycle, cardiac output, neural Integration of cardiovascular function, electrocardiogram. Composition of blood, biochemistry of ABO blood groups, Mechanism of blood coagulation (intrinsic and extrinsic pathway).
3. **Endocrine glands:** Comparative structure & function of pituitary and thyroid gland in chordates. Mechanism of hormone action.

**UNIT-III: Structure and function of respiratory and excretory systems. (14 Lectures)**

1. **Respiratory system-**Types and structure of fish gill. Accessory respiratory organs in fishes. Transition from water to air breathing: w.r.t. comparative anatomy and functional significance of lungs in amphibians, reptiles, birds and mammals. Breathing and gas exchange, gas transport,
2. **Excretory system:** Types and development of kidneys and their ducts in anamniotes and amniotes. Nephron- structure, types and their function. Physiology of excretion (Ammonotelic, Uricotelic, Ureotelic) in vertebrates; Urine formation in mammal, counter current mechanism, Role of ADH and RAAS in excretion. Mechanisms of osmoregulation in fresh water and marine organisms (fishes).

**UNIT- IV: Structure and function of nervous and reproductive systems. (14 Lectures)**

1. **Nervous system:** Introduction to central and peripheral nervous (autonomic) systems. Structural and functional evolution of brain and spinal cord in various classes of vertebrates. Structure, type and functions of neuron, Nerve impulse and its transmission (myelinated and non-myelinated). Reflex action. Types of sense organs- vision, hearing, taste, smell and touch in chordates. Mechanism of thermoregulation in homeotherms and poikilotherms.
2. **Reproductive system:** Comparative details of testes and ovaries from fishes to mammals; Reproductive strategies (ovipary, ovo-vivipary and viviparity) in vertebrates, Estrous and menstrual cycle,

**PRACTICAL**

1. Temporary mount of external scales in fishes (cycloid, placoid, ganoid, ctenoid).
2. Comparative study of brain with the help of models and charts.
3. Comparative study of urinogenital system with the help of models and charts.
4. Comparative study of heart with the help of models and charts.
5. Study of axial and appendicular skeleton of vertebrates.
6. Expose and display afferent Branchial system, weberian ossicles and IX-X<sup>th</sup> cranial nerve of fish (carp).
7. Quantitative determination of nutrients: Carbohydrate (Anthrone method), Protein (Lowry's method), Cholesterol (Solkowski's test).
8. Estimation of haemoglobin.
9. Counting of different types of blood cells (RBC & WBC) using haemocytometer.
10. Submit a report based on-effect of temperature on rate of opercular movement of fish.
11. Group discussion or Seminar presentation on a related topics given below.

**Pool of Topics for Group discussion or Seminar presentation :**

1. Evolution of terrestrial animals	2. Thermoregulation in vertebrates	3. Osmoregulation in fish
4. Estrous and menstrual cycle	5. Blood groups and their importance	6. Scales in fishes and reptiles
7. Deep-sea Adaptation in mammals	8. Kidney development in vertebrates	9. Evolution of aortic arches
10.Cranial nerves in vertebrates	11. Integumentary derivatives in bird and mammals	12. Jaw suspension in vertebrates

### Format for conducting CA and ESE practical examination :

CA (30 marks)	ESE (20 marks)
1. Assessment based on practical topics (class test)- <b>10</b> 2. PPT/Poster preparation, presentation and write up submission- $3+4+3=10$ 3. Attendance and Participation in class- <b>5</b> 4. Practical skills, laboratory reports, etc- <b>5</b>	1. Experiment (Sl no 7, 8, 9)- Performance in experiment-3, Principle-1, Procedure-2 result and inference-2, <b>(8)</b> OR, Dissection (Sl no 6)- Exposing and display-5, Drawing-2, Labelling-1. <b>(8)</b> 2. Identification (Sl no 1 to 5)- Naming-0.5, Characters-1.5 ( $2 \times 3 = 6$ ) 3. LNB and Project report - $2+2 = 4$ 4. Viva- <b>2</b>

**NOTE :**

- *CA can be done multiple times even by more than one teacher. An average will be taken for marks capturing.*
- *LNB should be prepared in inter-leaf practical note book with date & Teacher's sign.*
- *A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.*

**Recommended readings :**

1. Weichert, C.K. (1970) Anatomy of Chordates (4th edition).
2. Jordan, E. L. and Verma, P. S. (2013) Chordate Zoology (14th edition).
3. Saxena, R. K. and Saxena, S. (2015) Comparative Anatomy of Vertebrates (2nd edition).
4. Vander, A.; Sherman, J. and Luciano, D. (2003) Human Physiology (9th edition).
5. Randall, D. et al. (2002) Eckert Animal Physiology (5th edition) Freeman.
6. Hill, R.W. et al. (2008) Animal Physiology (3rd edition) Sinaur Associates.
7. Guyton, A.C. et al. (2008) Textbook of Medical Physiology (12th Ed) W.B. Saunders Co.
8. Withers, P.C. et al. (1992) Comparative Animal Physiology (1st edition) Brooks Cole.
9. Kent, G. C. and Carr, R. K. (2018) Comparative anatomy of vertebrates (9Ed), Mc Graw Hill.

**Course Name: Essentials of Beekeeping**  
**Course Code: BSCPZOOSE301**

Course Type: SE (Theoretical)	Course Details: SEC-1		L-T-P: 4-0-0
Credit: 4	Full Marks: <b>50</b>	CA Marks	ESE Marks
		Theoretical	Theoretical
		<b>10</b>	<b>40</b>

**About the course :**

This course tells the students what tools and equipment will be needed, the main activities in the beekeepers year, the laws and by laws governing keeping bees; discover the principles of sustainable beekeeping and how these principles can guide your beekeeping into an enduring practice.

**Learning outcomes :**

After successfully completing this course, the students will be able to:

- Explain what are the prerequisite to get started in beekeeping.
- Describe the laws around beekeeping in Vancouver.
- Discuss the responsibilities of urban beekeepers.
- Identify where to purchase equipment and demonstrate how to assemble it.
- Name and identify major parts of the honeybee such as the stinger or mandibular parts.
- Describe bee biology and anatomy from the perspective of managing bees.
- Describe the importance of wax and identify what to look for in comb during hive inspections.

**THEORY****Unit I: Introduction to Apiculture**

(12 Lectures)

1. History of Bees and Beekeeping,
2. Systematics, Bee species,
3. Bee morphology (*Apis indica*),
4. Colony organization and Polymorphism,
5. Caste system, Division of labour,
6. Bee pasturage
7. Foraging and Honey flow periods.

**Unit II: Bee keeping as an occupation**

(13 Lectures)

1. Extent of Beekeeping in West Bengal and India,
2. Limitations on the development of beekeeping,
3. Advantages of extensive Beekeeping.
4. Beekeeping equipments: Bee box and tools and initiation into keeping a colony,
5. The future of beekeeping.

**Unit III: The first step in beekeeping**

(14 Lectures)

1. Purchase of a colony,
2. The Apiary site, how to manage (Seasonal and Routine) a colony, the manipulation of a colony.
3. Bee products: Honey, Bee wax, Pollens, Royal Jelly, Propolis and Bee venom.
4. Taking care of bee (brood and adult) diseases and enemies.
5. Establishment of a colony.
6. Bee flora and planned pollination services (Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens)

**Unit IV: Entrepreneurship in Beekeeping industry****(13 Lectures)**

1. Harvesting and marketing of bee products.
2. Bee Keeping Industry – Recent Efforts.
3. Important Institutions pertinent to Apiculture: National Bee keeping.

***Recommended readings:***

1. Abrol , D. P. (1997) Bees and Beekeeping. Kalyani Publisher, New Delhi.
2. Abrol, D. P. (2010) A Comprehensive guide to Bees and Beekeeping. Scientific Publisher, New Delhi.
3. Withhead, S. B. (2010) Honey bees and their management Axis books Publisher, Jodhpur.
4. Nagaraja, N. and Rajagopal , D. (2013) Honey bees: Diseases, Parasites, Pests, Predator and their management. M.J.P Publisher, Chennai.
5. Dharamsing and Singh, D. P. A Handbook of Beekeeping, Agrobios India (Publisher),Jodhpur.

# SEMESTER-IV (PROGRAM)

**Course Name: Cytogenetics, Biochemistry, Immunology, Evolutionary Biology**  
**Course Code: BSCPZOO401**

<b>Course Type: Core (Theoretical &amp; Practical)</b>	<b>Course Details: CC-1 (4)</b>			<b>L-T-P: 4-0-4</b>	
<b>Credit: 6</b>	<b>Full Marks:</b>		<b>CA Marks</b>	<b>ESE Marks</b>	
	<b>100</b>	<b>Practical</b>	<b>Theoretical</b>	<b>Practical</b>	<b>Theoretical</b>
	<b>30</b>	<b>10</b>	<b>20</b>	<b>40</b>	

**About the course :**

The course gives insight into the principles of cytology, genetics, immunology and Biochemistry. The students will know about the cell physiology and evolutional biology.

**Learning outcomes :**

After successfully completing this course, the students will be able to :

- know about various components of a cell,
- know about cell physiology and sub-cellular metabolic processes
- know about components of immune system and their role in host defence system
- Undertake research in relevant field in future.

## **THEORY**

**Unit I: Cytogenetics**

**(12 Lectures)**

1. Ultra structure and function of Plasma membrane (Fluid mosaic model), Mitochondria, Golgi, Endoplasmic reticulum, Lysosome & Ribosome,
2. Chromosome structure: nucleosome model, giant chromosome
3. Cell division: Mitosis & Meiosis,
4. Structure and Properties of DNA and RNA,
5. Mechanism of Replication in prokaryotes.
6. Transcription & Translation in prokaryotes.
7. Genetics of Thalassemia and Hemophilia,
8. Down syndrome, Turner & Klinefelter syndrome,
9. Chromosomal Sex determination in *Drosophila* and Man.
10. Basic idea of Linkage and crossing over.

**Unit II: Biochemistry**

**(12 Lectures)**

1. Classification and structure of Carbohydrates, Proteins and Lipids.
2. Enzymes: Classification, its properties and mode of action (Michaelis-Menten equation).
3. Glycolysis, Krebs' cycle and ATP synthesis, Gluconeogenesis.
4. Transamination, deamination, urea cycle.
5.  $\beta$ -Oxidation of fatty acid (even number).

**Unit III: Immunology**

**(10 Lectures)**

1. Cells and organs of the Immune system,
2. Innate immunity, Adaptive immunity (Cell mediated and humoral).
3. Structure and functions of different classes of immunoglobulins.

4. Structure and functions of MHC molecules.
5. Antigen-antibody interactions.
6. Vaccine: principle and types.

**Unit IV: Evolutionary Biology****(10 Lectures)**

1. Origin of Life.
2. Lamarckism, Darwinism, Neo-Darwinism.
3. Types of fossils, significance.
4. Hardy Weinberg Principle, Factors affecting Hardy Weinberg Principle, Gene and allele frequency.
5. Genetic drift, Bottleneck effect, Founder effect.
6. Biological species concept-merits and demerits.
7. Modes of speciation (Allopatric, Sympatric).

**PRACTICAL**

1. Study of Human Karyotypes.
2. Study of homology and analogy from suitable specimens/ pictures
3. Histological study of spleen, thymus and lymph nodes through slides/ photographs
4. Temporary slide preparation and identification of mitotic and meiotic stages using onion root tip/grasshopper testes.
5. ABO blood group determination.
6. Group discussion or Seminar presentation on a related topics given below:

**Pool of Topics for Group discussion or Seminar presentation :**

1. ABO blood grouping	2. Chromosomal banding & Karyotyping	3. Lamarckism
4. Species Concept	5. Tissue Grafting and Tolerance	6. Origin of species
7. Antigen-antibody interaction	8. Vaccine and vaccination	9. Thalassemia
10. Sex-linked disorders	11. Immune system-A defense barrier	12. Mutation

**Format for conducting CA and ESE practical examination :**

CA (30 marks)	ESE (20 marks)
1. Assessment based on practical topics (class test)- <b>10</b> 2. PPT/Poster preparation, presentation and write up submission- $3+4+3=10$ 3. Attendance and Participation in class- <b>5</b> 4. Practical skills, laboratory reports, etc- <b>5</b>	1. Experiment (Sl no 4,5)- Performance in experiment-3, Principle-1, Procedure-2 result and inference-2, (8) 2. IDENTIFICATION (Sl no 1 to 3)- Naming-0.5, Characters-1.5 ( $2 \times 4 = 8$ ) 3. LNB -2 4. VIVA-2

**NOTE :**

- CA can be done multiple times even by more than one teacher. An average will be taken for marks capturing.
- LNB should be prepared in inter-leaf practical note book with date & Teacher's sign.
- A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.

**Recommended readings:**

1. Nelson, D.L. & Cox, M.M. (2017) Lehninger Principles of Biochemistry (7th edition) Worth.
2. Hall, B. K. and Hallgrímsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers
3. Goldsby, R.A.; Kindt, T.J. and Kuby, J. (2006) Immunology (6th edition).
4. Russell, P.J. (2010) Genetics (Benjamin Cummings).

**Course Name: Essentials of Sericulture**  
**Course Code: BSCPZOOSE401**

Course Type: <b>SE (Theoretical)</b>	Course Details: <b>SEC-2</b>		<b>L-T-P: 4-0-0</b>
Credit: 4	Full Marks: <b>50</b>	CA Marks	ESE Marks
		Theoretical	Theoretical
		<b>10</b>	<b>40</b>

**About the course :**

The course gives insight into the principles of sustainable sericulture and how these principles can guide your silkworm rearing into an enduring practice. The students will know about the laws and by laws governing keeping silkworm.

**Learning outcomes :**

*Upon successful completion of this course, students should be able to:*

- Generation of skilled manpower in the field of sericulture,
- To impart training in extension management and transfer of technology,
- To impart training in Post Cocoon Technology, and
- To provide field exposure

**THEORY****Unit I: Silkworm distribution and races****(12 Lectures)**

1. The silkworms. Its morphological characteristics.
2. Distribution and types of races. Exotic and indigenous races of silkworm.
3. World silk production World map and silk road, spread of Sericulture to China, Europe, South Korea, Japan, India and other countries.
4. Tasar practices in tropical and temperate climate.

**Unit II: Biology of silkworm and rearing technology****(13 Lectures)**

1. Mulberry and non-mulberry Sericulture (Silk worm and respective host plants).
2. Biology of silkworm (Mulberry and Tasar).
3. Selection of mulberry variety and establishment of mulberry garden (emphasis on chawki garden),
4. Incubation- definition, requirement of environmental conditions, incubation devices; identification of stages of development; black boxing and its importance.
5. Model Rearing house and uses of rearing appliances.
6. Silkworm rearing technology: Early age and Late age rearing Selection of silkworm races/breeds for rearing.
7. Types of mountages, Spinning, harvesting and storage of cocoons.

**Unit III: Diseases & pests of silk worm with prevention & control****(14 Lectures)**

1. Introduction; classification of silkworm diseases.
2. Protozoan disease: symptomatology due to *Nosema bombycis* infection, source, mode of infection and transmission, cross infectivity, prevention and control.
3. Bacterial, Viral, Fungal diseases: causative agents, symptoms, transmission prevention and control.
4. Pests of silk worms (Uzi fly, Dermestid beetle).
5. Disinfectants: Formalin, bleaching powder RKO.

**Unit IV: Prospects of Sericulture in India**

1. Importance of mulberry silk.
2. Forestry and non-mulberry sericulture.
3. Silk industry in different states, employment, potential in mulberry and non-mulberry sericulture.
4. Employment generation in sericulture: Role of women in sericulture.
5. Sericultural practices in rain-fed and irrigated conditions;
6. Sericulture organization in India; Role of state departments of Sericulture, Central Silk Board, Universities and NGOs in Sericulture development.

***Recommended readings:***

5. Manual on sericulture (1976). Rome : Food and Agriculture Organization of the United Nations, Agricultural Services Division.
6. Ullal, S.R. and . Narasimhanna, M.N. (1987) Handbook of Practical Sericulture: CSB, Bangalore.
7. Silkworm Rearing and Disease of Silkworm (1956) Ptd. By Director of Ptg., Stn. & Pub. Govt. Press, Bangalore
8. Jolly, M. S. (1986) Appropriate Sericultural Techniques; Ed., Director, CSR & TI, Mysore.
9. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1 (1972) Fuzi Pub. Co. Ltd., Tokyo, Japan.
10. Narasimhanna, M. N. (1988) Manual of Silkworm Egg Production; CSB, Bangalore.
11. Sengupta, K. (1989) A Guide for Bivoltine Sericulture. CSR & TI, Mysore.

# SEMESTER-V (PROGRAM)

**Course Name: Fundamentals of Genetic Engineering and Biotechnology**  
**Course Code: BSCPZOODSE501**

<b>Course Type: DSE (Theoretical &amp; Practical)</b>		<b>Course Details: DSEC-1 (1)</b>			<b>L-T-P: 4-0-4</b>		
<b>Credit: 6</b>		<b>Full Marks:</b>		<b>CA Marks</b>		<b>ESE Marks</b>	
		<b>Practical</b>		<b>Theoretical</b>		<b>Practical</b>	
		<b>100</b>		<b>30</b>		<b>20</b>	
						<b>40</b>	

### **About the course :**

This course gives an insight into the direct manipulation of DNA to alter the characteristics of an organism in a particular way. It envisages concepts, mechanisms, biological designs, functions and evolutionary significance of genetic modification or manipulation in special organisms and also discusses the recent advance in recombinant DNA technology.

### **Learning outcomes :**

*Upon successful completion of this course, students should be able to:*

- Develop an understanding of the fundamental molecular tools and their applications of DNA modification and cloning.
- Appreciate shifting their orientation of learning from a descriptive explanation of biology to a unique style of learning through graphic designs and quantitative parameters to realize how such research and innovations have made science interdisciplinary and applied.
- Develop future course of their career development in higher education and research with a sound base.
- Apply their knowledge with problem solving approach to recommend strategies of genetic engineering for possible applications in Biotechnology and allied industry.

## **THEORY**

### **UNIT I: Introduction to genetic engineering** **(13 Lectures)**

1. Scope of Genetic Engineering and Biotechnology.
2. Enzymes as Tools for Genetic Engineering: Restriction Enzymes, Restriction-Modification System, *E. coli* DNA Polymerase (Klenow), DNA-methylase, DNA-ligase, Taq DNA polymerase, Reverse Transcriptase.
3. Vehicles for DNA cloning: Plasmid DNA vectors (Features and classification, pBR322, Cosmid,) bacteriophage lambda derived vectors (Phagemid, M13).

### **UNIT II: Recombination and cloning** **(13 Lectures)**

1. DNA (Gene) cloning, recombinant DNA.
2. cDNA library, genomic library, Isolation of gene from gene library.
3. Screening and identification of recombinant DNA clone from gene library.
4. Expression of recombinant protein from a DNA clone in bacteria.
5. Preparation of insulin by rDNA technology. Concept of molecular farming.

### **UNIT III: Recent advances in gene technology** **(13 Lectures)**

1. Transgenic animals: methodology and application.
2. Mechanism of gene technology: Restriction enzyme digestion. Ligation, Cloning, Transformation, Calculation of transformation efficiency.
3. Recent trends in Gene technology: Gene Targeting: Knock-ins and Knock-outs. Targeted Genome Editing: CRISPRs.

4. Polymerase Chain Reaction (PCR) and Site-directed mutagenesis.

#### **UNIT IV: Genomic studies; ethical issues in genetic engineering**

**(13 Lectures)**

1. DNA Sequencing and Genome Analysis,
2. Human Genome Project and Human Genome Sequences.
3. Applications of Genetic Engineering and Biotechnology in agriculture, medicine and its economic and social implications, Ethical precautions.

#### **PRACTICAL**

1. **Video-graphic demonstrations** on the following topics- Microinjection, selection of recombinant clone, preparation of cDNA library, Knock-out method, CRISPR, RNAi, transgenic animal (zebra fish).
2. Chart presentation of Restriction enzyme digestion.
3. Separation of molecules (protein/DNA) using electrophoresis,
4. Construction of circular and linear restriction map from the data provided.
5. Calculation of transformation efficiency from calcium chloride method.
6. Identification of vectors mentioned in theory by model/photograph.
7. Models / PPT presentation on topics given below:

<b>Pool of Topics for Group discussion or Seminar presentation :</b>		
1. Growth hormone	2. Antibiotics from micro-organisms.	3. Streptokinase
4. Recombinant interferon	5. Microbial degradation of waste materials.	6. Insulin
7. Colony stimulating factors	8. Transgenic tomato & rice	9. Industrial enzymes
10. Expression vector	11. Knock-out mouse	12. cDNA Library
13. Genome Sequencing	14. Genetic engineering and Ethics	15. Replica plating

#### **Format for conducting CA and ESE practical examination :**

<b>CA (30 marks)</b>	<b>ESE (20 marks)</b>
1. Assessment based on practical topics (class test)- <b>10</b>	1. Experiment (Sl no 3 to 5)-Principle-2, procedure-2, Experiment/construction/calculation-4, result and inference-2, (10)
2. PPT/Poster preparation, presentation and write up submission- <b>3+4+3=10</b>	2. Identification (Sl no 6)- Sc. Name-0.5, Character-1, importance-0.5 (2x3=6)
3. Attendance and Participation in class- <b>5</b>	3. LNB -2
4. Practical skills, laboratory reports, etc- <b>5</b>	4. VIVA-2

**NOTE :**

- CA can be done multiple times even by more than one teacher. An average will be taken for marks capturing.
- LNB should be prepared in inter-leaf practical note book with date & Teacher's sign.
- Project report (Presentation mandatory), Field report, Write-up, etc to be prepared separately.
- A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.

#### **Recommended readings:**

1. Primrose, S.B. and Twyman, R. (2006) Principles of Gene manipulation and Genomics (7th edition) Blackwell Publishing.
2. Nicholl, D.S.T. (2008) An introduction to Genetic Engineering (3rd edition) Cambridge University Press.
3. Watson, J.D. (2006) Recombinant DNA (3rd edition) Cold Spring Harbor Laboratory Press.
4. Brown, T.A. (2001) Gene Cloning and DNA Analysis: An Introduction.
5. A PBS Documentary entitled, "Playing God" [History of Genetic Engineering].

**Course Name: Basics of Livestock Management and Animal Husbandry**  
**Course Code: BSCPZOODSE502**

<b>Course Type: DSE (Theoretical &amp; Practical)</b>	<b>Course Details: DSEC-1(1)</b>			<b>L-T-P: 4-0-4</b>																	
<b>Credit: 6</b>	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th align="center" colspan="2">CA Marks</th> <th align="center" colspan="2">ESE Marks</th> </tr> <tr> <th align="center">Practical</th> <th align="center">Theoretical</th> <th align="center">Practical</th> <th align="center">Theoretical</th> </tr> </thead> <tbody> <tr> <td align="center"><b>100</b></td> <td align="center"><b>30</b></td> <td align="center"><b>10</b></td> <td align="center"><b>20</b></td> </tr> <tr> <td align="center"><b>40</b></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>			CA Marks		ESE Marks		Practical	Theoretical	Practical	Theoretical	<b>100</b>	<b>30</b>	<b>10</b>	<b>20</b>	<b>40</b>					
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	<b>100</b>	<b>30</b>	<b>10</b>	<b>20</b>	<b>40</b>																

**About the course :**

The course provides intensive study in livestock production, management, marketing, nutrition, breeding, production records, selection, animal health, waste management, and conservation practices.

**Learning outcomes :**

*Upon successful completion of this course, students should be able to:*

1. Understand skills and requirements necessary to find and maintain a job.
2. Select and develop a breeding system for a livestock enterprise.
3. Understand the importance of genetic improvement in animal production.
4. Formulate feed rations for different classes of livestock.
5. Identify common problems associated with livestock and horse herd health and solutions.
6. Identify current and future issues relating to animal husbandry.
7. Understand different marketing opportunities available for livestock production.

## **THEORY**

**Unit I: Animal products and breeding systems** **(13 Lectures)**

1. Scope of Livestock Industry; Livestock Enterprises; Issues in Animal Agriculture.
2. Animal Products: Importance of Animal Products; Beef; Pork; Lamb; Poultry Products.
3. Advanced Reproduction and Breeding: Reproductive Systems, Common Breeding Systems including cattle Breeding, and Goat Breeding.
4. Role of Hormones and environment on animal breeding. Reproductive Technologies (AI).

**Unit II: Animal nutrition** **(13 Lectures)**

1. Nutritional requirements: Energy requirements for maintenance, growth; Production of milk, egg, wool, and meat.
2. Carbohydrates & Fats, Protein, Minerals & Vitamins, Water etc. common Feedstuffs Systems for expressing energy value of foods in ruminants, pigs and poultry.
3. Application of Direct and indirect calorimetry. Advanced Ration Formulations.

**Unit III: Maintenance of breeds** **(13 Lectures)**

1. Common Breeds of Livestock: Breeds of Cattle, goat and poultry: Selecting live stocks;
2. Facilities and Equipment; Housing,
3. Maintenance and health care;
4. Management of breeding stocks and products.
5. Vaccination programmes and Deworming programmes.

**Unit IV: Marketing and related issues.** **(13 Lectures)**

1. Planning and Marketing; Culling, Forward Contracting, Backgrounding.
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2. Quality control; Future prospects.
3. Basic principles of Genetics and tools for genetic improvement.
4. Current issues affecting the livestock industry

## **PRACTICAL**

1. Estimation (quantitative) of proteins in feed (Lowry).
2. Virtual demonstration of endocrine glands and their influence on growth of livestock.
3. Estimation of albumen and yolk quantity in eggs.
4. Estimation of calcium in egg shell (Back titration method).
5. Estimation of cholesterol and peroxides in meat.
6. Group discussion or Seminar presentation on a related topics given below:

<b>Pool of Topics for Group discussion or Seminar presentation :</b>		
1. Dairy management	2. Breeding system and grading up	3. Livestock feed formulations
4. Poultry management	5. Pink revolution in India	6. Goat breeding and management
7. AI technology	8. White revolution in India	9. Scope of Livestock Industry in India

### **Format for conducting CA and ESE practical examination :**

<b>CA (30 marks)</b>	<b>ESE (20 marks)</b>
<ol style="list-style-type: none"> <li>1. Assessment based on practical topics (class test)-<b>10</b></li> <li>2. PPT/Poster preparation, presentation and write up submission-<b>3+4+3=10</b></li> <li>3. Attendance and Participation in class-<b>5</b></li> <li>4. Practical skills, laboratory reports, etc-<b>5</b></li> </ol>	<ol style="list-style-type: none"> <li>1. Experiment A (Sl no 1, 3)- Principle-1, procedure-1.5, Experiment-3, result and inference-2, precaution-0.5 (8)</li> <li>2. Experiment B (Sl no 4,5)-Principle-1, procedure-1.5, Experiment-3, result and inference-2, precaution-0.5 (8)</li> <li>3. LNB -2</li> <li>4. VIVA-2</li> </ol>

**NOTE :**

- CA can be done multiple times even by more than one teacher. An average will be taken for marks capturing.
- LNB should be prepared in inter-leaf practical note book with date & Teacher's sign.
- Project report (Presentation mandatory), Field report, Write-up, etc to be prepared separately.
- A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.

### **Recommended readings:**

1. Taylor, R.E and Field, T.G. (2004).Scientific Farm Animal Production: An Induction to Animal Science. Prentice-Hall.
2. Acker, D. and Cunningham, M. (1998). Animal Science & Industry. Prentice-Hall.
3. Blakely, J. and Bade, D. (1985). The Science of Animal Husbandry. Prentice-Hall.
4. Cambell, J. and Lasley, J. (1975). The Science of Animals that Serve Mankind. McGraw-Hill.
5. Cooper, E. L. (1990). Agriscience: Fundamentals & Applications Delmer: Albany.
6. American Youth Horse Council (1999) Handbook: A Guide to Equine Care and Management.
7. Morrison, F. (1949). Feeds and Feeding (8th edition) Morrison: Ithaca

**Course Name: Public Health and Hygiene**  
**Course Code: BSCPZOOSE501**

Course Type: SE ( <b>Theoretical</b> )	Course Details: SEC-3		L-T-P: <b>4-0-0</b>
Credit: 4	Full Marks: <b>50</b>	CA Marks	ESE Marks
		Theoretical	Theoretical
		<b>10</b>	<b>40</b>

**About the course :**

The course designed for public health and hygiene at graduation level will give understanding for health hygiene, dietary issues, diseases related to malnutrition, communicable and non-communicable diseases.

**Learning outcomes :**

*After successfully completing this course, the students will be able to:*

- Identify current national and global public health problems.
- Aware about the issues of food safety, water safety, vaccination, exercise and obesity, exposure to toxins.
- Frame a public health plan during any epidemic or spread of infectious disease etc.
- Analyze case studies of infant mortality and obesity.
- Assess the health inequalities with regard to gender, race, ethnicity, income etc.

**THEORY**

<b>Unit-I: Maintenance of personal and community hygiene</b>	<b>(13 Lectures)</b>
1. Introduction to public health and hygiene- determinants and factors.	
2. Pollution and health hazards; water and air borne diseases.	
3. Radiation hazards: Mobile Cell tower and electronic gadgets (recommended levels, effects and precaution).	
4. Role of health education in environment improvement and prevention of diseases.	
5. Personal hygiene, oral hygiene and sex hygiene.	
6. Importance and maintenance Community Hygiene.	
<b>Unit-II: Nutrient deficiency diseases</b>	<b>(13 Lectures)</b>
1. Classification of food into micro and macro nutrients.	
2. Balanced diet, dietary plan for an infant, normal adult, pregnant woman and old person.	
3. Importance of dietary fibres.	
4. Significance of breast feeding.	
5. Malnutrition anomalies – Anaemia (Iron and B12 deficiency), Kwashiorkar, Marasmus, Rickets, Goiter (cause, symptoms, precaution and cure).	
6. Substitution of diet with required nutrients to prevent malnutrition disorders.	
<b>Unit-III: Communicable and contagious diseases</b>	<b>(13 Lectures)</b>
1. Infectious agents responsible for diseases in humans.	
2. Communicable viral diseases (causative agent, symptoms, precaution and remedy)- measles, chicken pox, poliomyelitis, swine flu, dengue, chickungunya, rabies, leprosy and hepatitis.	
3. Communicable bacterial diseases (causative agent, symptoms, precaution and remedy)- tuberculosis, typhoid, cholera, tetanus, plague, whooping cough, diphtheria, leprosy.	
4. sexually transmitted diseases (causative agent, symptoms, precaution and remedy)- AIDS, syphilis and gonorrhoea.	
5. Health education and preventive measures for communicable diseases.	

**Unit-IV: Non-communicable diseases and cure****(13 Lectures)**

1. Non-communicable diseases such as hypertension, stroke, coronary heart disease, myocardial infarction. Osteoporosis, osteoarthritis and rheumatoid arthritis—cause, symptom, precautions.
2. Diabetes- types and their effect on human health.
3. Gastrointestinal disorders- acidity, peptic ulcer, constipation, piles (cause, symptoms, precaution and remedy) etc. Obesity (Definition and consequences).
4. Mental illness (depression and anxiety).
5. Oral and lung cancer and their preventive measures.

***Recommended readings :***

1. Mary Jane Schneider (2011) Introduction to Public Health.
2. Muthu, V.K. (2014) A Short Book of Public Health.
3. Detels, R. (2017) Oxford Textbook of Public Health (6th edition).
4. Gibney, M.J. (2013) Public Health Nutrition.
5. Wong, K.V. (2017) Nutrition, Health and Disease.

## SEMESTER-VI (PROGRAM)

**Course Name: Introduction to Wild Life Conservation and Management**  
**Course Code: BSCPZOODSE601**

<b>Course Type: DSE (Theoretical &amp; Practical)</b>		<b>Course Details: DSEC-1(2)</b>			<b>L-T-P: 4-0-4</b>	
<b>Credit: 6</b>	<b>Full Marks: 100</b>	<b>CA Marks</b>		<b>ESE Marks</b>		
		<b>Practical</b>	<b>Theoretical</b>	<b>Practical</b>	<b>Theoretical</b>	
		<b>30</b>	<b>10</b>	<b>20</b>	<b>40</b>	

### **About the course :**

The course is an introduction to wildlife management and gives an account of the tools used by wildlife managers. Topics covered are to equip students with adequate knowledge of various biodiversity monitoring methodologies, conservation and management issues of vertebrate pests, wildlife conflict and over abundant species, wildlife health and diseases.

### **Learning outcomes :**

*After successfully completing this course, the students will be able to:*

- Develop an understanding of how animals interact with each other and their natural environment.
- Develop the ability to use the fundamental principles of wildlife ecology to solve local, regional and national conservation and management issues.
- Develop the ability to work collaboratively on team-based projects.
- Demonstrate proficiency in the writing, speaking, and critical thinking skills needed to become a wildlife technician.
- Gain an appreciation for the modern scope of scientific inquiry in the field of wildlife conservation management.
- Develop an ability to analyze, present and interpret wildlife conservation management information.

## **THEORY**

### **Unit-I: Value of wildlife and need for its conservation**

**(15 Lectures)**

1. Definition, value and importance of wildlife;
2. Wildlife conservation, ethics and importance of conservation;
3. Ecosystem interaction, animal distribution in biome
4. Causes of depletion of wildlife w. r. t. extinction of animals;
5. Types of protected areas and the concept of zoning within the protected areas;
6. Wildlife Sanctuaries and National Parks in India: general strategies (policy) and issues;
7. Animal movement, concept of home range and territory;
8. Tracking movement by remote sensing and GIS.

### **Unit-II: Population dynamics**

**(11 Lectures)**

1. Impact of topography, geology, soil and water on wildlife population.
2. Impact of habitat destruction and fragmentation on wildlife population.
3. Biological parameters such as food, cover, forage and their impact on wild life population.
4. Population attributes; concepts of exponential and logistic growth rates of wildlife.
5. Density dependent and independent population regulation.
6. Impact of introduced species on preexisting flora and fauna of wildlife.
7. Identification and estimation of wild animals by fecal sample analysis, hair identification, pug marks and census methods.

**Unit-III: Wildlife Conservation****(13 Lectures)**

1. Wildlife conservation objectives- strategies and issues [Poaching, Forest fire, Mining, Hunting and illegal trading, Tourism, Wild life corridor, marine pollution]
2. Captive breeding techniques and translocation and reintroduction.
3. Inviolate area and critical habitats and their impact on wildlife.
4. Different terrestrial habitats of wildlife in India.
5. Restoration of degraded habitat.
6. Damage caused by wildlife in India and its mitigation.
7. Sick animal refuges in protected areas.

**Unit-IV: Rehabilitation and management****(13 Lectures)**

1. Types of wildlife management-manipulative, custodial management of over abundant wild animal populations causing damages to nearby inhabitants and their crops and animals.
2. Use of Tools (Compass, Binoculars, Spotting scope, Range Finders, Drone, radio collar, Camera trap) and techniques to control the menace of wild animals.
3. Ma-wildlife conflict resolution and mitigation.
4. Management of exotic and invasive wetland species in India.
5. Habitat manipulation– control and regulation of grazing, Weed eradication.
6. Major diseases of domestic and wild animals and their control and impact of wild life tourism.

**PRACTICAL**

1. Identification, ecotype with conservation status and preparation of colour album of flora (*Ginkgo biloba*, Red sandalwood), mammalian fauna (Himalayan musk deer, Gangetic dolphin, Golden langur, Pangolin, Fishing cat), avian fauna (Great Indian bustard, Pink headed duck), herpetofauna (Gharial, Rock python, King cobra, Indian star tortoise).
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses).
3. Familiarization and study by photographic plate of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc.
4. Demonstration of different field techniques (wild life census: Jolly-Seber method) for flora and fauna.
7. Determination of population density in a natural/ hypothetical community by quadrat method and calculation of Sorenson's Similarity & Shannon-Weiner diversity indices for the same community
8. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.
9. Group discussion or Seminar presentation on a related topics given below:

**Pool of Topics for Group discussion or Seminar presentation :**

1. Project Tiger	2. Rhino vision in India	3. Crocodile conservation
4. Elephant project	5. Green corridor	6. Red data book
7. Ecotourism	8. GIS-Remote sensing & GPS	9. Wild life protection act
10. Invasive species	11. Man-wildlife conflict	12. Wetland management

### Format for conducting CA and ESE practical examination :

CA (30 marks)	ESE (20 marks)
1. Assessment based on practical topics (class test)- <b>10</b> 2. PPT/Poster preparation, presentation and write up submission- $3+4+3=10$ 3. Attendance and Participation in class- <b>5</b> 4. Practical skills, laboratory reports, etc- <b>5</b>	1. Estimation of Species abundance/richness from provided data (Sl no 7)-principle-1, result & discussion-3 (4) 2. Identification (Sl no 1)- Naming-0.5, conservation status-0.5, Ecotype-1, character-1 ( $3 \times 2 = 6$ ) 3. Spotting (Sl no 3)- Naming-0.5, importance-0.5 ( $1 \times 3 = 3$ ) 4. LNB & Field visit report - $2+3=5$ 5. VIVA-2

**NOTE :**

- CA can be done multiple times even by more than one teacher. An average will be taken for marks capturing.
- LNB should be prepared in inter-leaf practical note book with date & Teacher's sign.
- **Project report (Presentation mandatory), Field report, Write-up, etc to be prepared separately,**
- A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.

### Recommended readings:

1. Caughley, G., and Sinclair, A.R.E. (1994) Wildlife Ecology and Management. Blackwell Science.
2. Woodroffe, R., Thirgood, S. and Rabinowitz, A. (2005) People and Wildlife, Conflict or Co-existence? Cambridge University.
3. Bookhout, T.A. (1996) Research and Management Techniques for Wildlife and Habitats (5<sup>th</sup> Ed) The Wildlife Society, Allen Press.
4. Sutherland, W.J. (2000) The Conservation Handbook: Research, Management and Policy. Blackwell Sciences.
5. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008) Problem solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing.

**Course Name: Physiology of Mammals****Course Code: BSCPZOODSE602**

<b>Course Type: DSE (Theoretical &amp; Practical)</b>	<b>Course Details: DSEC-1(2)</b>			<b>L-T-P: 4-0-4</b>	
<b>Credit: 6</b>	<b>CA Marks</b>			<b>ESE Marks</b>	
	<b>Full Marks:</b>	<b>Practical</b>	<b>Theoretical</b>	<b>Practical</b>	<b>Theoretical</b>
	<b>100</b>	<b>30</b>	<b>10</b>	<b>20</b>	<b>40</b>

**About the course :**

The course deals with various physiological functions in mammals. It also gives an account of the metabolic/ biochemical pathways and the probable impact of environment on them.

**Learning outcomes :**

After successfully completing this course, the students will be able to:

- Understand the physiology at cellular and system levels.
- Understand the mechanism and regulation of breathing, oxygen consumption and determination of respiratory quotient.
- Understand how mammalian body gets nutrition from different biomolecules.
- Understand the process of digestion and excretion.
- Understand the organization of nervous system and process of nerve conduction.
- Understand the process of vision and hearing.
- Understand the process of muscle contraction.
- Learn the determination of haemoglobin content, blood groups and blood pressure.

**THEORY**

<b>Unit-I: An overview of respiration and circulation in mammals</b>	<b>12 Lectures</b>
1. Respiration: Mechanism and regulation of breathing; Transport of oxygen and carbon dioxide; Respiratory quotient.	
2. Circulation: Blood buffers, blood groups, blood cells, cardiac cycle, Haemopoiesis, homeostasis.	
<b>Unit-II: An overview of digestion and excretion in mammals</b>	<b>10 Lectures</b>
1. Nutrition and Digestion: Balanced diet; Digestion and absorption of carbohydrates, proteins and fats; Gastrointestinal hormones: role in digestion.	
2. Excretion: Nephron; urine formation; Regulation of urine formation: role of renin, ADH, aldosterone.	
<b>Unit-III: An overview of nervous system and coordination in mammals</b>	<b>16 Lectures</b>
1. Nervous System: Organization, neuron and glial cells- types and structure.	
2. Synapses – types and transmission, resting membrane potential: genesis.	
3. Action potential: initiation and conduction.	
4. Vision: Structure of eye, retinal components, and photoreceptors: ionic basis of potential generation.	
5. Hearing: Structure of ear, Mechanoreceptor: ionic basis of potential generation.	
<b>Unit-IV: An overview of Muscular system and muscle contraction in mammals</b>	<b>11 Lectures</b>
1. Muscles: Types, Ultra structure of skeletal, smooth and cardiac muscles, muscle proteins.	
2. Neuromuscular junction.	
3. Molecular and chemical basis of muscle contraction.	
4. Characteristics of muscle twitch, tetanus and fatigue, isotonic and isometric contractions.	

## PRACTICAL

1. Preparation of temporary mounts: Blood film, Squamous epithelium, Striated muscle fibres and nerve cells.
2. Counting of white blood corpuscles and red blood corpuscles.
3. Preparation of haemin crystals.
4. Estimation of haemoglobin content
5. Determination of blood groups
6. Measurement of blood pressure using sphygmomanometer.
7. Recording of simple muscle twitch with electrical stimulation (or Virtual)
8. Demonstration of reflex action.
9. Study of permanent histological sections of mammalian oesophagus, stomach, duodenum, rectum, lung, kidney and brain cells.
10. **Group discussion or Seminar presentation** on topics (Given Below):

Pool of Topics for Group discussion or Seminar presentation :		
1. Physiology of Lung	2. CO <sub>2</sub> transport & Chloride shift	3. Oxygen dissociation curve
4. Cardiac cycle	5. Buffer systems in human	6. Gastrointestinal hormone
7. Hemopoiesis	8. Heart valves & its dysfunction	9. Neural regulation of digestion
10. Countercurrent & RAAS	11. Absorption of biomolecules in gut	12. Synaptic transmission
13. Action potential	14. Mechanism of hearing and seeing	15. Muscle physiology

### Format for conducting CA and ESE practical examination :

CA (30 marks)	ESE (20 marks)
1. Assessment based on practical topics (class test)-10 2. PPT/Poster preparation, presentation and write up submission-3+4+3=10 3. Attendance and Participation in class-5 4. Practical skills, laboratory reports, etc-5	1. Experiment (Sl no 2-8, any one)-Principle-1, procedure-2, Experiment-2, result -1, (6) 2. Mounting (sl no 1)- Mounting-2, Drawing-1 & labelling-1 (4) 3. Identification (Sl no 9)-Naming-0.5 and features-1.5 (2 x 3=6) 4. LNB-2 5. VIVA-2

**NOTE :**

- Identification could be done by using card printed with photograph/drawing/data/preserved specimen/permanent slide.
- CA can be done multiple times even by more than one teacher. An average will be taken for marks capturing.
- LNB should be prepared in inter-leaf practical note book with date & Teacher's sign.
- Project report (Presentation mandatory), Field report, Write-up, etc to be prepared separately.
- A maximum of 4 students can present same topic of GD/seminar presentation, as a group or solo.

### Recommended readings:

1. Barret, K.; Brooks, H.; Boitano, S. And Barman, S. (2010) Ganong's Review of Medical Physiology (23rd edition) Lange Medical.
2. Guyton, A.C. and Hall, J.E. (2006) A text book of Medical Physiology (11th edition) Saunders.
3. Keele, C.A. & Neil, E. (1989) Samson Wright's Applied Physiology (13th edition) Oxford.
4. Tortora, G.J. & Derrickson, B.H. (2009). Principles of Anatomy and Physiology. 12<sup>th</sup> Ed, John Wiley and Sons, Inc.
5. Chatterjee C.C. (2020) Human physiology: VOL 1 & 2, 13ED, CBS publishers.

**Course Name: Insect Pest, Vector Biology and Management**  
**Course Code: BSCPZOOSE601**

Course Type: SE (Theoretical)	Course Details: SEC-4		L-T-P: 4-0-0
Credit: 4	Full Marks: <b>50</b>	CA Marks	ESE Marks
		Theoretical	Theoretical
		<b>10</b>	<b>40</b>

**About the course :**

The course provides an insight into the types of insect pests and vectors and the factors driving their spread. It also enlightens about the methods used to bring down their population below the threshold for a better management.

**Learning outcomes :**

*Upon successful completion of this course, students should be able to:*

- Identify the types of insect pests particularly the most common one.
- Know the methods of sampling of the pests.
- Understand the mode of action of nematicides and the consequences of their use.
- Understand the effective way of insect pest management strategy.

## **THEORY**

**UNIT I : Background to Insect Pests and Vectors** **(13 Lectures)**

1. Insect pests and vectors of plant and animal diseases.
2. Pest status: (major, minor, occasional, migrant).
3. Human practices and pest occurrence. Disease outbreaks.
4. Population dynamics of pest.
5. Density dependent and independent factors affecting pest and vector population.
6. Allocation of sampling units. Sampling and monitoring methods of arthropod pests.

**UNIT II: Approaches to Insect Pest and Vector Management** **(13 Lectures)**

1. Insecticides. Types of insecticides, Formulation; Toxicity and safety.
2. Application of insecticides: Droplet size.
3. Application equipment Problems associated with using insecticides.
4. Environmental and cultural control (Irrigation, Fertilizer, Sanitation, Alternate hosts, Multiple and intercropping, Separation in time and space, Crop geometry).
5. Host resistance: Basis for resistance, mechanisms of resistance.

**UNIT III: Approaches to Insect Pest and Vector Management** **(14 Lectures)**

1. Biocontrol agents: Predators, Parasitoids, Parasites.
2. Pathogens as biocontrol agent: fungi, viruses, bacteria, microsporidia, nematodes, arthropods.
3. Transmission of pathogens. Area-wise management of pest.
4. Techniques of biocontrol: constraints and reasons for failure of biocontrol.
5. Use of pheromones/ allelochemicals in pest management; Mating disruption/confusion, Alarm pheromones and oviposition deterrents; repellents.
6. Exclusion and barriers, Traps. Physical disturbance.
7. Use of Larvivorous Fish and plants in vector control.

**UNIT IV: Legislation and other alternatives of pest control**

1. Exclusion and routes of entry.
2. Risk assessment; Damage thresholds Forecasting;
3. Genetically modified organisms: pest control property and concerned issues.
4. Integrated vector management. The integrated control/ IPM; Constraints towards IPM adoption.
5. Eradication versus management concept.
6. Increasing agroecosystem resistance Legislation for Pesticide use; Effects of regulation.

***Recommended readings:***

1. Van Emden, H.F. and M.W. Service. (2004) Pest and Vector Control. Cambridge University Press.
2. Cameron, M. & Lorenz, L. (2013) Biological and Environmental Control of Disease Vectors. CABI, UK
3. Chaterjee, K.D. (1981) Parasitology : Protozoology and Helminthology : Introduction to Clinical Medicine.(12th .Edition) Chaterjee Medical Publishers
4. Mullen, G. and Durden L. (2009). Medical and veterinary entomology, Academic press, London.
5. Kochchar, S.K. (2009). A Text Book of Parasitology. Wisdom Press