

Department of Zoology

School of Biological Sciences



Curriculum Framework

B.Sc. Zoology

Based on National Education Policy- 2020

Doctor Harisingh Gour Vishwavidyalaya

(A Central University)

Sagar-Madhya Pradesh-470003

Level: 5 Semester I			
Nature of Course	Course Code	Course Title	Credits
Discipline Specific Major	ZOO-DSM-111	Animal Diversity - Theory	4
	ZOO-DSM-112	Animal Diversity - Practical	2
Ability Enhancement Course	ZOO-AEC-113	Environmental Science	2
Skill Enhancement Course	ZOO-SEC-114	Poultry Farming	2
Total Credits 10			
Semester II			
Nature of Course	Course Code	Course Title	Credits
Discipline Specific Major	ZOO-DSM-211	Comparative Anatomy and Developmental Biology of Vertebrates-Theory	4
	ZOO-DSM-212	Comparative Anatomy and Developmental Biology of Vertebrates-Practical	2
Ability Enhancement Course	ZOO-AEC-213	Aquarium Fish Keeping	2
Skill Enhancement Course	ZOO-SEC-214	Sericulture	2
Total Credits 10			
Semester III			
Nature of Course	Course Code	Course Title	Credits
Discipline Specific Major	ZOO-DSM-311	Physiology and Biochemistry -Theory	4
	ZOO-DSM-312	Physiology and Biochemistry -Practical	2
Ability Enhancement Course	ZOO-AEC-313	Science Communication and Popularization	2
Skill Enhancement Course	ZOO-SEC-314	Bee Keeping	2
Total Credits 10			

Semester IV			
Nature of Course	Course Code	Course Title	Credits
Discipline Specific Major	ZOO-DSM-411	Genetics and Evolutionary Biology-Theory	4
	ZOO-DSM-412	Genetics and Evolutionary Biology-Practical	2
Ability Enhancement Course	ZOO-AEC-413	Human Nutrition	2
Skill Enhancement Course	ZOO-SEC-414	Toxicology	2
			Total 10
Semester V			
Nature of Course	Course Code	Course Title	Credits
Discipline Specific Major	ZOO-DSM-511	Immunology-Theory	4
	ZOO-DSM-512	Immunology-Practical	2
Ability Enhancement Course	ZOO-AEC-513	History of Indian Science	2
Skill Enhancement Course	ZOO-SEC-514	Public Health and Hygiene	2
			Total 10
Semester VI			
Nature of Course	Course Code	Course Title	Credits
Discipline Specific Major	ZOO-DSM-611	Applied Zoology-Theory	4
	ZOO-DSM-612	Applied Zoology-Practical	2
Ability Enhancement Course	ZOO-AEC-613	Good Laboratory Practices	2
Skill Enhancement Course	ZOO-SEC-614	Computer Application	2
			Total 10

Total Credits =60

Semester I			
Nature of Course	Course Code	Course Title	Credits
Discipline Specific Major	ZOO-DSM-111	Animal Diversity -Theory	4
	ZOO-DSM-112	Animal Diversity - Practical	2
Ability Enhancement Course	ZOO-AEC-113	Environmental Science	2
Skill Enhancement Course	ZOO-SEC-114	Poultry Farming	2
Total Credits			10

**B.SC. I SEMESTER
DISCIPLINE SPECIFIC MAJOR
COURSE TITLE: ANIMAL DIVERSITY
COURSE CODE: ZOO-DSM-111
THEORY**

L	T	P	C
4	0	0	4

Objective: To gain an understanding of the structural and functional diversity of Invertebrate and Vertebrate animals.

Unit I: Lower Invertebrates

a. Protista

General Characters and Classification up to classes.
Locomotory Organs and locomotion in Protozoa.

b. Porifera

General Characters and Classification up to classes.
Canal System in *Sycon*

c. Cnidaria

General Characters and classification up to classes.
Polymorphism in Hydrozoa.

d. Nematelminthes

General Characters and classification up to classes.
Life history of *Ascaris lumbricoides* and its parasitic adaptations.

Unit II: Higher Invertebrates-I

a. Platyhelminthes

General characters and classification up to classes.
Life history of *Taenia solium*.

b. Annelida

General characters and classification up to classes.
Metamerism and Coelom formation in Annelida.

c. Arthropoda

General characters and classification up to classes.
Vision in Arthropoda.
Metamorphosis in Insects.

Unit III: Higher Invertebrates-II

a. Mollusca

General characters and classification up to classes.
Torsion in Gastropods

b. Echinodermata

General characters and classification up to classes.
Water Vascular system in Asteroidea.

c. Hemichordata

General features and affinities of *Balanoglossus*.

Unit IV: Lower Chordates

a. Protochordata

General features and affinities of Urochordata and Cephalochordatas
Metamorphosis in *Herdmania*

b. Agnatha

General features of Agnatha and Classification up to classes.

c. Pisces

General features and Classification up to order
Osmoregulation

d. Amphibia

General features and Classification up to order.
Parental care in Amphibia.

Unit V: Higher Chordates

a. Reptiles

General features and Classification up to order.

b. Aves

General features and Classification up to order.

c. Mammals

Classification up to order.
Origin of mammals.

Suggested Readings:

1. 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.
2. Young J. Z., 2004. The Life of Vertebrates. Oxford university press. Pough H. Vertebrate life, Pearson International.
3. Kotpal R.L., 2019, Modern text book of Zoology: Invertebrates. Rastogi Publication, New Delhi. Barrington.
4. Kotpal R.L., 2019, Modern text book of Zoology: Vertebrates. Rastogi Publication, New Delhi. Barrington.
5. Pough H. *Vertebrate life*, VIII Edition, Pearson International.

Learning Outcomes:

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

- Learn structural and functional diversity in different groups of animals.
- Gain knowledge and skill in the fundamentals of animal sciences.

**B.SC. I SEMESTER
DISCIPLINE SPECIFIC MAJOR
COURSE TITLE: ANIMAL DIVERSITY
COURSE CODE: ZOO-DSM-112
PRACTICAL**

L	T	P	C
0	0	2	2

Students will study the external features of the following animals-

- 1. Protozoa:** *Amoeba*, *Euglena*, *Plasmodium*, *Paramecium*.
- 2. Porifera:** T. S. and L.S. of *Sycon*, *Hyalonema*, and *Euplectella*, *Euspongia*.
- 3. Cnidaria:** *Obelia*, *Physalia*, *Aurelia*, *Tubipora*, *Metridium*, *Coreallia*, *Pennatula*, *Madrepora*, *Zoanthus*, *Alcyonium*, *Porpita*, *Physalia*, *Gorgonia*.
- 4. Platyhelminthes:** *Taenia solium* and Study of its life cycle stages, *Dugesia*.
- 5. Nemathelminthes:** Male and female *Ascaris lumbricoides*.
- 6. Annelida:** *Aphrodite*, *Nereis*, *Heteronereis*, *Pheretima*, *Hirudinaria*, *Polygordius*, *Chaetopterus*.
- 7. Arthropoda:** *Palaemon*, *Cancer*, *Limulus*, *Palamnaeus*, *Scolopendra*, *Julus*, *Periplaneta*, *Apis*, *Bombax mori*, *Dragon fly*, *Lepus*, *Musca*, *Paripatus*, *Mentis*.
- 8. Mollusca:** *Chiton*, *Dentalium*, *Pila*, *Unio*, *Loligo*, *Sepia*, *Octopus*, *Solen*, *Limax*, *Dentalium*.
- 9. Echinodermata:** *Pentaceros*, *Ophiura*, *Echinus*, *Cucumaria* and *Antedon*, *Star fish*, *Ophiothorix*, *Echinus*, *Holothuria*, *Thyone*.
- 10. Hemichordata:** *Balanoglossus*.
- 11. Protochordata:** *Herdmania*, *Branchiostoma*.
- 12. Agnatha:** *Petromyzon*, *Myxine*.
- 13. Pisces:** *Sphyrna*, *Pristis*, *Torpedo*, *Labeo*, *Exocoetus*, *Anguilla*.
- 14. Amphibia:** *Ichthyophis/Ureotyphlus*, *Salamandra*, *Bufo*, *Hyla*.
- 15. Reptilia:** *Chelone*, *Hemidactylus*, *Chamaeleon*, *Draco*, *Viper*, *Naja*, *Crocodylus*, *Gavialis*.
- 16.** Key for Identification of poisonous and non-poisonous snakes.
- 17. Aves:** Study of six common birds from different orders.
- 18. Mammalia:** *Sorex*, *Bat*, *Funambulus*, *Loris*.
- 19. An “ animal album”** containing photographs, cut outs, with appropriate write up about the above mentioned taxa. Different taxa/topics may be given to different sets of students for this purpose.

**B.SC. I SEMESTER
ABILITY ENHANCEMENT COURSE
COURSE TITLE: ENVIRONMENTAL SCIENCES
COURSE CODE: ZOO-AEC-113
THEORY**

L	T	P	C
2	0	0	2

Objective: The purpose of this course is to understand the significance of the environment and the necessity of conserving natural resources for the betterment of human well-being.

Unit I: Introduction to Ecosystem

- a. Structure and function of different ecosystems
- b. Food chains, food webs and ecological succession.

Unit II: Natural Resources

- a. Land resources and land use change, Land degradation, soil erosion and desertification.
- b. Deforestation
- c. Water: Use and over-exploitation of surface and ground water, floods, droughts.
- d. Renewable and non-renewable energy sources.

Unit III: Biodiversity and Conservation

- a. Levels of biological diversity: genetic, species and ecosystem diversity.
- b. India as mega-biodiversity nation: Endangered and endemic species of India.
- c. Threats of biodiversity
- d. Conservation of biodiversity

Unit IV: Environmental Pollution

- a. Environmental pollution: types, causes and control.
- b. Nuclear hazards and human health risks.
- c. Solid waste management.

- d. Climate change, global warming, ozone layer depletion, acid rains.
- e. Pollution case studies.

Unit V: Human Communities, Policies & Practices

- a. Human population growth.
- b. Disaster management.
- c. Environmental movements: Chipko, Silent valley, Bishnoi of Rajasthan.
- d. Environmental Protection Act; Wildlife Protection Act; Forest Conservation Act.
- e. International agreements: Montreal and Kyoto protocols and convention on Biological Diversity.
- f. Environmental ethics: Role of Indian and other religions and cultures in environment Conservation.

Suggested Readings:

1. Erach Bharucha, 2005. Text book of Environmental Studies for undergraduate courses, University Grants Commission, New Delhi.
2. Odum E.P., 1983. Basic Ecology, Sanders, Philadelphia.
3. Cunningham W.P., Cooper, T.H., Gorhani, E and Hepworth, M.T., 2001. Environmental Encyclopedia, Jaico Publ. House, Mumbai.

Learning outcomes:

After successful completion of this course, the students will be able to:

- Understand interactions between organisms and their environment, drive the dynamics of individuals, populations, communities, and ecosystems.
- Recognize the ecological basis for regional and global environmental issues.

**B.SC. I SEMESTER
SKILL ENHANCEMENT COURSE
COURSE TITLE: POULTRY FARMING
COURSE CODE: ZOO-AEC-114
THEORY**

L	T	P	C
2	0	0	2

Objective: To acquire knowledge and skills in poultry farming as a means of providing employment opportunities.

Unit I: Overview of Poultry Farming

- a. Types of Breed, Rearing methods, Laying cages
- b. Nutritive value of egg and Meat.
- c. General features of Plymouth Rock, Light Sussex, Minorca, Rhode Island, Red and White Leghorn.

Unit II: Classification of Fowls

- a. Based on their use as Egg and Meat.
- b. Commercial layers.
- c. Dual purpose varieties.
- d. Varieties of fowl for Game and Ornamental purposes.

Unit III: Poultry Feeding

- a. Management of Egg Layers.
- b. Management of Broilers in large scale farms.
- c. Housing and Equipment.

Unit IV: Poultry diseases

- a. Viral, Bacterial, Fungal, Protozoan and Parasitic Lice etc.
- b. Prevention and precautions during vaccination.

Unit V: Management of modern Poultry Farms

- a. Methods of Brood rearing.
- b. Progressive plans to promote Poultry as a Self- Employment venture.

Suggested Readings:

1. Sainsbury D., 1999. Poultry Health and Management: Chickens, Ducks, Turkeys, Geese, Quail, Blackwell Science.
2. McMullin, 2004. Pocket Guide to Poultry Health and Disease, Nottingham University Press.
3. Rose S., 1996. Principles of Poultry Science, CABI Publishing.

Learning Outcomes:

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

- Identify fowl species use poultry species, their various developmental stages, poultry diseases and their prevention in order to generate employment opportunities.

Semester II			
Nature of Course	Course Code	Course Title	Credits
Discipline Specific Major	ZOO-DSM-211	Comparative Anatomy and Developmental Biology of Vertebrates-Theory	4
	ZOO-DSM-212	Comparative Anatomy and Developmental Biology of Vertebrates-Practical	2
Ability Enhancement Course	ZOO-AEC-213	Aquarium Fish Keeping	2
Skill Enhancement Course	ZOO-SEC-214	Sericulture	2
			Total Credits 10

B.SC. II SEMESTER
DISCIPLINE SPECIFIC MAJOR (DSM)
COURSE TITLE: COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF
VERTEBRATES
COURSE CODE: ZOO-DSM-211
THEORY

L	T	P	C
4	0	0	4

Objective: To acquire knowledge on comparative anatomy and embryonic development in animals.

Unit I: Comparative Anatomy -I

- a. **Integumentary System:** Derivatives of integument with reference to glands and digital tips.
- b. **Skeletal System:** Axial and Appendicular Skeleton.
- c. **Digestive System:** Brief account of alimentary canal and digestive glands.

Unit II: Comparative Anatomy -II

- a. **Respiratory System:** Gills, lungs, air sacs and swim bladder.
- b. **Circulatory System:** Evolution of heart and aortic arches.

Unit III: Comparative Anatomy -III

- a. **Urinogenital System:** Succession of kidney, Evolution of urogenital ducts.
- b. **Nervous System:** Comparative account of brain.
- c. **Sense Organs:** Type of receptors: Vision, Hearing, Taste, Smell and Touch.

Unit IV: Early Embryonic Development

- a. **Gametogenesis:** Spermatogenesis and Oogenesis.
- b. Types of eggs, Egg membranes.
- c. Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy.
- d. Planes and patterns of cleavage.
- e. Type of Blastula; Fate maps.
- f. Early development of frog and chick up to the formation of three germinal layers.
- g. Embryonic induction and organizer.

Unit V: Late and Post Embryonic Development

- a. Fate of three germinal layers.
- b. Extra-embryonic membranes in birds.
- c. Implantation of embryo in human.
- d. Placenta (Structure, types and functions).
- e. Metamorphosis: Changes, hormonal regulations in amphibians.
- f. Regeneration: Mode of regeneration, epimorphosis, morphallaxis and compensatory regeneration.
- g. Ageing: Concepts and theories.

Suggested Readings:

1. Kardong K. V.(2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.
2. Raven P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi.
3. Carlson Bruce M. (1996). Patten's Foundations of Embryology, McGraw Hill, Inc.
4. Gilbert S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
5. Kalthoff, (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers Lewis
6. Wolpert, (2002). Principles of Development. II Edition, Oxford University Press

Learning Outcomes:

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

- Understand comparative anatomy of different systems in vertebrates
- Learn the mechanism of embryonic development and implantation of foetus.

B.SC. II SEMESTER
DISCIPLINE SPECIFIC MAJOR (DSM)
COURSE TITLE: COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF
VERTEBRATES
COURSE CODE: ZOO-DSM-212
PRACTICAL

L	T	P	C
0	0	2	2

1. Disarticulated skeleton of Fowl

- a. Vertebrae (atlas, fused thoracic, synsacrum, pygostyle)
- b. Limb bones (humerus, radio-ulna, femur, tarso-metatarsus)
- c. Girdles (pectoral, Fercula and pelvic)

2. Disarticulated skeleton of Rabbit

- a. Vertebrae (atlas, axis, lumbar, sacral, caudal)
- b. Limb bones (humerus, radio-ulna, femur, tibio-fibula)
- c. Girdles (pectoral and pelvic)

3. Skull

- a. One herbivorous (Rabbit)
- b. One carnivorous (Dog)

4. Study of developmental stages in frog: whole mounts and sections through permanent slides.

- a. Cell stages (2,4,8,16)
- b. Late cleavage
- c. Embryo – (4mm, 7mm)
- d. Egg (WM)
- e. Morula, Blastula, Gastrula, Neurula.
- f. Tadpole gill (T.S.)
- g. External Gill (WM)
- h. Tadpole (WM)
- i. Tail region (C.S)

5. Examination of gametes – frog/rat- sperm and ova through permanent slides or photomicrographs.

6. Study of placenta using microphotographs.

B.SC. II SEMESTER
ABILITY ENHANCEMENT COURSE (AEC)
COURSE TITLE: AQUARIUM FISH KEEPING
COURSE CODE: ZOO-AEC-211
THEORY

L	T	P	C
1	1	0	2

Objective: In order to obtain the requisite information for the purpose of maintaining an aquarium, with considerations for both decorative and commercial purposes.

Unit I: Introduction to Aquarium Fish Keeping

- a. History and importance of aquarium fish keeping.
- b. The potential scope of aquarium as a Cottage Industry.
- c. Exotic and endemic species of aquarium Fishes

Unit II: Biology of Aquarium Fishes

- a. Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes.
- b. General features of Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish.

Unit III: Food and feeding of Aquarium fishes

- a. Use of live fish feed organisms.
- b. Preparation and composition of formulated fish feeds

Unit IV: Fish Transportation

- a. Live fish transport handling,
- b. Packing and forwarding techniques.

Unit V: Maintenance of Aquarium

- a. General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry.

Suggested Readings:

1. Arumugam N. (2010) .Home Aquarium and Ornamental Fish Culture. Saras Publication, New Delhi.
2. Vincent Hargreaves (2010). Complete book on Fresh water Aquarium. Thunder Bay, Oxford.
3. e-contents Aquarium Fish and their maintenance.

Learning Outcome:

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

- Setting up of fresh water aquarium.
- Learning the maintenance of an aquarium.

**B.SC. II SEMESTER
SKILL ENHANCEMENT COURSE
COURSE TITLE: SERICULTURE
COURSE CODE: ZOO-SEC-214
THEORY**

L	T	P	C
1	1	0	2

Objective: To acquire the necessary information for sericulture and to create employment opportunities.

Unit I: Classification of commercial varieties of mulberry silk worms

Mulberry plantation establishment and cultivation practices.

Unit II: Diseases of mulberry silk worms

Fungal, bacterial, Viral and Nematode diseases, Deficiency diseases and their remedial measures.

Unit III: Silkworm rearing operations

Chawki rearing and Late age rearing techniques.

Unit IV: Physical and commercial characters of Cocoon.

Reeling operations, by-products of Sericulture and their importance.

Unit V: Economic importance of Sericulture

Future and progress of Sericulture Industry in India. Prospects of Sericulture as Self-Employment venture.

Suggested Readings:

1. M. Madan Mohan Rao, 2010. An Introduction to Sericulture. Paras Publication. Delhi.
2. e-content on Silkworm Rearing Technology, Mulberry Cultivation & Physiology, Mulberry Crop Protection, Sericulture Extn. Management & Economics, Silkworm Crop Protection.

Learning Outcomes:

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

- Develop an understanding of various prerequisite to get started with sericulture.
- Learning about the commercial varieties of silkworms and their products.

Semester III			
Nature of Course	Course Code	Course Title	Credits
Discipline Specific Major	ZOO-DSM-311	Physiology and Biochemistry -Theory	4
	ZOO-DSM-312	Physiology and Biochemistry -Practical	2
Ability Enhancement Course	ZOO-AEC-313	Science Communication and Popularization	2
Skill Enhancement Course	ZOO-SEC-314	Bee Keeping	2
			Total Credits 10

**B.SC. III SEMESTER COURSE
DISCIPLINE SPECIFIC MAJOR
COURSE TITLE: PHYSIOLOGY AND BIOCHEMISTRY
COURSE CODE: ZOO-DSM-311
THEORY**

L	T	P	C
4	0	0	4

Objective: To have a comprehensive understanding of the physiological and biochemical aspects of animal systems.

Unit I Digestion and Respiration

- a. Digestion and absorption of carbohydrates, proteins and fats; Gastrointestinal hormones.
- b. Mechanism and regulation of breathing; Transport of oxygen and carbon dioxide, Respiratory quotient.
- c. Blood buffers.
- d. Pulmonary ventilation, Respiratory volumes and capacities.
- e. Transport of Oxygen and carbon dioxide in blood.

Unit II Cardiovascular system, Excretion and Endocrine Glands in mammals

- a. Blood: Composition, Homeostasis.
- b. Heart structure, Origin and conduction of the cardiac impulse.
- c. Cardiac cycle.
- d. Structure and function of nephron.
- e. Mechanism of Urine formation.
- f. Structure and function of pituitary, thyroid, parathyroid, pancreas and adrenal glands.

Unit III Nerve, Muscle and Coordination in mammals

- a. Structure of a neuron, Resting membrane potential and Graded potential.
- b. Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres.
- c. Ultrastructure of skeletal muscle, Molecular and chemical basis of muscle contraction.
- d. Vision: Structure of eye, retinal components, and photoreceptors: ionic basis of potential generation.

- e. Hearing: Structure of ear, mechanoreceptor: ionic basis of potential generation.

Unit- IV: Carbohydrate Metabolism and Lipid Metabolism

- a. Principle of bimolecular organization, configuration and conformation.
- b. Water as biological solvent.
- c. Carbohydrates and Lipids: Structure and biological importance.
- d. Classification - Reducing and non-reducing sugars, monosaccharides, Oligosaccharides (Disaccharides), polysaccharides (peptidoglycans and glycosaminoglycans).
- e. Glycolysis, Krebs cycle, Electron transport chain and ATP synthesis Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis.

Unit-V: Protein metabolism and nucleic acids:

- a. Proteins: Composition and Biological significance.
- b. Amino acids -Structure, classification and properties, Ionization, titration curve.
- c. Enzymes: Nomenclature and classification, general properties, cofactors, Mechanism of action.
- d. Structure -Bases, nucleosides and nucleotides, DNA structure.
- e. Genetic code.

Suggested Readings:

1. Tortora, G.J.& Derrickson, B.H., 2009, Principles of Anatomy and Physiology, John Wiley & Sons, Inc.
2. Widmaier, E.P., Raff, H. &Strang, K.T., 2008, Vander's Human Physiology, McGraw Hill.
3. Guyton, A.C. & Hall, J.E., 2011, Textbook of Medical Physiology, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
4. Berg, J. M., Tymoczko, J. L. and Stryer, L., 2006. Biochemistry, W.H Freeman and Co.
5. Nelson, D. L., Cox, M. M. and Lehninger, A.L., 2009. Principles of Biochemistry, W.H Freeman and Co.
6. Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V., 2009. Harper's Illustrated Biochemistry, Lange Medical Books/Mc Graw Hill.

Learning Outcomes:

After the completion of the course, the students will able to-

- understand the physiology at cellular and system levels.
- understand how mammalian body gets nutrition from different biomolecules.

**B.SC. III SEMESTER COURSE
DISCIPLINE SPECIFIC MAJOR
COURSE TITLE: PHYSIOLOGY AND BIOCHEMISTRY
COURSE CODE: ZOO-DSM-312
PRACTICAL**

L	T	P	C
0	0	2	2

1. Counting of Red Blood Corpuscles.
2. Counting of White Blood Corpuscles.
3. Preparation of haemin crystals.
4. Estimation of haemoglobin Percentage.
5. Preparation of casein from milk.
6. Examination of permanent slides of endocrine glands of mammalian pituitary, thyroid, parathyroid, pancreas, adrenal gland, testis and ovary.
7. Examination of permanent histological slides of spinal cord, duodenum, small intestine and large intestine, liver, lung, kidney, bone, cartilage,.
8. Qualitative analysis of Carbohydrates, Proteins.
9. Separation of amino acids or proteins by paper chromatography.
10. Iodine test for starch.
11. Preparation of models of nitrogenous bases, nucleosides and nucleotides.

**B.SC. III SEMESTER COURSE
ABILITY ENHANCEMENT COURSE
COURSE TITLE: SCIENCE COMMUNICATION AND POPULARIZATION
COURSE CODE: ZOO-AEC-313
THEORY**

L	T	P	C
1	1	0	2

Objective: to emphasise the need of effectively disseminating scientific information and knowledge in order to enhance the overall welfare of Society.

Unit-I: Print Science Communication

- a. Role of science and technology in human development.
- b. Writing and communicating popular articles effectively.
- c. Case studies of celebrated works of science communicators including Cosmos by Carl Sagan, works of Bill Bryson, Richard Dawkins, Richard Feynman, Isaac Asimov, Carl Zimmer and Matt Riddley.
- d. Importance for communication through regional languages.

Unit-II: Visual Media Science Communication

- a. Science outreach through visual media: Creating science documentaries.
- b. Scripts, citing authentic sources, case study: Famous documentaries of Carl Sagan, David Attenborough and Prof. Yashpal.
- c. Cultural Studies of Science and Technology-technoscientific culture- Science Fiction Studies- cinema and Science.
- d. Science in Indian popular culture.

Unit-III: Internet Science Communication

- a. Science popularization through internet: Social media, Websites, Blogs, You tube, Podcast etc.
- b. Sensitization on important issues like climate change, deforestation, biodiversity loss, important of science etc.

Unit-IV: Science Outreach Talks

- a. Tactics for providing a charismatic and effective public talk.
- b. Use of metaphors, speaking in context.
- c. Museum displays and public exhibitions.

Unit V: Public Sensitization in Science

- a. Science outreach for biodiversity conservation, sensitization of public.
- b. Science communication during disasters- Public Engagement with Science and Technology.
- c. Public sphere-multiple publics-the deliberative turn.

Suggested Readings:

1. Selected works of Carl Sagan, works of Bill Bryson, Richard Dawkins, Richard Feynman, Isaac Asimov, Carl Zimmer and Matt Riddley.
2. Gigante, E. Marie (2018). Introducing Science Through Images: Cases of Visual Popularization (Studies in Rhetoric/Communication), University of South Carolina Press.

Learning outcomes:

After the completion of this course, the learner will be able to:

- Utilize visual media science communication for creating scripts and documentaries.
- Identify the need and role of science communication in human development.
- Contribute in science popularization through internet communication and public Sensitization.

**B.SC. III SEMESTER COURSE
SKILL ENHANCEMENT COURSE
COURSE TITLE: BEE KEEPING
COURSE CODE: ZOO-SEC-314
THEORY**

L	T	P	C
1	1	0	2

Objective: To acquire knowledge about the cultural practises of honey bees for the purpose of commercial production of Honey and byproducts.

Unit I: Introduction to Apiculture

- a. History of Bees and Beekeeping.
- b. Systematics, Bee species, Bee morphology.
- c. Colony organization, Polymorphism, Caste system, Division of labour.
- d. Bee flora, Foraging and Honey flow periods.

Unit II: Bee keeping as an occupation

- a. Extent of Beekeeping in India.
- b. Limitations on the development of beekeeping,
- c. Advantages of extensive Beekeeping.
- d. Beekeeping equipment: Bee box and tools and initiation into keeping a colony.

Unit III: The first step in beekeeping and Bee diseases

- a. Purchase of a colony, the Apiary site, how to manage a colony, the manipulation of a colony.
- b. Bee products: Honey, Bees wax, Pollens, Royal Jelly, Propolis and Bee venom.
- c. Bee diseases and enemies.

Unit IV: Beekeeping techniques

- a. Establishment of a colony. Bee flora and planned pollination services.
- b. Important Institutions pertinent to Apiculture: National Bee Board, Bee research and Training Institute, Apiaries.
- c. Economic importance and extension of Bee keeping.

Unit V: Apiary management

- a. Routine management.
- b. Seasonal management, Migratory beekeeping.
- c. Harvesting and marketing of bee products.
- d. The future of beekeeping.

Suggested Readings:

1. Abrol, D. P. (1997), Bees and Beekeeping. Kalyani Publisher, New Delhi.

Learning Outcome:

By the end of the course, the student should be able to:

- Identify and describe the fundamentals and scientific basis of beekeeping.
- Recognize biological principles applicable to many organisms by using the honey bee as a study subject.

Semester IV			
Nature of Course	Course Code	Course Title	Credits
Discipline Specific Major	ZOO-DSM-411	Genetics and Evolutionary Biology -Theory	4
	ZOO-DSM-412	Genetics and Evolutionary Biology -Practical	2
Ability Enhancement Course	ZOO-AEC-413	Human Nutrition	2
Skill Enhancement Course	ZOO-SEC-414	Toxicology	2
			Total Credits 10

**B.SC. IV SEMESTER COURSE
DISCIPLINE SPECIFIC MAJOR
COURSE TITLE: GENETICS AND EVOLUTIONARY BIOLOGY
COURSE CODE: ZOO-DSM-411
THEORY**

L	T	P	C
4	0	0	4

Objective: To gain knowledge about genetics and the evolutionary biology of animals.

Unit I: Introduction to Genetics

- a. Classical and Modern concept of Gene (Cistron, Muton, Recon), Alleles etc.
- b. Mendel's Principles of Inheritance, Incomplete dominance and co-dominance.
- c. Structure and function of genes, molecular basis of genetic variation.
- d. Multiple alleles, lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression.
- e. Sex linked inheritance, extra chromosomal inheritance involving mitochondria and chloroplast.

Unit II: Linkage, Crossing Over, Chromosomal Mapping and Sex Determination

- a. Linkage and crossing over.
- b. Somatic cell genetics – an alternative approach to gene mapping.
- c. Hormonal influence on sex determination-Freemartin and sex reversal.
- d. Role of environmental factors- *Bonellia* and Crocodile.

Unit III: Mutation and Quantitative Genetics

- a. Chromosomal Mutation: Deletion, Duplication, Inversion, Translocation, Transition and Transversion
- b. Aneuploidy and Polyploidy.
- c. Gene mutation: Induced versus Spontaneous mutations, Back versus Suppressor mutations.
- d. Karyotype, banding and nomenclature of chromosome subdivisions.
- e. Genetic disorders: chromosomal aneuploidy (Down, Turner and Klinefelter syndromes). Chromosome translocation (Chronic Myeloid Leukemia) and deletion ("cry du cat" syndrome), gene mutation (sickle cell anemia).

Unit IV: Evolutionary theories and origin of life:

- a. Lamarckism, Darwinism and Neo-Darwinism.
- b. Evidences of Evolution.
- c. Origin of Life.
- d. History of earth and formation of fossils.
- e. Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population).

Unit V: Species Concept and Speciation:

- a. Species concept (Advantages and Limitations).
- b. Modes of speciation (Allopatric, Sympatric).
- c. Macro-evolutionary Principles (Darwin's Finches).
- d. Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution.
- e. Phylogenetic trees, multiple sequence alignment, construction of phylogenetic trees, interpretation of trees.

Suggested Readings:

1. Gardner, E.J, Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics, Wiley India.
2. Snustad, D.P, Simmons, M.J. (2009). Principles of Genetics, John Wiley and Sons Inc.
3. Klug, W.S, Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics, Benjamin Cummings.
4. Russell, P. J. (2009). Genetics- A Molecular Approach, Benjamin Cummings.
5. Ridley, M. (2004). Evolution, Blackwell Publishing.
6. Hall, B. K. and Hallgrimsson, B. (2008). Evolution, Jones and Bartlett Publishers

Learning Outcomes:

After completion the course, students will be able to-

- Apply the principles of Mendelian inheritance.
- Enable the students to understand the evolution of universe and life.

**B.SC. IV SEMESTER COURSE
DISCIPLINE SPECIFIC MAJOR (DSM)
COURSE TITLE: GENETICS AND EVOLUTIONARY BIOLOGY
COURSE CODE: ZOO-DSM-412
PRACTICAL**

L	T	P	C
0	0	2	2

1. Study of Mendelian Inheritance and gene interactions (Non-Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.
2. Study of Linkage, recombination, gene mapping using the data.
3. Study and verification of Hardy-Weinberg Law.
4. Study of Human Karyotypes (Normal and abnormal).
5. Study of fossil evidences from plaster cast models and pictures.
6. Study of homology and analogy from suitable specimens/ pictures.
7. Preparation of Models and Charts: Phylogeny of horse with diagrams/cut out of limbs and teeth of horse ancestors.
8. Darwin's Finches with diagrams/cut out of beaks of different species.

**B.SC. IV SEMESTER COURSE
ABILITY ENHANCEMENT COURSE (AEC)
COURSE TITLE: HUMAN NUTRITION
COURSE CODE: ZOO-AEC-413
THEORY**

L	T	P	C
1	1	0	2

Objective: To develop an understanding of a balanced diet and deficiencies caused by malnutrition.

Unit I: Carbohydrate, protein and Lipid as important food sources

- a. Biomedical importance of Carbohydrates, Proteins and Lipids.
- b. Brief outline of metabolism: glycogenesis & glycogenolysis (in brief), glycolysis, citric acid cycle- Clinical significance.
- c. Proteins - Functions, classification, food sources, composition, essential & non-essential amino acids, protein deficiency-biomedical importance.

Unit II: Fat as a source of energy

- a. Fats & oils: Function of fats, classification, food sources, composition, saturated and unsaturated fatty acids, biomedical importance, essential fatty acids.
- b. Brief out line of metabolism: Beta oxidation of fatty acids, Ketosis, Cholesterol and its Clinical significance.
- c. Vitamins and minerals - sources and functions, deficiency status.
- d. Water: importance as a nutrient, function, sources, requirement, water balance and effect of deficiency.

Unit III: Nutritional requirements and calories of a balanced diet

- a. Basal metabolic rate, energy requirements of man, women, infants and children.
- b. Nutritional value of foods- cereals, fruits, milk, egg, meat, fish. Balanced diet.
- c. Nutrition requirements as per physiological stages of pregnancy, food selection, complication of pregnancy.
- d. Nutrition requirements during lactation and during infant growth and development, breast feeding, infant formula, introduction of supplementary diet.

Unit IV: Malnutrition and health requirements

- a. Nutritional requirement and growth in preschool children growth.
- b. Nutritional requirement of school children, importance of snacks, school lunch.
- c. Nutritional needs and feeding pattern during adolescence and adulthood.
- d. Geriatric nutrition: Factors affecting food intake and nutrition related problems.
- e. Food of nutritional value, Role of fibres in human nutrition; Effect of cooking and heat processing on the nutritive value of food; processed supplementary food; Food sanitation and hygiene.

Unit V: Addictive behaviour

- a. Anorexia nervosa, bulimia & alcoholism.
- b. Nutrient drug interaction.
- c. Feeding the patients - Psychology of feeding the patient, assessment of patient needs.

Suggested Readings:

1. Gopalan C., Ramasastri B.S. & Balasubramanian, S.C. (1971). Nutritive value of Indian foods. National Institute of Nutrition, Hyderabad.
2. Gopalan D. & Vijayaraghavan K. (1971). Nutrition atlas of India, ICMR, New Delhi.
3. Ghosh S. (1981). The feeding care of infants and young children, UNICEF, New Delhi.
4. Mudambi S.R. (1995). Fundamentals of food and nutrition. New age international, New Delhi.
5. Swaminathan M. (1989). Handbook of food and nutrition. Bappco, Bangalore.

Learning outcomes:

After the completion of this course, the students will be able to:

- Know about essential nutrients and required macro and micro nutrients
- Cultivate proper feeding habits.

**B.SC. IV SEMESTER COURSE
SKILL ENHANCEMENT COURSE (SEC)
COURSE TITLE: TOXICOLOGY
COURSE CODE: ZOO-SEC-414
THEORY**

L	T	P	C
1	1	0	2

Objective: To gain comprehensive understanding of the detrimental impact induced by xenobiotics.

Unit I: Basic Concept of Toxicology

- a. Introduction of toxicology, history of toxicology, definition of toxicology.
- b. Definition of poison, definition of toxicity and classification of toxicants.
- c. Mode of action of toxic agents.

Unit II: Xenobiotics

- a. Xenobiotics: Definition and Types.
- b. Mechanism of Xenobiotic metabolism.

Unit III: Pesticides and Heavy Metal Toxicity

- a. Pesticides and their toxicological effects.
- b. Classification of Pesticides, Insecticides, Mode of action of Insecticide.
- c. Heavy Metal Toxicity.

Unit IV: Evaluation of toxicity

- a. Acute, sub-Acute and chronic assays LD50, LC50.
- b. Maintenance and general handling of animals for toxicological laboratory.
- c. Ecotoxicology, clinical toxicology, occupational and nano-toxicology.

Unit V: Targets of toxic damages and Biochemical Mechanism of toxicity

- a. Damage caused by toxins/drugs on liver, kidney, gall bladder and lungs.
- b. Liver necrosis: Carbon tetrachloride, Valproic Acid, and Iproniazid.
- c. Kidney damage: Chloroform, antibiotics- gentamycin.
- d. Neurotoxicity: Isoniazid, Parquet, Primaquine, Cyclophosphamide.

Suggested Readings:

1. Williams P.L., James R. C., Roberts S.M. (2003). Principles of Toxicology: Environmental and Industrial Applications, John Wiley & Sons, Inc.
2. Klaassen C. (2007). Casarett and Doull's Toxicology The basic science of poisons, McGraw-Hill.
3. Duffs J. and Worth H. (2006). Fundamental Toxicology, RSC Publishing.

Learning outcomes:

After completing this course, the students will be able to-

- Examine the application, how xenobiotics disrupt normal cellular processes of genomics, proteomics, and metabolomics.
- Understand mechanisms of systemic and organ toxicity induced by xenobiotics.

Semester V			
Nature of Course	Course Code	Course Title	Credits
Discipline Specific Major	ZOO-DSM-511	Immunology -Theory	4
	ZOO-DSM-512	Immunology-Practical	2
Ability Enhancement Course	ZOO-AEC-513	History of Indian Science	2
Skill Enhancement Course	ZOO-SEC-514	Public Health and Hygiene	2
			Total Credits 10

**B.SC. V SEMESTER COURSE
DISCIPLINE SPECIFIC MAJOR (DSM)
COURSE TITLE: IMMUNOLOGY
COURSE CODE: ZOO-DSM-511
THEORY**

L	T	P	C
4	0	0	4

Objective: To get a thorough understanding of immunology and its significance in maintaining state of health.

Unit I: Overview of the Immune system

- a. Introduction to basic concepts of Immunology.
- b. Principles of Innate and adaptive Immune system.
- c. Cells of the Immune system.
- d. Haematopoiesis.
- e. Organs of Immune system (primary and secondary lymphoid organs).

Unit II: Antigen and Antibody

- a. Characteristics of antigen- antigenicity and Immunogenicity, epitopes, Haptens, Adjuvant.
- b. Classification, properties and functions of Immunoglobulins.
- c. Antigenic determinants: Isotype, Allotype and Idiotypic.
- d. Antigen and antibody interactions, affinity, avidity.
- e. Monoclonal antibodies, Hybridoma technology.

Unit III: Immune Pathways

- a. Working of the immune system I- Structure and functions of MHC.
- b. Exogenous and endogenous pathways of antigen presentation and processing.
- c. Working of immune system II- Basic properties and functions of cytokines.
- d. Types and functions of complement system.

Unit IV: Acquired immunity, Hypersensitivity and autoimmune disorders

- a. Immune system in health and disease I- Hypersensitivity: types and functions.
- b. Introduction to concepts of autoimmunity and immunodeficiency.
- c. Immunotoxins and their applications.

Unit V: Immune system in disease

- a. Immune system in health and disease II- Infectious agents.
- b. Course of adaptive response to infection.
- c. General introduction to vaccines.

Suggested Readings:

1. Goldsby R.A., Kindt T.J. and Kuby J. (2006). Immunology, W. H. Freeman Publishers.
2. Roitt I., Brostoff J. and Male D. (2012). Immunology, Mosby Publishers.
3. Kimball John W., Introduction to Immunology, Macmillan USA.

Learning Outcomes:

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

- Identify the major cellular and tissue components which comprise the innate and adaptive immune system.
- The role of immune system in health and diseases.

**B.SC. V SEMESTER COURSE
DISCIPLINE SPECIFIC MAJOR (DSM)
COURSE TITLE: IMMUNOLOGY
COURSE CODE: ZOO-DSM-512
PRACTICAL**

L	T	P	C
0	0	2	2

1. Study of lymphoid organs (by slides or micrographs): Spleen, Lymph nodes, thymus, bone marrow
Bursa fabricus.
2. WBC Differential count.
3. ABO and Rh blood group determination.
4. Radial Immuno-diffusion.
5. Demonstration of Ouchterlony's double diffusion assay.
6. Preparation, cell count and percentage viability of Spleenocytes.
7. Demonstration of Enzyme Linked Immune Sorbent Assay (DOT-ELISA).
8. Demonstration of Immuno-electrophoresis.

**B.SC. V SEMESTER COURSE
ABILITY ENHANCEMENT COURSE
COURSE TITLE: HISTORY OF INDIAN SCIENCE
COURSE CODE: ZOO-AEC-513
THEORY**

L	T	P	C
1	1	0	2

Objective: To develop a comprehensive knowledge of the history of Indian science.

Unit I: Science in Ancient and Medieval India

- a. History of development in astronomy, mathematics, engineering and medicine subjects in Ancient India.
- b. Influence of the Islamic world and Europe on developments in the fields of mathematics, chemistry, astronomy and medicine
- c. Innovations in the field of agriculture-new crop introduced, new techniques of irrigation.

Unit II: Indian Science before and after Independence

- a. Introduction of different surveyors, zoologists and doctors as early scientist in Colonial India.
- b. Indian perception and adoption for new scientific knowledge in Modern India.
- c. Establishment of premier research organizations like CSIR, DRDO, ICAR, IISERS and ICMR, IIT's, Establishment of Atomic Energy Commission.
- d. Launching of the space satellites, ISRO's accomplishments.
- e. Zoological survey of India(ZSI).

Unit III: Prominent Indian scientists

- a. Eminent scholars in mathematics and astronomy: Baudhayana, Aryabhatta, Brahmgupta, Bhaskaracharya, Varahamihira, and Nagarjuna.
- b. Medical science of Ancient India (Ayurveda and Yoga): Susruta, Charak.
- c. Scientists of Modern India: Srinivas Ramanujan, C.V. Raman, Jagdish Chandra Bose, Homi Jehangir Bhabha, Vikram Sarabhai etc.

Unit IV: Prominent research in Animal Sciences in Republic of India

- a. History of animal tissue culture with context to India; green, white and pink revolutions in India.

- b. The pioneers associated with First gene cloning, First genome sequencing from India.
- c. Premier Research institutes and current eminent scientists in India.
- d. GM organisms.

Unit V: Women in Indian Science

- a. Under representation of women in Science.
- b. Current status with regard to women in Science in the Indian context.
- c. Women achievers in Indian Science.

Suggested Readings:

1. Kuppuram G. (1990). History of Science and Technology in India, South Asia Books.
2. Handa O.C. (2014). Reflections on the history of Indian Science and Technology, Pentagon Press.
4. Habib I. (2016). A people's history of India 20: Technology in Medieval India, Tulika Books.
5. Rahman A. *et al.* (1982). Science and Technology in Medieval India – A Bibliography of Source Materials in Sanskrit, Arabic and Persian, New Delhi: Indian National Science Academy.
6. Subbarayappa B.V. & Sarma K.V. (1985). Indian Astronomy – A Source Book, Bombay.

Learning outcomes:

On completion of this course, the students will be able to-

- Develop understanding of various branches of science during different eras.
- Analyse the role played by different Indian organizations in science.
- Appraise the contribution of different Indian Scientists.

**B.SC. V SEMESTER COURSE
SKILL ENHANCEMENT COURSE
COURSE TITLE: PUBLIC HEALTH AND HYGIENE
COURSE CODE: ZOO-SEC-514
THEORY**

L	T	P	C
1	1	0	2

Objective: To comprehend the significance of cleanliness and health.

Unit I: Maintenance of Personal hygiene

- a. Introduction to public health and hygiene- determinants and factors.
- b. Pollution and health hazards; water and air borne diseases.
- c. Radiation hazards: Mobile Cell tower and electronic gadgets (recommended levels, effects and precautions).
- d. Personal hygiene, oral hygiene and sexual hygiene.

Unit II: Nutrient deficiency diseases

- a. Classification of food into micro and macro nutrients.
- b. Balanced diet, dietary plan for an infant, child, normal adult, pregnant woman and old person.
- c. Importance of dietary fibres.
- d. Malnutrition anomalies – Anaemia (Iron and Vitamin B12 deficiency), Kwashiorkar, Marasmus, Rickets, Goitre (cause, symptoms, precaution and cure).

Unit III: Communicable and contagious diseases

- a. Communicable viral diseases: Measles, Chicken pox, Poliomyelitis, Swine flu, Dengue, Corona, Chikungunya, Rabies, Leprosy and Hepatitis.
- b. Communicable bacterial diseases: Tuberculosis, Typhoid, Cholera, Tetanus, Plague, Whooping cough, Diphtheria, Leprosy.
- c. Sexually transmitted diseases- AIDS, syphilis and gonorrhoea.

Unit IV: Non-communicable diseases and cure

- a. Non-communicable diseases such as hypertension, stroke, coronary heart disease, myocardial infarction.

- b. Osteoporosis, osteoarthritis and rheumatoid arthritis-cause, symptoms, precautions.
- c. Diabetes- types and their effect on human health.
- d. Gastrointestinal disorders- acidity, peptic ulcer, constipation, piles (cause, symptoms, precaution and remedy).

Unit V: Other Common diseases

- a. Obesity (Definition and consequences).
- b. Mental illness (depression and anxiety).
- c. Oral and lung cancer and their preventive measures.
- d. Breast cancer, Uterine cancer and their preventive measures.

Suggested 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.
4. Gibney, M.J. (2013). Public Health Nutrition.
5. Wong K.V. (2017). Nutrition, Health and Disease.

Learning outcomes:

After successfully completing the 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.

Semester VI			
Nature of Course	Course Code	Course Title	Credits
Discipline Specific Major	ZOO-DSM-611	Applied Zoology -Theory	4
	ZOO-DSM-612	Applied Zoology Practical	2
Ability Enhancement Course	ZOO-AEC-613	Good Laboratory Practices	2
Skill Enhancement Course	ZOO-SEC-614	Computer Application	2
			Total Credits 10

**B.SC. VI SEMESTER COURSE
DISCIPLINE SPECIFIC MAJOR (DSM)
COURSE TITLE: APPLIED ZOOLOGY
COURSE CODE: ZOO-DSM-611
THEORY**

L	T	P	C
4	0	0	4

Objective: To develop comprehension regarding natural resources and their application for the betterment of human well-being.

Unit I: Fish culture

- a. Fish Culture, different types of ponds.
- b. Cultivable fishes.
- c. Integrated fish farming.
- d. Processing and Preservation of fish.
- e. By products of fishing industry and common fish diseases.

Unit II: Culture other than fishes

- a. Pearl Culture.
- b. Prawn culture.
- c. Molluscan Fisheries.

Unit III: Commercially important Insects

- a. Apiculture: Morphology and Biology of honey bees, Species of honey bees in India, Methods of Bee keeping.
- b. Lac culture: Lac insect and its life cycle, Cultivation of lac insect, host plants, processing and uses of lac.
- c. Sericulture: Types of silk, silkworms and their host plants, life history of silkworm.

Unit IV: Common Pest of Crops

- a. Biology, Control and damage caused by stored grain pests: *Helicoverpa armigera*, *Pyrilla erpusilla* and *Papilio demoleus*, *Callosobruchus chinensis*, *Sitophilus oryzae* and *Tribolium castaneum*.

- b. Biology, Control and damage caused by vegetable and crop insects: *Sylepta derogate*, *Scipophaga incertulas*, *Emmalocera depraessella*.
- c. Biology, Control and damage caused by common fruit Insects: *Chaetanaphothrips signipennis*, *Idioscopus clypealis*, *Deudorix Isocrates*.

Unit V: Vermiculture

- a. Vermicomposting Worms.
- b. Rearing of earthworms for the production of compost.
- c. Vermiwash Collection.
- d. Vermimeal.

Suggested Readings:

1. Shukla G.S. and Upadhyaya, V.B. (1999-2000). Economic Zoology, Rastogi Publishers.
2. Mani M.S. (2006). Insects, NBT, India.
3. Jabde P.V. (2005) Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac culture. Discovery Publishing Pvt. Ltd.

Learning outcomes:

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

- Understand the culture techniques of commercially important animals.

**B.SC. VI SEMESTER COURSE
DISCIPLINE SPECIFIC MAJOR
COURSE TITLE: APPLIED ZOOLOGY
COURSE CODE: ZOO-DSM-612
PRACTICAL**

L	T	P	C
0	0	2	2

1. Morphological characterization of edible fish species.
2. Identification of two major carps – *Labeo rohita* and *Catla catla*.
3. Study of permanent slide of cycloid scales.
4. Study of social behaviour in bees.
5. Worker honey bee with emphasis on leg modifications (through specimens/charts) and whole mount preparation of legs.
6. Life cycle of mulberry silkworm, *Bombyx mori* (model/chart/specimens) and life cycle of tasar silkworm *Antheraea mylitta*.
9. Life cycle of lac insect *Laccifer lacca*.
7. External morphology and nomenclature of dairy animals.
8. Determination of the specific gravity of milk by using a mercury lactometer.
9. Study of Vermiculture.

B.SC. VI SEMESTER COURSE
ABILITY ENHANCEMENT COURSE
COURSE TITLE: GOOD LABORATORY PRACTICES
COURSE CODE: ZOO-AEC-613
THEORY

L	T	P	C
1	1	0	2

Objective: To acquire knowledge on the proper handling and regulation of laboratory facilities.

Unit I: General Laboratory Practices

- a. Understanding the details on the label of reagent bottles.
- b. Molarity and normality of common acids and bases.
- c. Dilutions, Percentage solutions, Molar, Molal and Normal solutions.
- d. Technique of handling micropipettes.
- e. Knowledge about common corrosive and toxic chemicals and safety measures.

Unit II: Tissue Micro-Techniques

- a. Weighing and staining procedures.
- b. Classification and chemistry of stains.
- c. Staining equipment.
- d. Reactive dyes and fluoro-chromes (GFP and other tags).

Unit III: Methods to Study Tissue Structure

- a. Whole mounts, squash preparations, clearing, maceration and sectioning.
- b. Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant fixatives.
- c. Tissue dehydration using graded solvent series.
- d. Paraffin; Preparation of thin and ultrathin sections.

Unit IV: Overview of Biological Problems

- a. History; Key relevant problems associated with Zoology research areas, their solution and basic understanding of animal models.
- b. Identifying sources of hazards: Poisonous chemicals, broken glass, Explosion, Fire.
- c. Sample collection, recording of data.

- d. Safety/First aid measures: Fume hoods, eye fountain, emergency shower, fire extinguisher, eye protection gear.

Unit V: Laboratory hierarchy and SOP

- a. Levels of Laboratories.
- b. Log Book Maintenance.
- c. Basic SOPs for instrument handling and Maintenance.

Suggested Readings:

1. Seiler J.P. (2005). Good Laboratory Practices: the why and how. Springer-Verlag Berlin and Heidelberg GmbH & Co. K
2. Garner W.Y., Barge M.S. and Ussary P.J. (1992). Good Laboratory Practice Standards: Application for field and Laboratory studies. Wiley.

Learning outcomes:

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

- Apply practical skills in science courses with the understanding of general laboratory practices.
- Use various micro techniques used in Zoology.

**B.SC. VI SEMESTER COURSE
SKILL ENHANCEMENT COURSE
COURSE TITLE: COMPUTER APPLICATION
COURSE CODE: ZOO-SEC-614
THEORY**

L	T	P	C
1	1	0	2

Objective: To acquire proficiency in the utilisation of computer technologies for biological study.

Unit I: about PC, operating system and software

- a. Introduction to PC and Window operating system, application software (Windows, MS word).
- b. Introduction of spreadsheet (MS Excel): application, formula and functions.
- c. Creating basic graphs using spreadsheet applications.
- d. MS Power point application and functions.

Unit II: Computer Networking

- a. Introduction to computer networking, data communication, components of data communication.
- b. LAN, MAN, WAN, wireless LAN.

Unit III: Internet Resources and Multimedia

- a. The Internet and Multimedia: Internet History, Multimedia on the Web.
- b. Text and pictures for the web page.
- c. Video Conferencing, e-Commerce, m-Commerce, VOIP, blogs.

Unit IV: Bibliography management

- a. Advanced Google search operators.
- b. Introduction to Google Scholar and accessing scholarly literature from Internet.
- c. Introducing bibliography management software, Styles and Templates.

Unit V: Artificial Intelligence (AI) Tools for biologists

- a. Role of AI in Biological research.
- b. AI tools for Zoologists.

Suggested Readings:

1. User manual and online user manual of respective software for the most updated content.

Learning outcomes

After the completion of this course the learner will be able to:

- Apply the basic operations of spreadsheet applications.
- Recognize advanced resources for accessing scholarly literature from internet.