HAVERI UNIVERSITY, HAVERI

B.Sc. ZOOLOGY

SYLLABUS

DISCIPLINE SPECIFIC CORE: SEM – I - IV

DISCIPLINE SPECIFIC ELECTIVE: SEM – V - VI

OPEN ELECTIVE: SEM – V - VI

SKILL ENHANCEMENT COURSE: SEM IV/ V/ VI

(with Effect from 2024-25)

AS PER NEP (REVISED): 2024

Preamble

Zoology is one of the major subjects in the branch of basic sciences that deals with study of animals. The course is premeditated to introduce students to the study of zoology at the organismal and organ function levels. The curriculum is designed with a blend of classical aspects in Zoology and advanced and specialized areas in the subject.

The three year degree in Zoology offers Discipline Specific Core Courses [DSC] in Animal Diversity, Parasitology, Comparative anatomy, Cell Biology, Developmental Biology, Animal Physiology and Biochemistry. In addition to core courses, at semester V and semester VI, Discipline specific Elective Courses (DSE) comprising branches such as Histology, Applied Zoology, Biostatistics, Animal Behaviour, Evolutionary Biology, Ecology, Zoogeography, Wildlife biology, Genetics, Biotechnology and Nanotechnology have been offered. A Skill Enhancement Courses [SEC] in Bee keeping has been offered that has to be opted by the student either during IV, V or VI semester. Other combination students have the opportunity to study Economic Zoology and Health and Hygiene as Open elective course (OE) in Zoology.

After completion of the program, it is expected that, students will understand and appreciate: animal diversity, the structure, functions and life processes at cellular, tissue, organ and system level, significance of evolution, few applications of Zoology and basic concepts of human health. The students would also gain an insight into laboratory and field work through the practical course, field work and the project work.

Haveri University, Haveri U.G. Zoology course structure -2024-25 onwards

Semester	Type	Theory/ Practical	Core Subject Code	Title	Credits	Teaching hour per week	Total Teaching hours	IA	(SEE marks)	Total Marks	Exam (Hrs)
Discipline Specific Core											
I	DSC-1	Theory		Diversity of Non chordates and Parasitology Theory	4	4	60	20	80	100	3 hrs
I	DSC-2	Practical		Diversity of Non chordates and Parasitology Practical	2	4	56	10	40	50	3 hrs
II	DSC-3	Theory		Chordate Biology and Comparative anatomy	4	4	60	20	80	100	3 hrs
II	DSC-4	Practical		Chordate Biology and Comparative anatomy Practical	2	4	56	10	40	50	3 hrs
III	DSC-5	Theory		Cell Biology and Developmental Biology	4	4	60	20	80	100	3 hrs
III	DSC-6	Practical		Cell Biology and Developmental Practical	2	4	56	10	40	50	3 hrs
IV	DSC-7	Theory		Animal Physiology and Biochemistry	4	4	60	20	80	100	3 hrs
IV	DSC-8	Practical		Animal Physiology and Biochemistry Ppractical	2	4	56	10	40	50	3 hrs
*V	DSE-1	Theory		Histology, Applied Zoology and Biostatistics	4	4	60	20	80	100	3 hrs
V	DSE-2	Practical		Histology, Applied Zoology and Biostatistics Practical	2	4	56	10	40	50	3 hrs
V	DSE-3	Theory		Animal Behaviour and Evolutionary Biology	4	4	60	20	80	100	3 hrs
V	DSE-4	Practical		Animal Behaviour and Evolutionary Biology Practical	2	4	56	10	40	50	3 hrs
*VI	DSE-5	Theory		Ecology, Zoogeography & Wild Life Biology	4	4	60	20	80	100	3 hrs
VI	DSE-6	Practical		Ecology, Zoogeography & Wild Life BiologyPractical	2	4	56	10	40	50	3 hrs
VI	DSE-7	Theory		Genetics, Biotechnology & Nanotechnology	4	4	60	20	80	100	3 hrs
VI	DSE-8	Practical		Genetics, Biotechnology & Nanotechnology Practical	2	4	56	10	40	50	3 hrs
V	OE-1	Theory		Economic Zoology	3	3	45	20	80	100	3 hrs
VI	OE-2	Theory		Health and Hygiene	3	3	45	20	80	100	3 hrs
Skill Enhancement Course (SEC)											
**VI, V, VI	SKILL	Practical		Bee keeping	2	4	56	10	40	50	3 hrs

* At V semester student shall either choose DSE1&2 Or DSE3&4 and at VI semester either DSE5& 6 Or DSE 7&8. ** In this subject, student shall opt. Skill Enhancement course (SEC) either during IV, V or VI Semester only.

Haveri University, Haveri

B.Sc. Zoology

Programme Specific Outcomes (PSO):

On completion of the 03 years Degree in Zoology students will be able to:

- Compare and contrast the characteristics of animals that differentiate them from other forms of life.
- Develop deeper understanding of key concepts of Zoology at biochemical, molecular, cellular, physiological, histological and systematic level
- Understand and be aware of relevant theories, paradigms, concepts and principles of zoology.
- Apply the knowledge of Zoology to understand the complex life Processes and phenomena
- Illustrate zoological science for its application in branches like Parasitology, apiculture, aquaculture and agriculture etc.
- Connect and apply biological knowledge to other disciplines and to integrate knowledge into their personal and professional lives.
- Understand the ecological impact on the evolutionary history of not only mankind but also unfolding the secrets of origin of life and classical Zoology
- Perform laboratory procedure with suitable technique in Histology, Physiology, Cytology, Developmental biology, Bio- chemistry, Genetics, Environment biology, Evolution and Animal Biotechnology,
- Carry out analysis of biological data using statistical tools.
- Develop skills in rearing honey bees and extraction of honey and hive products.

B.Sc. Semester–I
Discipline Specific Core

Course Title: Diversity of Non-Chordates and Parasitology (Theory)
Course Code:

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-1	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Learn about the importance of systematics, taxonomy and structural organization of animals.
- Appreciate the diversity of non-chordates living in diverse habit and habitats.
- Understand evolutionary history and relationships of different non-chordates through functional and structural affinities.
- Critically think about the organization, complexity and characteristic features of non-chordates.
- Getting familiarized with the morphology and anatomy of representatives of various animal phyla.
- Comprehend the pathogenic effects of protozoan and helminth parasites and their control measures
- Enhance collaborative learning and communication skills through practical sessions, team work, group discussions, assignments and projects

Units	**Course Title: Diversity of Non-Chordates and Parasitology (Theory) Code:**	**60 hrs**
Unit-1	**Introduction**: Biodiversity and its importance, Principles of animal classification, definition of species. **Phylum Protozoa:** General characters and classification up to classes; locomotion and reproduction in Protozoa. Type study: Paramecium (Morphology and Reproduction) **Phylum Porifera:** General characters and classification up to classes; Types of canal system and endoskeleton in sponges. Type study: Sycon (Morphology andReproduction) **Phylum Cnidaria:** General characters and classification up to classes; Polymorphism in Physalia. Type study: Obelia (Morphology and Reproduction). Biological importance of Corals and coral reefs **Ctenophora:** General characteristics and evolutionary significance.	**15 hrs**

Unit-2	**Phylum Platyhelminthes:** General characters, parasitic adaptations and classification up to classes; Type study: Planeria (Morphology and Reproduction) **Phylum Nemathelminthes:** General characters and classification up to classes; Type study: Ascaris (Round worm)- (Morphology and Reproduction) **Phylum Annelida:** General characters and classification upto classes; Metamerism in Annelida. Type study: Earthworm - (Morphology and Reproduction) Phylum: Onychophora: Salient features of Peripatus and its systematic position	**15hrs**
Unit-3	**Phylum Arthropoda:** General characters and classification up to classes; metamorphosis in Insects and economic importance of insects. Type study: Palaemon (Prawn) - (Morphology, Appendages, Nervous system and Reproduction). **Phylum Mollusca:** General characters and classification upto classes; Torsion in gastropods, Pearl formation. Type study: Pila (morphology, shell, respiration, nervous system and Reproduction). Foot and shell in mollusca **Phylum Echinodermata:** General characters and classification upto classes; Water-vascular system in Asteroidea. Type study: Starfish (Morphology and Reproduction) Echinoderm larvae.	**15hrs**
Unit-4	**Parasitology:** Morphology, Life Cycle, Pathogenicity and Prophylaxis of human pathogenic parasites: *Entamoeba histolytica*, *Plasmodium vivex*, , *Taenia solium*, *Paragonim uswestermani*, *Ancylostoma duodenale, Enterobios vermicularis,Wuchereria bancrofti,* Ticks and Mites	**15hrs**

References:

1. Barnes, R.S.K.; Calow,P.; Olive,P.J.W.; Golding,D.W.; Spicer, J.I.(2002) The Invertebrates: Synthesis,BlackwellPublishing.

2.Hickman,C.; Roberts,L.S.; Keen,S.L.; Larson, A. and Eisenhour, D. (2018) Animal Diversity, McGraw-Hill.

3. Holland, P.(2011) The Animal Kingdom: A Very Short Introduction, Oxford University Press.

4. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition.E.L.B.S. and Nelson.

5.Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia

6. Bushbaum, R.(1964)Animals without Back bones.University of Chicago Press.

7. Belding D. L. Mereditch .(1956). Textbook of Parasitology. New York.

8. Chatterji K.D. Parasitology (Protozoology & Helminthology). Medical Publishers, Calcutta, India.

9. Chandler A.C. and Read C.P. (1961). Introduction to Parasitology. John, Wiley and Sons, Inc.

Online Tools and Web Resources:

· Swayam (MHRD) Portal

· Animal Diversity (https://swayam.gov.in/courses/5686-animal-diversity)

· Advances in Animal Diversity, Systematics and Evolution (https://swayam.gov.in/courses/5300-zoology)

Details of Formative assessment (IA) Theory for all the papers

Type of Assessment	**Weight age**	**Commencement**
Internal assessment test-1	5 marks	10th week
Internal assessment test-2	5 marks	12th week
Assignment	10 marks	
Total	**20 marks**	

General pattern of Theory Question paper with 3 hrs duration for all the semesters

Max. Marks=80

PART- A

Question number 1-10 carry 2 marks each (All questions are compulsory) 10X2=20marks

PART-B

Question number 11-18 carry 5 marks each. Answer any SIX. 6X 5=30 marks

PART-C

Question number 19-22 carry 10 marks each. Answer any THREE 3x10=30 marks

B.Sc. Semester–I

Discipline Specific Core

Course Title: Diversity of Non-Chordates and Parasitology (Practical)
Course Code:

Type of Course	Theory /Practical	Credits	Instruction Hour per week	Total No. of Lectures/Hours /Semester	Duration Of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC-2	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Understand basics of classification of non-chordates.
- Learn and understand the internal systems of non-chordates.
- Develop the skills to identify different classes and species of animals.
- Know uniqueness of a particular animal and economic importance of non-chordates.
- Enhancement of basic laboratory skill like keen observation and drawing.
- Help to know the stages of the life cycles of the parasites and the respective infective stages
- Understand the pathogencity of parasitic Protozoan's and Helminthes

Expt. No.	Course Title :Diversity of Non chordates and Parasitology (Practical) Code:	56hrs
1	Preparation and observation of protozoan culture. **Protozoa**: Study of *Amoeba*, *Euglena*, *Noctiluca*, *Paramecium* and *Vorticella* (Permanent slides/ Charts).	**4hrs**
2	**Porifera:** Study of *Sycon, Euplectella, Hyalonema, Spongilla*and *Euspongia* T.S of *Sycon*, Spicules and Gemmules (Specimens/ Permanent slides/ Charts)	**4hrs**
3	**Cnidaria:** Study of *Aurelia* and *Metridium*(Specimens). Slides/Charts of *Hydra*, *Obelia* - polyp and medusa, and *Ephyra* larva, **Study of Corals**- *Astraea, Fungia, Corallium, Gorgonia, Millepora*and *Pennatula*	**4hrs**
4	**Helminthes:** Study of *Planaria, Fasciola hepatic* adult and Larval stages,Ascaris- (Male and female), T.S. of male and female Ascaris (Specimens/Charts)..	**4hrs**
5	**Annelida:** Study of *Nereis, Heteronereis, Sabella, Aphrodite , Leech* (Specimens/Charts). Slide/Chart of T.S. of earthworm through typhlosole.	**4hrs**
6	**Arthropoda**: Studtyof *Panaeus, Palaemon, Astracus*, Scorpion, Spider, *Limulus, Peripatus, Millipede, Centipede*, Praying mantis, Termite Queen, Moth, Butterfly, Dung beetle /Rhinocerous beetle (Any six specimens). Slide/Chart of Larvae-Nauplius, Zoea, Mysis.	**4hrs**
7	**Mollusca:** Studyof*Chiton, Mytilus, Aplysia, Pila, Octopus, Sepia* (Specimens) and Glochidium larva (Slide/Chart). **Shell Pattern**- *Unio, Ostrea, Cypria, Murex, Nautilus, Patella, Dentalium,* Cuttlebone	**4hrs**
8	**Echinodermata**: Study of Astropecten, Brittle star, Sea Urchin, Sea Cucumber, Sea lilly (Specimens/Charts). Slides/Charts of Bipinnaria larva, Echinopluteus larva	**4hrs**

9	**Virtual Dissection/Cultured specimens:** Earthworm –Digestive system, Nervous system, Mounting of setae, nephridia, ovary, blood gland and spermatheca .	**8hrs**
10	Mounting of Insect mouth parts : Mosquito, Honey bee, Housefly**.**	**4hrs**
11	**Study of Protozoan parasites :** Slides /specimens of *Entamoeba histolytica, Plasmodium vivax (*Life cycle, pathogen icity, control measures and treatment)	**4hrs**
12	**Helminth parasites :** Slides /specimens of *,Taenia, Paragonimus, Ancylostoma, Enterobios, Wuchereria,* Ticks and mites (Life cycle, pathogenicity, control measures and treatment)	**8hrs**

SCHEME OF PRACTICAL EXAMINATION:

1. Explain the _____ system in _____Earthworm	10
2. Protozoan culture/ Rectal parasites / Nephredia /ovary /seta/mouthparts/blood glands/Spermatheca	04
3. Identifications (A to E)	10
4. Parasitology (spotting-2)	06
5. Viva	05
6. Journal	05
Total	**40**

Note: Same scheme may be used for IA (formative assessment test) and should be reduced to ten (10) marks.

B.Sc. Semester–II
Discipline Specific Core

Course Title: Chordate Biology and Comparative Anatomy (Theory)
Course Code:

Type of Course	Theory /Practical	Credits	Instruction Hour Per week	Total No. Of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-3	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Understand different classes of chordates, level of organization and evolutionary relationship between different subphyla and classes, within and outside each class.
- Study about diversity in animals making students understand about their distinguishing features.
- Appreciate similarities and differences in life functions among various groups of animals in Phylum Chordata.
- Comprehend the circulatory, nervous and skeletal system of chordates.
- Know about the habit and habitat of chordates in marine, freshwater and terrestrial ecosystems.
- Understand and compare the difference between organ systems in various groups.

Units	**Course Title: Chordate Biology and Comparative Anatomy (Theory) Code:**	**60 hrs**
Unit-1	**Chordates:** Origin of Chordates; Basic characters of chordates and classification uptoclasses. **Protochordates:** General features and phylogeny of Protochordata, Classification of Protochordates: **Hemichordata:** Type Study: *Balanoglossus*- habit and habitat, morphology, coelom. Tornaria larva and its affinities. **Urochordata:** Type study: *Herdmania*- habit and habitat, morphology, Ascidian tadpole-structure and its retrogressive metamorphosis. **Cephalochordata:** Type study: *Amphioxus* -habit and habitat, morphology, digestive system, feeding mechanism, excretory and circulatory system.	**15hrs**
Unit-2	**Origin of Chordata:** Dipleurula concept and the Echinoderm theory of origin of chordates **Agnatha:** General characters of Agnatha and classification uptoclasses. Salient features of Cyclostomata with examples. Ammocoete larva and its significance. Migration in Lamprey. **Pisces:** General characteristics of Chondrichthyes and Osteichthyes, Classification up to order. Migration, osmoregulation and swim bladder in fish. **Amphibia:** Origin of Amphibia, General characters and classification up to order, parental care and neoteny in Amphibia,	**15hrs**

	Reptilia: General characters and classification up to orders (living reptiles only) with suitable examples. Mesozoic reptiles. Arcade and fossae in reptiles. Poisonous and non-poisonous snakes, biting mechanism in snakes, types of venom.	
Unit-3	**Aves:** General characters and classification. Distinctive features of archaeornithes and neornithes with reference to palaeognathae, Impennae and Neognathae, with suitable examples. Flight adaptations, beak and foot modifications. Migration in birds.Flightless birds **Mammals:** General characters and classification up to orders. Distinctive features of prototheria and metatheria and eutheriawith examples. Salient features of eutheria. Important characters of primates, Chiroptera, Cetacea, Perissodactyla, Artidacyla, Carnivora, Rodentia, Lagomorpha, and Pholiodota with examples. Rat as type study (excluding muscular and skeletal system)	**15hrs**
Unit-4	**Comparative Anatomy of Vertebrates:** Comparative account of, heart and brain. Comparative account of Axial and Appendicular skeleton in Amphibians (Frog), Reptiles (Varanus), Aves (Pigeon) and Mammals (Rabbit)	**15hrs**

References:

1. Colbert *et al*: Colbert's Evolution of the Vertebrates: A history of the back boned animals through time. (5thed2002, Wiley–Liss).
2. Hildebrand: Analysis of Vertebrate Structure(4thed1995,JohnWiley)
3. Kenneth V.Kardong (20015) Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill
4. McFarland*et al.,*:Vertebrate Life (1979,Macmillanpublishing)
5. Parker and Haswell: Text Book of Zoology, Vol. II(1978,ELBS)
6. Romer and Parsons:The Vertebrate Body (6thed1986, CBS Publishing, Japan)
7. Young: The Life of Vertebrates (3rded 2006,ELBS/Oxford)
8. Weichert C.K. and William Presch(1970).Elements of Chordate Anatomy, Tata Mc Graw Hills.
9. Pough H. (2018). Vertebrate life X Edition, Pearson International.

Online Tools and Web Resources:

- https://www.khanacademy.org/science/biology/crash-course-bio-ecology/crash-coursebiology-science/v/crash-course-biology-123.
- https://opentextbc.ca/biology2eopenstax/chapter/chordates/

B.Sc. Semester–II
Discipline Specific Core

Course Title: Chordate Biology and Comparative Anatomy (Practical)
Course Code:

Type of Course	Theory /Practical	Credits	Instruction Hour Per week	Total No. Of Lectures/Hours /Semester	Duration Of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC-4	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Understand the external morphology of proto-chordates and chordates
- Study the cartilaginous, bony and ornamental fishes
- Understand the systematic position and classification of Chordates.
- Learn organization of different organ systems in a vertebrate model
- Study the comparative anatomy and internal systems of vertebrates
- Understand and compare the Skeletal system in different vertebrates

Expt. No.	Course Title: Chordate Biology and Comparative Anatomy (Practical) Code:	56 Hrs
1	**Protochordata**: Study of *Balanoglossus, Herdmania*and *Amphioxus,* T.S. of *Amphioxus* through pharynx and intestine. **Cyclostomata:** *Petromyzon, Myxine.* Ammocoete larva	**4 hrs**
2	**Pisces**: Study of cartilaginous fishes – *Torpedo, Trygon, Pristis, Mylioobaties, Scolidion. (Any four)* Bony fishes– Hippocampus, Echeneis, Exocoetus, Anguilla, Diodon,. Ophiocephalus, Clarias (Any six).	**8 hrs**
3	**Amphibia:**Study ofIchthyophis, Ambystoma, Axolotl larva, Siren, *Hoplobatrachustigerinus* ,*Duttaphrynusmelenostictus*(Bufo) , *Rhacophorus malabaricus,*	**4 hrs**
4	**Reptilia**: Study of Turtle, Tortoise, Mabuya, Draco, Chameleon, Varanus, Phyranosoma. Snakes**:** Typhlops, Dryophis,Hydrophis, Cobra, Krait, Russell's viper and, Crocodile	**4 hrs**
5	Aves: Study of Duck, Jacana, Coot, Indian roller, Owl, Brahminy kite, Koel	**4 hrs**
6	**Mammals** : Study of Pangolin, , Squirrel, Bat, Hedgehog, Hystrix and Loris	**4 hrs**
7	**Virtual Dissection/Cultured specimens:** Fish: Digestive system, Afferent and efferent branchial systems, Cranial nerves,	**8 hrs**
8	**Virtual Dissection/Cultured specimens:** Fish : Male Urinogenital system, Female Urinogenital system, Mounting of scales	**8 hrs**
9	Comparative anatomy of Heart, and Brain in Vertebrates	**4 hrs**
10	Skeletal system in Frog and Varanus	**4 hrs**
11	Skeletal system in Pigeon and Rabbit	**4 hrs**

FIELD ORIENTED PROJECTS:

1. Field Study is compulsory
2. Visit to Zoo/forest/sanctuaries/national park/surrounding area to study the animal diversity related to project i.e. study of fishes, amphibians, reptiles, birds and mammals.

SCHEME OF PRACTICAL EXAMINATION

1. Explain the _____ system of _____	08
2. Comparative anatomy (any one)	03
3. Osteology (any two)	06
4. Identify and comment on A to D	08
5. Field Study report	05
6. Viva	05
7. Journal	05
Total	**40**

Note: Same scheme may be used for IA (formative assessment test) and should be reduced to ten (10) marks.

B.Sc. Semester–III
Discipline Specific Core

Course Title: Cell Biology and Developmental Biology (Theory)
Course Code:

Type of Course	Theory /Practical	Credits	Instruction Hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC-5	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Understand principles and working of different types of microscopes
- Familiarize students with the structural and functional aspects of cell, the basic unit of life, and its different organelles.
- Understand the cyclic events and types of cell division, processes of cell death and cellular aging.
- Comprehend the knowledge on cancer cell and causes of cancer.
- Acquaint the developmental process in animals.
- Understand stages of development in frog and chick.

Units	**Course Title:Cell Biology and Developmental Biology (Theory)** **Code:**	**60 hrs**
Unit-1	**Microscopy:** Light, electron and phage contrast microscopes. Applications of optical microscopes, Numerical Aperture (NA) Resolution, Contrast, depth of field and depth of focus, Angular magnification, Spherical aberration, Chromatic aberration of optical system (definitions only). **Types of cells** (Eubacteria, archaebacteria, eukaryotes), **Prokaryotic cell organization** (Prokaryotic cell structure, Bacterial cell walls) **Eukaryotic cell organization** (Brief idea of structure and function of - Plasma membrane, Nucleus, Endoplasmic reticulum, Golgi apparatus, Mitochondria, Chloroplast, Lysosome, Peroxisome. Cytoskeleton	**15 hrs**
Unit-2	**Chromosomes**: Types of chromosomes, chromosomal fine structure, heterochromatin and euchromatin, Polytene chromosomes. **Nucleic acids** :Identification of genetic material, Hershey - Chase experiment, Structure of DNA, Watson and Crick DNA model- types of DNA, replication of DNA; RNA: Types, structure and functions **Cell cycle and cell division**: Various phases of mitosis and meiosis. Cellular ageing and cell death: Apoptosis: definition and significance Necrosis: definition and examples. **Cancer biology**: Types of cancer, oncogenes, carcinogenic agents. physical, chemical and biological, causes of cancer.	**15 hrs**

Unit 3	**Developmental Biology:** Introduction and scope of Developmental Biology. **Overview of gametogenesis**. Spermetogenesis and oogenesis **Fertilization:** Types and mechanism of fertilization, approximation of gametes, fertilizin and antifertilizin, acrosome reaction, amphimixis. Monspermic and polyspermic fertilization. Significance of fertilization. **Types of eggs and** C**leavag**e: Types of eggs based on amount and position of yolk. Cleavage: holoblastic, meroblastic, radial and spiral types with examples. **Early development of Frog**: Structure of frog's egg, cleavage, blastula, fate maps, gastrulation, morphogenesis, notogenesis, and neurulation. Metamorphosis in frog. **Parthenogenesis**: Kinds of parthenogenesis. Natural, arrhenotoky, and thelytoky. Artificial parthenogenesis, significance of parthenogenesis	**15 hrs**
Unit-4	**Organizer Phenomena**: Definition, potencies of the dorsal lip of the blastopore of amphibian gastrula, Brachet's experiment, experiment of Spemann and Mangold, induction, chemical nature of organizer, parts of organizer, theories of organizer phenomenon. **Development of Chick:** Extra embryonic membranes**:** Development, structure and functions of yolk sac, amnion, chorion and allantois. Structure of hen's egg, cleavage, blastula, gastrulation, origin and structure of primitive streak, structure of 18, 24, 36 and 48 hrs chick embryos. **Placenta**: Classification of placenta based morphological and histological structure with examples. Functions of placenta.	**15 hrs**

References:

1. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. VI EditionJohn Wiley and Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIIEdition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. V Edition.ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
5. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James(2008). *Molecular Biology of the Cell*, V Edition, Garland publishing Inc., New York.and London.
6. Inside the Cell (2005); US Department of Health Sciences, National Institute of Health,Natinal institute of General Medicine Sciences.
7. Lodish, H., D. Baltimore, A. Berk, L. Zipursky, M. Matsudaira and J. Darnell. (2010). Molecular Cell Biology, Eds. 3, Scientific American & W. H. Freeman. New York.
8. Powar C B.: Cell Biology, Himalaya Publication, Meerut
9. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
10. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press.

11. Carlson, R. F. Patten's Foundations of Embryology.
12. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers.
13. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press
14. Patten, Bradley M. (1957)Early embryology of Chick McGraw-Hill Book Company

Online Tools and Web Resources:

- https://swayam.gov.in/courses/5065-molecular-biology
- https://swayam.gov.in/courses/4916-molecular-biology
- https://www.youtube.com/user/cecedusat
- https://www.hhmi.org/biointeractive/human-embryonic-development
- https://www.khanacademy.org/science/biology/developmental-biology
- https://ocw.mit.edu/courses/biology/7-22-developmental-biology-fall-2005/index.htm
- https://embryology.med.unsw.edu.au/embryology/index.php/Main_Page

B.Sc. Semester–III
Discipline Specific Core

Course Title: Cell Biology and Developmental Biology (Practical)
Course Code:

Type of Course	Theory /Practical	Credits	Instruction Hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC-6	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Understand the properties of various chemicals used in preparation of fixatives and preservatives used for biological materials.
- Understand various stages of cell division.
- Learn the staining techniques for cytological materials and prepare permanent slides
- Understand developmental processes in animal models.
- Prepare stained permanent slides of developmental stages in Chick embryo

Expt. No.	Course Title: Molecular Cell Biology and Developmental Biology (Practical) Code:	56 Hrs
1	Study of fixatives and stains: Preparation of formaldehyde (4 to 10%), alcohol (70 to 100 %) Bouin's fluid, Carnoy's fluid, borax carmine (alcoholic), eosin (alcoholic), iron hematoxylin, acetocarmine, aceto-orcien, Schiff's reagent (Feulgen method) and Giemsa's stain	**8hrs**
2	Observation and study of permanent slides for mitosis, meiosis, and salivary gland chromosomes	**4hrs**
3	Squash preparation of onion root tip to study stages of mitosis	**4hrs**
4	Preparation of permanent slides of mitosis using onion root tip	**4hrs**
5	Squash preparation of Grass hopper testis/ flower bud to study stages of meiosis.	**4hrs**
6	Preparation of permanent slides of meiosis using Grass hopper testis/flower bud	**4hrs**
7	Preparation of polytene chromosome in Chironomus larvae	**4hrs**
8	Estimation of DNA by DPA method	**4hrs**
9	Estimation of RNA by Orcinol method	**4hrs**
10	Stages of development of frog: the study of cleavage stages, blastula, gastrula and neurula and various stages of tadpole	**4hrs**
11	Observation of various stages of frog development in nature	**4hrs**
12	Study of permanent slides of chick embryo: 18 hrs, 24 hrs, 36 hrs and 48 hrs whole mounts and T.S. of 18 hrs and 24 hrs, 36hrs chick embryos	**4hrs**
13	Mounting of chick embryo	**4hrs**
14	Preparation of permanent slides of chick embryo(wm)	**8hrs**

SCHEME OF PRACTICAL EXAMINATION

1.	Estimation of DNA/RNA/Squash preparation(mitosis/meiosis)	08
2.	Mounting of chick embryo	07
3.	Composition and preparation of stain /micrometry	03
4.	Identifications (Cell divison-1,Frog development-2, Chick development WM-1, TS.-1)	10
5.	Submission of 2 permanent slides (Chick embryo/cell division)	02
6.	Viva	05
7.	Journal	05
	Total	**40**

Note: Same scheme may be used for IA (formative assessment test) and should be reduced to ten (10) marks.

B.Sc. Semester–IV
Discipline Specific Core

Course Title: Animal Physiology and Biochemistry (Theory)
Course Code:

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-7	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Understand and explain different terms and processes in physiology.
- Articulate physiological mechanism of different systems in animals.
- Illustrate processes of digestion, respiration, circulation, nervous coordination, excretion and endocrine activities.
- Understand structure and function of bio molecules.
- Explain mechanism of enzyme action.
- Understand the process of bioenergetics involved in the production of cellular energy.

Units	**Course Title: Animal Physiology and Biochemistry (Theory)** **Course Code:**	**60 hrs**
Unit-1	**Digestion:** Mechanical digestion, chemical digestion. Digestion and absorption of proteins, carbohydrates and lipids. Hormonal regulation of enzyme secretion. **Respiration:** External and internal respiration. Respiratory pigments, hemoglobin, hemocyanin, erythrocruorin and hemerythrin. Physiology of respiration, exchange of gases, transport of oxygen, oxygen dissociation curves, Bohr effect, transport of carbon dioxide, chloride shift, respiratory quotient. **Circulation**: Types of circulation. Structure, functions and regulation of human heart. Blood pressure. Compostion of human blood. Neurogenic and myogenic hearts. **Muscle contraction**: Principal types of muscles. Ultrastucture of striated muscles, role of myosin, actin, tropomyosin, troponin and actinin; Mechanism of muscle contraction and relaxation, Chemical changes during muscle contraction. Neuromuscular junction	**15hrs**
Unit-2	**Structure and Types of Neuron:** Origin of action potential and its propagation in Myelinated and Non- Myelinated nerve, Saltatory conduction. Synapse: Types of Synapse and Synaptic Transmission **Excretion:** Excretion in aquatic, terrestrial and aerial animals: ammonotelism, ureotelism and uricotelism with examples; Ornithine cycle. Physiology of urine formation in man **Immunology**: Components of immune system, Bone marrow, thymus, spleen, bursa of Fabricius, payer's patches, T and B cells, antigens and antigenicity,	**15hrs**

	immunoglobulin, structure of immunoglobulin G (Ig G) and immunization AIDS: causative factors, effects and preventive measures	
Unit-3	**Study of Bio-molecules**: Carbohydrates: Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates. Proteins: Amino acids: Structure, Classification and General properties of α-amino acids; Physiological importance of essential and non-essential amino acids.Bonds stabilizing protein structure; Levels of organization in proteins; Protein denaturation; Introduction to simple and conjugate proteins. Lipids: Structure and significance: Physiologically important saturated and unsaturated fatty acids, Triacylglycerols, Phospholipids, Glycolipids and Steroids.	**15 hrs**
Unit-4	**Enzymes:** Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; **Enzyme kinetics;** Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax, Lineweaver-Burk plot; Multi-substrate reactions; **Enzyme inhibition**; Allosteric enzymes and their kinetics; Regulation of enzyme action. **Vitamins:** Characteristics and types of fat Soluble and water soluble vitamins. **Bioenergetics:** Glycolysis: Steps and energetics of Glycolysis. Brief idea of Glycogenesis, Glycogenolysis and Gluconeogenesis. Kreb's Cycle, Electron transport chain. Beta oxidation of fatty Acids.(Lipid Metabolism)	**15hrs**

References:

1. Introduction to Animal Physiology, Ian Kay, 2000, Bios Scientific Publishers Limited.
2. Textbook of Medical Physiology, Guyton A. C. & Hall J. E., 2006, 11th Edition, Hercourt Asia Pvt. Ltd. / W. B. Saunders Company.
3. Principles of Anatomy & Physiology, 2006, 11th Edition, Tortora G. J. & Grabowski S., John Wiley & sons, Inc.
4. Haematology: De Gruchi.
5. Human physiology, Vol. I & II, 1980, 12th Edn. Dr. C. C. Chatterjee, Medical Applied Agency, Kolkata.
6. Text book of Animal Physiology, 2008, 2nd Edn. Nagabhushanam, S. V. S. Rana,S. Kalavathy, Oxford University Press, India
7. Animal Physiology: Adaptation and Environment, 1997, Schmidt-Nielsen, Knut Cambridge University Press.
8. Principles of Biochemistry, 1993, 2nd Edn, Lehninger A. L. Nelson D.L. & Cox M.M. CBH Publisher and distributors, Delhi.
9. Biochemistry, 1995 5th Edn. Zuby G. Wm, C. Brown Communications USA.
10. Outline of Biochemistry, 1995 5th Edn., Conn E. E., Stumph P. K. Bruening G. & Doi,R. H. John Wiley & Sons, USA.

B.Sc. Semester–IV

Course Title: Animal Physiology and Biochemistry (Practical)

Course Code:

Type of Course	Theory /Practical	Credits	Instruction Hour Per week	Total No. of Lectures/Hours /Semester	Duration Of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-8	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Learn to identify the tests to detect the functional groups
- Observe the enzyme action
- Estimate the amount of protein from a given animal tissue.
- Acquaint the methods of blood cell counting
- Analyse the urine sample for normal and abnormal constituents.
- Estimate the haemoglobin levels in blood samples.
- Learn to monitor the blood pressure.

Expt. No.	**Course Title: Animal Physiology and Biochemistry (Practical) Course Code:**	**56 Hrs**
1	Qualitative tests for Carbohydrates: Monosaccharide, Disaccharide and polysaccharide	**8 hrs**
2	Qualitative tests for Proteins	**4 hrs**
4	Qualitative tests for Lipids	**4 hrs**
4	Action of salivary amylase	**4 hrs**
5	Quantitative estimation of protein (Spectrophoto meter)	**4 hrs**
6	Estimation of haemoglobin	**4 hrs**
7	RBC total count	**4 hrs**
8	WBC total count	**4 hrs**
9	WBC differential count	**4 hrs**
10	Blood clotting time and Preparation of hematin crystals	**4 hrs**
11	Normal and abnormal constituents of urine	**4 hrs**
12	Osmotic hemolysis in blood cells	**4 hrs**
13	Demonstration of Blood pressure monitoring	**4 hrs**

SCHEME OF PRACTICAL EXAMINATION

1. Qualitative test for proteins/carbohydrates/fats	10
2. Normal/abnormal constituents of urine	05
3. Preparation of hematin crystals/ Clotting time/ Action of Salivary amylase	05
4. Haemoglobin estimation /TC/DC	10
5. Viva	05
6. Journal	05
Total	**40**

Note: Same scheme may be used for IA (formative assessment test) and should be reduced to ten (10) marks.

B.Sc. Semester–V
Discipline Specific Elective

Course Title: Histology, Applied Zoology and Biostatistics (Theory)
Course Code:

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures /Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE-1	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Describe and discuss different structures and functions of tissues and organs.
- Understand the Importance of vermin culture in organic farming.
- Learn the methods cultivation and harvesting the fisheries resources and their by-products.
- Understand the economics of rearing the poultry birds and raising the dairy animals
- Learn silkworm rearing techniques and Insect pest management
- Use of the statistical tool in presentation and analysis of data.

Units	**Course Title:Histology, Applied Zoology and Biostatistics(Theory)** **Course Code:**	**60 hrs**
Unit-1	**Histology**: Definition and scope of Histology, Review of types of animal tissues (Epithelial, connective, nervous and muscular tissue). Study of histological structure and functions of the following mammalian organs:Tongue, Salivary gland, Stomach, Intestine, Testis, Ovary, Liver, Pancreas, Thyroid, Adrenal and Kidney	**15 hrs**
Unit-2	**Vermitechnology:** Earthworm life cycle: Type of earthworms based on habitat and feeding habit. Establishment of vermicompost unit. Advantage of vermicompost over farmyard manure. Vermi meal: worm protein and its importance in fish and poultry feed. Vermi wash. **Aquaculture**: Fresh water, brackish and marine fish resources in India. culture of Exotic and Indian Major carps. Monoculture, Composite fish culture. Induced fish breeding. Crustacean and Molluscan fishery. Prawn and pearl culture. **Poultry**: Introduction, Indigenous and exotic poultry breeds. Methods of poultry keeping, nutritive value of egg and meat, poultry diseases	**15hrs**
Unit-3	**Dairy technology**: Introduction, success story of Indian dairy industry. Indigenous and exotic breeds of cattle, Indian Buffalo breeds. Breeding and cattle improvement in India, Milk by products, Nutritive value of milk **Sericulture**: Mulberry varieties and cultivation methods. Types of silkworms, (Mulberry silkworms and Non-Mulberry silkworms).Life history of silkworm. Silkworm rearing: chawki rearing and late age worms rearing. Mounting and harvesting. Silk worm diseases **Insect Pest management**: Important agricultural/ horticultural pests. Life cycle	**15hrs**

	and damaged caused by pests of cotton, sorghum, pulses and fruits. House hold pests. Integrated pest management: principle, concept and practice.	
Unit-4	**Biostatistics** :Use of statistics in life sciences, data collection, observations and variables, sampling and sampling methods, representation, tabular and graphical representations; frequency tables, line graphs, bar graphs, histograms, frequency polygon and curve and pie charts; measure of central tendency; mean; median and mode. Measures of dispersion: range, standard deviation; Standard error. Chi-squire test, t-test and ANOVA. Use of SPSS software and Microsoft excel for statistical analysis.	**15hrs**

References:

1. Ross, M. H. & W. Pawlina (2010). Histology: A Text and Atlas, 6th Edition, Lippincott Williams & Wilkins, Maryland.
2. Jhingran, V.G. (1982) Fish and Fisheries in India. Hindustan publication Corp, India.
3. Pandey, K and J.P. Shukla (2013) Fish and Fisheries. Rastogi publication
4. Shukla, G.S. &Upadhyay, V.B : Economic Zoology, 4e, 2002, Rastogi.
5. Srivastava, C.B.L. : Fishery Science and Indian Fisheries, 2002, KitabMahal.
6. Pandey M. (2015): Biostatistics-Basic and Advanced-MV Learning.
7. Dina NathPandit (2022): Statistics: A Modern Approach :Hindustan Publishing Corporation.

Web sources:

8. http://agropedia.iitk.ac.in/content/integrated-fish-cum-pig-farming
9. http://vikaspedia.in/agriculture/poultry/quail-farming
10. https://nptel.ac.in/courses/126104003/LectureNotes/Week-1_04 Pest,pdf

B.Sc. Semester–V
Discipline Specific Elective

Course Title: Histology, Applied Zoology and Biostatistics (Practical)
Course Code:

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration Of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE-2	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Learn the technique of fixing and processing the animal tissue for microtomy
- Understand different staining methods to process the tissue and prepare the slides.
- Learn the methods of establishing vermicompost unit and harvesting the compost
- Understand the breeds of poultry and the methods of rearing them.
- Learn different methods involved in fish culture and keeping dairy animas.
- Use the statistical tools analysis and interpretation of data.

Expt. No.	**Course Title:Histology, Applied Zoology and Biostatistics (Practical) Course Code:**	**56 hrs**
1	Observation of mammalian histology slides of the organs studied in the theory paper	**4hrs**
2	Study the process of fixing, processing and embedding of tissue for microtomy. Preparation of paraffin block and section cutting and spreading	**4hrs**
3	Staining of histological tissues	**4hrs**
4	Preparation of permanent histology slides, two slides to be submitted at the time of practical examination	**4hrs**
5	Study of different Earthworms and establishment of compost pit	**4hrs**
6	Study of indigenous and Exotic poultry breeds and the diseases affecting poultry birds	**4hrs**
7	Study of exotic and indigenous Dairy breeds and the diseases affecting them	**4hrs**
8	Study of Inland fishes, commercially important marine fishes, crustacean and molluscan fishery.	**4hrs**
9	Study of lifecycle of silk moth	**4hrs**
10	Silk worm diseases	**4hrs**
11	Study of Insect pests and their control measures(IPM)	**4hrs**
12	Biostatistics practical: Measures of central tendency i). Obtain the mean, median and mode ii). Form a frequency distribution table of the data and then compute mean, median and mode, plotting of pie charts, bar graph and frequency polygon	**4hrs**
13	Demonstration of use of Microsoft excel and SPSS software for statistics applications	**4hrs**

14	Visit to nearby poultry , dairy and vermiculture unit	**4hrs**

SCHEME OF PRACTICAL EXAMINATION:

1. Preparation of permanent histology slide	08
2. Identifications	
a. Histology –Any 2	04
b. Poultry / Dairy breed/ silkworm life cycle(one each)	06
c. Fishery science(2)	04
3. Histology slide submission – 2 slides	04
4. Biostatistics	04
5. Viva	05
6. Journal	05
Total	**40**

Note: Same scheme may be used for IA (formative assessment test) and should be reduced to ten (10) marks.

B.Sc. Semester–V
Discipline Specific Elective

Course Title: Animal Behaviour and Evolutionary Biology (Theory)
Course Code:

Type of Course	Theory /Practical	Credits	Instruction Hour Per week	Total No. of Lectures/Hours /Semester	Duration Of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSE-3	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Students will be able to picturize fundamentals of animal behaviour
- Learn patterns of animal behaviour.
- Analyse social and reproductive behaviour in animals
- Understands the theories of origin of life on earth.
- Define the Lamarckism and Darwinism concepts of evolution.
- Analyse the evidences supporting the evolutionary process.
- Trace the geological time scale and events of mass extinction.
- Study the phases in the evolution of horse and man.
-

Units	**Course Title: Animal Behaviour and Evolutionary biology (Theory)** **Course Code:**	**60 hrs**
Unit-1	**Introduction to Animal Behaviour:** Origin and history of Ethology; Brief profiles of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen. Proximate and ultimate causes of behaviour, Methods of studying animal behaviour **Patterns of Behaviour** Stereotyped behaviours (Orientation, Reflexes); Individual behavioural patterns; Instinct vs. Learnt behaviour; associative learning, classical and operant conditioning, habituation, imprinting. **Coloration and mimicry**: Definition, types of mimicry, Batesian and Mullerian, protective, aggressive and warning mimicry with suitable Indian examples Animal communication: Functions of signals, odours, sounds and light	**15hrs**
Unit-2	**Social Behaviour**: Aggregations - Schooling in fishes, flocking in birds, herding in mammals; group selection, kin selection, altruism, inclusive fitness, and social organization in insects and primates. **Reproductive Behaviour**: Evolution of sex, reproductive strategies, mating systems, courtship, sperm competition, sexual selection and parental care. Hormones and behaviour, pheromones and behaviour. **Biological rhythms**: Circadian, circannual, tidal/lunar, ultradian, infradian rhythms, synchronization of biological rhythms, phase shift. Photoperiodism with reference to birds and mammals	**15hrs**
Unit-3	**Evolution:** Origen of life on earth **.Theories of Evolution:** Lamarckism, Darwinism (Natural, Sexual and Artificial selection), Mutation Theory of	**15hrs**

	Evolution (Hugo de Vries) and Neo- Darwinism (Synthetic theory of evolution, gene mutation, gene flow, genetic drift, Hardy-Weinberg equilibrium). Adaptive radiations: Patterns of evolution (Divergence, Convergence, Parallel, Co-evolution).	
Unit-4	**Evidences of Evolution**: Relationship among organisms, Morphological and Anatomical evidences, Embryological evidences, Paleontological evidences, Bio-geographical evidences, Biochemical/Physiological evidences, Cytological evidences, Taxonomical evidences and Current evidences. **Geological Time Scale**/ Stratigraphic Scale. **Species Concept and Extinction**: Concept of species; Modes of speciation: Allopatric and Sympatric species; Mass extinction (Causes, Names of five major extinctions) Origin and evolution of Human and Horse**.**	**15hrs**

References:

1. An Introduction to animal behaviour: Aurbrey Manning and Marian S. Dawkins, Cambridge University Press 1995.
2. Essentials of organizational behaviour 5thed : Stephan Robbins, Prentics Hall of India New Delhi, 1997.
3. Animal Behaviour: McFarland D. ELBS With Longman, 1985.
4. Ethology: Barnett.
5. Ridley, M (2004) Evolution (3rdedition) Blackwell Publishing
6. Hall, B.K. and Hallgrimson, B(2008)Evolution(4thedition) Jones and Barlett Publishers
7. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). Evolution. ColdSpring, Harbour Laboratory Press.
8. Campbell, N. A. and Reece J. B. (2011). Biology. IX Edition, Pearson, Benjamin, Cummings.
9. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.

B.Sc. Semester–V
Discipline Specific Elective

Course Title: Animal Behaviour and Evolutionary biology (Practical)
Course Code:

Type of Course	Theory /Practical	Credits	Instruction Hour Per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSE-4	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Identify and differentiate the castes in social insects.
- Understand the courtship rituals and behaviours in different groups of animals
- Identify the different types of nests and nesting materials
- Verify Hardy-Weinberg principle to determine allelic frequency in a population
- Study the connecting links and fossils
- Trace the different phases of human evolution
- Understand the life of Dinosaurs

Expt. No.	**Course Title: Animal Behaviour and Evolutionary Biology (Practical) Course Code:**	**56 hrs**
1	Identification of castes in social insects	**4hrs**
2	Observation of courtship behaviour in animals (Charts/ videos)	**4hrs**
3	Observation of parental care in animals (Charts/ Videos)	**4hrs**
4	Observation of different types of nests and nest materials (Charts/Models)	**4hrs**
5	Study of colouration and mimicry (Charts / Vedeos)	**4hrs**
6	Application of Hardy-Weinberg principle to determine allelic frequency of: a. PTC trait in man b. blood group trait in man	**4hrs**
7	Study of connecting links and fossils (models/pictures); Connecting links/ Living fossils: Neopilina, Peripatus, Limulus, Latimeria, Sphenedon, Archeopteryx and Duck billed platypus	**4hrs**
8	Study of homology and analogy from suitable examples**.**	**8hrs**
9	Vestigial organs: Vermiform appendix, Wisdom teeth, Coccyx (tail bone), Tonsils, Body hairs, Nipples on males, Nictitating membranes of eye (Any three)	**8hrs**
10	Evolution of man and horse (charts or models)	**4hrs**
11	Mesozoic reptiles (charts or models)	**8hrs**
13	**Project work on** :Nests (Insect/ Bird), Colouration and mimicry/ Courtship behaviour (Visual/ Vocal)/ parental care/ organization of colony in insects	

SCHEME OF PRACTICAL EXAMINATION

1.	Identification	
	a) Nest (1), colouration / mimicry (1)	6
	Castes in social insects (1)	
	b) Homologous/ analogous organ (1)	8
	Living fossil (1) vestigial organ (1)	
	Connecting links (1)	
2.	Hardy-Weinberg principle (allelic frequency test problem)	8
3.	Project work	8
4.	Viva	05
5.	Journal	05
	Total	**40**

Note: Same scheme may be used for IA (formative assessment test) and should be reduced to ten (10) marks.

B.Sc. Semester–VI
Discipline Specific Elective

Course Title: Ecology, Zoogeography & Wild Life Biology (Theory)
Course Code:

Type of Course	Theory /Practical	Credits	Instruction Hour Per week	Total No. of Lectures/Hours /Semester	Duration Of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSE-5	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Develop an understanding of how animals interact with each other and their natural environment
- Get knowledge about all types of ecosystems, food chains, webs and energy models.
- Develop the ability to use the fundamental principles of wildlife ecology to solve local, regional and national conservation and management issues.
- 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

Units	**Course Title: Ecology, Zoogeography & Wild Life Biology (Theory)** **Course Code:**	**60 Hrs**
Unit-1	**Ecology:** Introduction to ecology, Definition, Types of ecosystem: Terrestrial, Aquatic, Desert, Grassland and Aerial . A biotic factors: Temperature and Light Food chain and Food web, Trophic levels.,. **Marine habitat:** Zonation of the sea and ecological classification of marine biota, coastal ecology, estuarine ecology and mangroves. **Freshwater habitat**: Lentic and Lotic systems. Ecological classification of fresh water animals.	**15hrs**
Unit-2	**Environmental Pollution:** Definition, types of pollutants, air, noise, soil, water and thermal pollution, ozone layer depletion, biomagnifications, bioaccumulation and bioremediation. Effects of pollution on plants and animals. **Toxicants –** Natural and synthetic toxicants and toxicity measurements. Global warming, Acid rain, Bio-accumulation, Bio-magnification, Eutrophication: types and its impact.	**15hrs**
Unit-3	**Zoogeography:** Study of distribution of animals in different zoogeographic realms **Distribution of Wildlife in India:** The Himalayan ranges, The peninsular India sub-region, Deccan plateau, Western ghats, Eastern hill chain, Aravali ranges, Indian desert, Tropical rain forests, Wildlife in	**15 hrs**

	Andaman and Nicobar Islands. **Wild life problems:** Hunting, overharvesting, habitat destruction &degradation, over population, and possibilities of climatic changes.	
Unit-4	**Wildlife Management and Conservation:** In-situ and ex-situ conservation methods;Wildlife sanctuaries, National parks, Biosphere reserves, Project Tiger, Project Elephant Project Lion, Zoological Gardens, **Habitat preservation and Captive breeding.** Wildlife Protection Act, 1972, Causes and depletion of Wildlife, General strategies and issues, Concept of home range and territory, Animal census, Tracing movement and Remote sensing and GIS	**15hrs**

References:

1. Colinvaux, P.A.(1993) Ecology (2ndedition) Wiley, John and Sons, Inc.
2. Krebs,C.J. (2001) Ecology (6thedition) Benjamin Cummings.
3. Odum,E.P.,(2008)Fundamentals of Ecology. Indian Edition. Brooks/Cole. (3rdEdition) Blackwell Sci.
4. Kendeigh, FC. (1984) Ecology with Special Reference to Animal and Man. Prentice HallInc.
5. Caughley,G., and Sinclair, A.R.E.(1994)Wildlife Ecology and Management. Blackwell Science.
6. Woodroffe,R.,Thirgood, S. and Rabinowitz,A.(2005) People and Wildlife, Conflict or Coexistence? Cambridge University.
7. Bookhout,T.A.(1996) Research and Management Techniques for Wildlife and habitats(5thedition) The Wildlife Society,Allen Press.
8. Sutherland,W.J.(2000)The Conservation Handbook: Research, Management and Policy. Blackwell.

B.Sc. Semester–VI
Discipline Specific Elective

Course Title: Ecology, Zoogeography & Wild Life Biology (Practical)
Course Code:

Type of Course	Theory /Practical	Credits	Instruction Hour Per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSE-6	**Practical**	**02**	**03**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Understand the basic concepts of environmental sciences, ecosystems, natural resources, population, environment and society.
- Understand the basic concepts of toxicology, their impact on human health and remedial measures
- Provide understanding and knowledge on modern concepts in wildlife management and relevant conservation policies and legislation and their enforcement mechanism at Global and Local Level.
- Understand the scientific approach to wildlife management and planning.
- Develop scientific skills for resolving human wildlife conflict including capture, handling, care and management of wild animals.

Expt. No.	**Course Title: Ecology, Zoogeography & Wild Life Biology (Practical) Course Code:**	**56 hrs**
1	Collection of water sample and analysis of physical parameters of water: Temperature, pH, Electrical Conductivity.	**4hrs**
2	Estimation of chemical parameters of water: Dissolved Oxygen (O_2), Carbon Dioxide (CO_2),	**8hrs**
	Estimation of Hardness, Chloride, Alkalinity, Total dissolved solids (TDS).	**8hrs**
3	Analysis of physical parameters of soil: pH, EC, Soil moisture, Soil temperature	**4hrs**
4	Determination of organic matter in the soil sample	**4hrs**
5	Study of tropical pond as an ecosystem: Study of flora and fauna and interaction between the various constituents using charts	**4hrs**
6	Analysis of air pollution: Air monitoring for particulate matter	**4hrs**
7	Collection, preservation and estimation of zooplanktons	**4hrs**
8	Study of threatened animals of India (charts/models/pictures): Tiger, Lion, one horned Rhinoceros, Golden langur, Lion tailed monkey, Musk deer, Kashmir stag, Great Indian horn bill and Indian rock python	**4hrs**
9	Location of Tiger reserves, National parks, Biosphere reserves, Wildlife sanctuaries of India on Map.	**4hrs**
10	Location of animals in different zoogeographic realms	**4hrs**

11	Visit to Zoo/ Sanctuaries/ National parks/ Biosphere reserves	**4hrs**
12	A**ny other practical depending upon feasibility**	

SCHEME OF PRACTICAL EXAMINATION

1.	Estimation	10
2.	Identification – 5	10
3.	Project work report on ecology/wildlife biology	10
4.	Viva	05
5.	Journal	05
	Total	**40**

Note: Same scheme may be used for IA (formative assessment test) and should be reduced to ten (10) marks.

B.Sc. Semester–VI

Discipline Specific Elective

Course Title: Genetics, Biotechnology and Nanotechnology (Theory)
Course Code:

Type of Course	Theory /Practical	Credits	Instruction Hour Per week	Total No. of Lectures/Hours /Semester	Duration Of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSE-7	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Learn Mendelian principles of inheritance.
- Analyse causes and factors that cause various genetic disorders
- Understand mechanisms of sex determination
- Learn different types of mutations and their importance.
- Understand principles involved cell culture techniques
- Learn the techniques involved in animal cloning
- Understand applications of biotechnology in different fields

Units	**Course Title: Genetics, Biotechnology and Nanotechnology (Theory)** **Course Code:**	**60 hrs**
Unit-1	**Introduction:** Heredity and environment, definition of genotype, phenotype, Mendel and his contributions, monohybrid and dihybrid crosses Interaction of genes: Supplementary factors, Dominant epistasis, Recessive epistasis, Complementary factors, Lethal genes Multiple alleles: Inheritance of coat colour in rabbit, isoalleles – psuedoalleles and position effect, ABO blood groups in human. Rh factor **Linkage and crossing over:** Linkage in Drosophila, theories of linkage, crossing over, cytological basis of crossing over, significance of crossing over, genetic map of chromosomes **Sex determination**: Chromosomal mechanism of sex determination, genic balance theory, gynandromorphs and intersexes. Environmental and hormonal effects on determination of sex. Amniocentesis **Sex linked inheritance:** Sex linked inheritance in Drosophila and man. Hemophilia and color blindness in man. Sex linkage in poultry. Y linked genes	**15hrs**
Unit-2	**Mutation**: Chromosomal aberrations, molecular basis of gene mutation and types **Human genetics**: Karyotype analysis: normal male, normal female, Down's syndrome, catcry syndrome, Turner syndrome, Klinefelter syndrome, and 21 trisomy; Common human genetic disorders, inborn errors of metabolism, albinism, phenylketonuria, alkaptoneuria, sickle cell anemia, thalassemia, Huntington,s chorea. Eugenics **Extra chromosomal inheritance**:Kappa particles in paramecium	**15hrs**

	Genetic code and gene expression: , Properties of genetic code, Wobble hypothesis, dogma of molecular cell biology, protein synthesis, Operon concept	
Unit-3	**Animal Biotechnology**: Introduction**:** Concept, scope, development, current status and future of animal biotechnology. **Animal cell culture**: Cell culture techniques; Cell lines and storage. Equipments, Culture media, Applications of animal cell culture. Gene cloning: Method of gene cloning; Molecular tools; Restriction enzymes, ligases and other enzymes, cloning vector. Application of gene cloning. Gene transfer techniques- Transformation; Microinjection; Electroporation; Polycations; Lipofection and Retroviral infection	**15hrs**
Unit-4	**Animal cloning**: Cloning in different animals with special reference to Dolly; Somatic cell nuclear transfer (SCNT) Transgenic animals, Gene therapy. Application of Animal Biotechnology**:** Production of regulatory proteins, Production and applications of monoclonal antibody, Recombinant vaccines; DNA vaccines **Nanotechnology**: Introduction to nano science and nanotechnology, Types of nano-materials nano-biotechnology in healthcare, environmental nanotechnology.Nanoparticles: Properties, synthesis, characterization and applications of nanotechnology	**15hrs**

References:

1.Glick, B. R., and Pasternak, J. J. *Molecular Biotechnology: Principles and Applications of Recombinant DNA* – II Ed. A. S. M. Press, 1998.

2. Tamarin, R. H. *Principles of Genetics.* V Ed. Wm. C Brown Publishers 1996.

3.Snustad, D. P., and Simmons, M. J. *Principles of Genetics.* John Wiley and Sons, Inc, 2003

4. Atherly, A. G., Girton, J.R., and Mcdonald, J. F. *The Science of Genetics*.Saunders College, 1999.

5. GanesV : Benjamin Lewin, CBS Pub. & Dist. New Delhi. 1997.

6. Gene Structure and Transcription : Trevor B.B. and Julian Burke, Oxford Univ. Press 1998.

7. Principles of Genetics 10th Ed: Eldon John Gardner, Michael J Simmons and D. Peter

8.Snustad., John Wiley & Sons N. Y. 1998. Concepts in Biotechnology:Eds., D.Balasubramanian, C.F.A. Bryce, K. Dharmalingam, J.Green and KunthalaJayaraman., University Press, Hyderabad, 1996.

9.Textbook of Nanoscience and Nanotechnology By B.S. Murty, P. ShankarBaldev Raj, B BRath, James Murday. Springer, 1 edition 2013.

10. Nanotechnology : Principles and Practices S. K. Kulkarni, Capital Publishing Company.

B.Sc. Semester–VI
Discipline Specific Elective

Course Title: Genetics, Biotechnology and Nanotechnology (Practical)
Course Code:

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration Of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSE-8	**Practical**	**02**	**03**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Study and interpret the changes in chromosomal pattern and identify the genetic disorders
- Identify the different mutant forms in drosophila
- Solve genetic problems related to Mendelian principles of inheritance.
- Calculate allelic frequency
- Learn to extract DNA and RNA
- Learn to prepare different media

Expt. No.	**Course Title: Genetics, Biotechnology and Nanotechnology (Practical) Course Code:**	56 hrs
1	Karyotype analysis: normal male, normal female, Down's syndrome, Catcry syndrome, Turner's syndrome, Klinefelter's syndrome, and 21 trisomy	**8 hrs**
2	Observations on Mutant forms of Drosophila.	**4 hrs**
3	Genetic problems: monohybrid inheritance (4), dihybrid inheritance (4)	**4 hrs**
4	Genetic problems: multiple alleles – ABO blood groups in humans (4)	**4 hrs**
5	Genetic problems: sex linked inheritance in Drosophila (2) and man (2)	**4 hrs**
6	Calculation of allele frequency – PTC (Phenyl Thio-Carbamide), tongue rolling, attached ear lobes.	**8 hrs**
7	Extraction/isolation of DNA and RNA from animal tissues/plant tissues	**8 hrs**
8	Preparation of buffers used in animal biotechnology	**4 hrs**
9	Preparation of different types of media	**4 hrs**
10	Demonstration of Agarose Gel Electrophoresis	**4 hrs**
11	Demonstration of Instruments used in animal Biotechnology (Charts. models)	**4 hrs**

SCHEME OF PRACTICAL EXAMINATION

1. Karyotype analysis	08
2. Extraction/isolation of DNA/RNA	07
3.Mutant forms of Drosophila (Any 2)	06
4/Genetic problem (3) –Monohybrid, dihybrid, multiple alleles and sex linked inheritance in drosophila and man	09
5.Viva	05
6.Journal	05
Total	**40**

Note: Same scheme may be used for IA (formative assessment test) and should be reduced to ten (10) marks.

OPEN ELECTIVE

B.Sc. Semester–IV semester

Zoology -Open elective-1

Course Title: Economic Zoology **(Theory)**
Course Code:

Type of Course	Theory /Practical	Credits	Instruction Hour Per week	Total No. of Lectures/Hours /Semester	Duration Of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OE-1	**Theory**	**03**	**03**	**45hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Learn the culture and economics of inland and marine fishes
- Understand different poultry breeds and their rearing process
- Learn to establish vermiculture unit and harvest the compost
- Understand the methods involved in Lac cultivation
- Learns silkworm rearing techniques.
- Understand the concept of integrated pest management

Units	**Course Title:** Economic Zoology **(Theory) Course Code:**	45 hrs
Unit-1	**Introduction:** Over view and importance of Economic Zoology **Fisheries:** Inland fisheries; Culture of major carps and exotic carps; Composite fish culture. Off-shore fisheries- commercially important marine fishes Sardine, Mackerel, Pomfret, Shark and ray fishes. Ornamental fishes; Crustacean and Molluscan fishery. Pearl culture; Fish by-products. **Poultry:** Principles of poultry housing, different breeding systems. Exotic and indigenous breeds. Management of layers and broilers: economics of meat and egg production. Diseases of poultry	**15 hrs**
Unit-2	**Vermiculture:** Establishment of vermiculture unit; Earthworm as a tool for the conversion of biodegradable wasteinto vermicompost; Earthworm protein as poultry and fish feed; Vermiwash. **Dairy science**: Indigenous and Exotic breeds. Principles and modern trends inbreeding dairy animals. Dairy products: Processing, preservation and marketing of milk and milk products. Nutritive value of milk. Dairy pathology: Viral, bacterial and parasitic (Endo-Ecto) infections. Vaccination and control of disease	**15 hrs**
Unit-3	**Sericulture, Lac culture and Insect pest management:** Importance of sericulture as a rural industry; Life cycle of *Bombyxmori*; Modern rearing methods, reeling, grading and marketing. Silkworm diseases. **Lac culture**: Cultivation and uses of lac. **Insect pest management**: Pests of economically important crops; Household pests; Damages caused by pests; Integrated Pest Management (IPM)- Different components and general idea about the biocontrol agents; Vertebrate(birds and rodents) pest management.	**15 hrs**

References:

1. Jhingran, V. G. *Fish and Fisheries of India*. Hindustan Publishing Corporation (India) New Delhi. 1983
2. Gupta, P. K. *Vermicomposting for sustainable Agriculture*. Agrobios (India) 2003
3. Dent, D. *Insect Pest Management*- II Ed. CABI, 2000.
4. Van Emden, H. F. *Pest Control*-II Ed. Cambridge Univ Press, 1989
5. JawaidAhsan and Sinha, S. P. *A hand book on Economic Zoology*, S. Chand and Co. Ltd. New Delhi. 2000.
6. Upadhya, R. K., Mukerji, K. G. and Rajak, R. L. *IPM system in Agriculture*. Vol. I and II. AdityaBooks Private Ltd. New Delhi
7. Jadhav and Sidiqui. *Handbook of poultry production and management*. Jaypee publishers, 2010.
8. Arthur, R and William, H. A. *Farming for pleasure and profit*: *Dairy farming Management of cows*. Kessinger Publishing Company, 2010.
9. Dhaliwal, G. S., and Heinrichs E. A. *Critical issues in Insect Pest Management.* CommonwealthPublishers, New Delhi, 1998.
10. Clive A Edwards, Norman Q Arancon , Rhonda L Sherman (Edtors) Vermiculture Technology : Earthworms, Organic wastes and Environmental Management 1 ed.CRS press.2010.
11. Dokuhon,Z.S. *Illustrated text book of Sericulture*. Oxford and IBH publishing Co., New Delhi,1998.

B.Sc. Semester–V semester

Zoology Open elective-2

Course Title: Public Health and Hygiene (Theory)
Course Code:

Type of Course	Theory /Practical	Credits	Instruction Hour Per week	Total No. of Lectures/Hours /Semester	Duration Of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
OE-2	**Theory**	**03**	**03**	**45hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Describe maintenance of personal hygiene
- Classify food into micro and macro nutrients
- Explain Non-communicable diseases/Life style diseases
- Discriminate between a pandemic, an epidemic, endemic, and an outbreak .
- Review Nutrient deficiency diseases

Units	**Course Title: Public Health and Hygiene (Theory)** **Course Code:**	**45 hrs**
Unit-1	Maintenance of personal hygiene Introduction to public health and hygiene- determinants and factors. Pollution and health hazards; water and air borne diseases. Radiation hazards: Mobile Cell tower and electronic gadgets (recommended levels, effects and precaution). Role of health education in environment improvement and prevention of diseases. Personal hygiene, oral hygiene and sex hygiene	**15 hrs**
Unit-2	Nutrient deficiency diseases Classification of food into micro and macro nutrients. Balanced diet, dietary plan for an infant, normal adult, pregnant woman and old person. Importance of dietary fibres. Significance of breast feeding. Malnutrition anomalies – Anaemia (Iron and B12deficiency), Rickets, Goitre (cause, symptoms, precaution and cure). Substitution of diet with required nutrients to prevent malnutrition disorders.	**15 hrs**
Unit -3	**Communicable and contagious diseases**: Infectious agents responsible for diseases in humans. The difference between a pandemic, an epidemic, endemic, and an outbreak. **Communicable viral diseases**- Covid -19, Measles, Chicken pox, Poliomyelitis, Swine flu, dengue, Chikun gunya, and Hepatitis. **Communicable bacterial diseases**: Tuberculosis, Typhoid, Cholera, Tetanus, Plague, Whooping cough, Diphtheria, Leprosy.	**15 hrs**

	Sexually transmitted diseases- AIDS, Syphilis. Health education and preventive measures for communicable diseases **Non-communicable diseases and cure**: Non-communicable diseases/Life style diseases: hypertension, stroke, coronary heart disease, myocardial infarction. Osteoporosis, osteoarthritis and rheumatoid arthritis-cause, symptom, precautions. Diabetes- types and their effect on human health. Gastrointestinal disorders-acidity, peptic ulcer, constipation, piles (cause, symptoms, precaution and remedy) etc. Obesity (Definition and consequences). Mental illness (depression and anxiety).	

References:

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

SKILL ENHANCEMENT COURSE

B.Sc. Semester–IV, V, VI semester

SKILL ENHANCEMENT COURSE

Course Title: Bee Keeping
Course Code:

Type of Course	Theory /Practical	Credits	Instruction Hour Per week	Total. No of Lectures/Hours /Semester	Duration Of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
Skill	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): Upon completion of the course, students should be able to:

- Describe the concepts of apiculture, understands traditional and modern bee keeping methods.
- Understands composition and properties of honey and its application in various fields.
- Demonstrate the technique of handling the bees and processing of honey
- Compare the indigenous and exotic species of honeybees and differentiate queen, workers and drone bees.

Expt. No.	Course Title: Bee Keeping Course Code:	56 hrs
1	**Introduction to Apiculture**: History of bee keeping, Scope and importance of bee keeping, Traditional bee keeping, Modern beekeeping. Beekeeping practices in India. Role of Khadi Gramodyog and Village development Corporation in apiculture development in India.	**4 hrs**
2	**Biology of Honey bee**: Indigenous and exotic bees: Colony and social organization in honeybees:– Role of Queen, drone, worker.	**4 hrs**
3	Morphology and Anatomy of bees, study of Digestive system ,	**4 hrs**
4	Study of sting apparatus, mouth parts,	**4 hrs**
5	Study and mounting of wax glands, pollen brush and pollen basket	**4 hrs**
6	**Bee keeping equipment:** Type Hives, Langstroth hives, Honey extractor, Smoker, Bee Veil, Gloves, Knife etc.	**4 hrs**
7	**Honey – Honey extraction & handling** — Processing of honey. Quality control standards. Composition and properties of honey. Honey testing kit. Application in various fields: Medicinal properties. Value added honey products ,& Royal jelly extraction..	**8 hrs**
8	**Other hive products**: Pollen: properties and uses, Propolis: properties and uses. Bee wax: extraction purification, properties and uses, Bee venom properties and uses. Royal jelly properties and uses	**4 hrs**
9	Study and cultivation of stingless bees, colony establishment and management	**4 hrs**
10	**Migratory Bee Keeping** - designing floral Calendar Improved Agricultural practices - crop pollination - Pesticides impact on Honey bees	**8 hrs**
11	**Initiation of Bee keeping**: Funding sources for beekeeping projects., preparation of proposal for financial assistance from bank, Steps involved in starting a beekeeping project, Marketing of honey and honey products	**4 hrs**
12	Field visit to nearby apiary for practical experience	**4 hrs**

References:

1. Prospective in Indian Apiculture - R.C. Mishra
2. Rearing queen bees in India - M.C. Suryanarayanaet. al.
3. Bee Keeping in India - G. K. Ghosh
4. Technology and value addition of Honey - Dr. D. M. Wakhle and K. D. Kamble.
5. ABC & XYZ of Bee culture - A. I. Root
6. Indian Bee Journal - All India Bee Keeping Association
7. Asian Bee Journal.

SCHEME OF PRACTICAL EXAMINATION

1.	Mounting of Mouth parts/ sting apparatus/ pollen brush/pollen basket/ wax gland	08
2.	Identifications (equipment/types of bees-4)	12
3.	Project report	10
4.	Viva	05
5.	Journal	05
	Total	**40**

Note: Same scheme may be used for IA (formative assessment test) and should be reduced to ten (10) marks.

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