MURSHIDABAD UNIVERSITY

CURRICULUM FOR FOUR YEARS

UNDER-GRADUATE COURSE IN ZOOLOGY

[NEP 2020]

w.e.f. 2025

Course Structure

Semester	MAJOR (4 Credits Each)	MINOR (4 Credits Each)	IDC/MDC (3 Credits Each)	AEC-Language (4 Credits Each)	SEC (3 Credits Each)	VAC (2 Credits Each)	Internship/ dissertation (4 Credit Each)	TOTAL CREDIT
I	1 Course	1 Course	1 Course	1 Course	1 Course	1 Course		**20**
II	1 Course	1 Course	1 Course	1 Course	1 Course	1 Course	INTERNSHIP (Additional for Certificate)	**20/24**
III	2 Courses	1 Course	1 Course		1 Course	1 Course		**20**
IV	4 Courses	1 Course					INTERNSHIP (Additional for Diploma)	**20/24**
V	4 Courses	1 Course						**20**
VI	4 Courses	1 Course						**20**
VII	4 Courses	1 Course						**20**
VIII	1 Course or 4 Courses (Honours without research)	1 Course					Research Project (Honours with research) (12 Credits)	**20**
TOTAL	**21/24 Courses (84/96 credits)**	**8 Courses (32 Credits)**	**3 courses (9 credits)**	**2 courses (8 credits)**	**3 courses (9 credits)**	**3 courses (6 credits)**		**160/164**

Detailed Course Structure

Sem	Major	Minor	SEC	MDC	VAC	AEC
I	Non-Chordate Biology	Diversity of the animal world	1. Medical Diagnostics 2. Sericulture	Environment and Biodiversity		English Communication
II	Chordate Biology	Diversity of the animal world	1. Basic Entomology & Pest Management 2. Apiculture	Environment and Biodiversity		
III	Cell biology Molecular Biology	Cell biology and Biochemistry	1. Aquaculture and fish keeping. 2. Poultry farming and Animal Husbandry management	Environment and Biodiversity		
IV	Biochemistry Animal Physiology Parasitology Immunology	Cell biology and Biochemistry				
V	Ecology Biodiversity and Conservation Biology Microbiology Biotechnology	Ecology, Biodiversity and Conservation Biology				
VI	Genetics Animal Behaviour Evolutionary biology Biosystematics and Taxonomy	Ecology, Biodiversity and Conservation Biology				

VII	Scientific Communication and Research Methodology	Genetics, Animal Behaviour and Evolutionary biology Genetics, Animal Behaviour and Evolutionary biology				
	Biostatistics and Bioinformatics					
	Analytical Techniques in Biology					
	Developmental biology					
VIII	Recombinant DNA Technology					

***** Students have to study any one of the SEC papers offered by the department in semester I, II and III.

1st Semester

Course Code	Subject	Marks	Credits	Hours/week
Major Course: ZOO-M-101 (T)	Non-Chordate Biology	60	**03**	**03**
ZOO-M-101 (P)	Non-Chordate Biology lab	20	**01**	**02**
Minor Course: Mi-101 (T)	Diversity of the animal world	60	**03**	**03**
ZOO-Mi-101 (P)	Diversity of the animal world lab	20	**01**	**02**
Skill Enhancement Course: ZOO-SEC-101 (T)	1. Medical Diagnostics or 2. Sericulture	40	**02**	**02**
ZOO-SEC-101 (P)	Medical Diagnostics lab or 2. Sericulture lab	20	**01**	**02**
Multidisciplinary Course: ZOO-MDC-101	Environment and Biodiversity	60	**03**	**03**
Value Added Course: **VAC-101**		40	**02**	**02**
Ability Enhancement Course AEC-101	English Communication	80	**04**	**04**
Total		**400**	**20**	**23**

2nd Semester

Course Code	Subject	Marks	Credits	Hours/week
Major Course: ZOO-M-201 (T)	Chordate Biology	60	**03**	**03**
ZOO-M-201 (P)	Chordate Biology lab	20	**01**	**02**
Minor Course: ZOO-Mi-101 (T)	Diversity of the animal world	60	**03**	**03**
ZOO-Mi-101 (P)	Diversity of the animal world lab	20	**01**	**02**
Skill Enhancement Course: ZOO-SEC-201 (T)	1. Applied Entomology & Pest Management or 2. Apiculture	40	**02**	**02**
ZOO-SEC-201 (P)	1. Applied Entomology & Pest Management lab or 2. Apiculture lab	20	**01**	**02**
Multidisciplinary Course: ZOO-MDC-101	Environment and Biodiversity	60	**03**	**03**
Value Added Course: VAC-201		40	**02**	**02**
Ability Enhancement Course AEC-201		80	**04**	**04**
Total		**400**	**20**	**23**

Examination pattern

Paper(s)	Internal Assessment	End Semester
Major Paper	**20** (15 internal assessment + 5 class attendance)	**60** 40 (theory) + 20 (Practical)
Minor Paper	**20** (15 internal assessment + 5 class attendance)	**60** 40 (theory) + 20 (Practical)
MDC Paper	**15**	**45**
SEC Paper	**15**	**45** 30 (theory) + 15 (Practical)
AEC Paper	**20**	**60**
VAC Paper	**10**	**30**

Question Pattern

<table>
<tr><th colspan="3">Major and Minor papers</th></tr>
<tr><th>Internal assessment (20)</th><th colspan="2">Semester end term</th></tr>
<tr><td rowspan="2">15 marks
2 x 5 = 10 marks (out of 8)
+
5 x 1 = 5 marks (out of 2)
Or
Viva/ project submission

class attendance = 5 marks</td><td>For written tests
40 marks
2 x 5 marks (out of 8)
5 x 2 marks (out of 4)
10 x 2 marks (out of 4)</td><td>For written tests
60 marks
2 x 5 marks (out of 8)
5 x 6 marks (out of 8)
10 x 2 marks (out of 4)</td></tr>
<tr><td colspan="2">For Practical tests
20 marks
Experiment - 10 marks
LNB + Viva voce – 5+5= 10 marks</td></tr>
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<table>
<tr><th colspan="3">SEC Paper</th></tr>
<tr><th>Internal assessment (15)</th><th colspan="2">Semester end term</th></tr>
<tr><td rowspan="2">For written tests
10 marks
2 x 5 marks (out of 8)

class attendance = 5 marks</td><td>For written tests
45 marks
2 x 5 mark (out of 8)
5 x 3 marks (out of 5)
10 x 2 marks (out of 4)</td><td>For written tests
30 marks
2 x 5 mark (out of 8)
5 x 2 marks (out of 4)
10 x 1 marks (out of 2)</td></tr>
<tr><td colspan="2">For Practical tests
15 marks
Experiment - 10 marks
LNB + Viva voce – 2+3= 5 marks</td></tr>
</table>

<table>
<tr><th colspan="2">MDC Paper</th></tr>
<tr><th>Internal assessment (15)</th><th>Semester end term (45)</th></tr>
<tr><td>For written tests/Viva/ project submission
10 marks
1 x 10 = 10 marks (out of 15)

class attendance = 5 marks</td><td>For written tests
45 marks
1 x 45 marks (MCQ) (Out of 50)</td></tr>
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<table>
<tr><th colspan="2">VAC Paper</th></tr>
<tr><th>Internal assessment (10)</th><th>Semester end term (30)</th></tr>
<tr><td>For written tests
10 marks
1 x 10 = 10 marks (out of 15)</td><td>For written tests
30 marks
1 x 30 marks (MCQ) (Out of 35)</td></tr>
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AEC Paper	
Internal assessment (20)	**Semester end term (60)**
For written tests **15 marks** 1 x 15 = 15 marks (out of 20) class attendance = **5 marks**	For written tests **60 marks** 1 x 60 marks MCQ (out of 70)

Semester - I

MAJOR COURSE: ZOO-M-101 (T): NON-CHORDATE BIOLOGY **CREDIT 03 MARKS: 60**

Course objective: The course aims to develop a comprehensive understanding of animal classification principles (taxonomic hierarchy, nomenclature rules, and systematic criteria); analyze structural and functional characteristics of major animal phyla (protozoa to hemichordata) with evolutionary adaptations; study key physiological processes (e.g., locomotion in amoeba, excretion in macrobrachium) and their ecological significance; evaluate phylogenetic affinities, body plans (symmetry, coelom types), and developmental patterns (protostomes vs. deuterostomes); and examine parasitic adaptations (helminths), conservation challenges (coral reefs), and taxonomic controversies (onychophora's position).

Unit 1: Basics of Animal Classification:

Definitions: Classification, Systematics and Taxonomy; Taxonomic Hierarchy, Taxonomic types, Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy.

Unit 2: Kingdom Animalia

Subkingdom Protozoa: General characteristics and Classification of Protozoa up to phylum (according to Levine et. al., 1981); Locomotion in *Amoeba;* Conjugation in *Paramoecium*.

Criteria for classification of multicellular animals: Body symmetry; Cleavage patterns, Body cavities with reference to pseudocoelom and coelom, Protostomes and Deuterostomes; Origin, evolution and segmentation of Metazoa.

Unit 3: Phylum Porifera

General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6th Ed.); Canal system and Spicules in sponges.

Unit 4: Phylum Cnidaria

General characteristics and Classification up to classes (Ruppert and Barnes, 1994, 6th Ed.), Metagenesis in *Obelia*; Polymorphism in Siphonophora; Coral reef: types, formation, threats and Conservation.

Unit 5: Helminths

General characteristics and Classification up to classes of Phyla Platyhelminthes and Nematoda (Ruppert and Barnes, 1994, 6th Ed.); Parasitic adaptations of helminths. Life cycle of *Fasciola hepatica, Ascaris lumbricoides*

Unit 6: Phylum Annelida

General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Excretion in Annelida; Metamerism in Annelida.

Unit 7: Phylum Onychophora

Affinities and Systematic Position of Onychophorans

Unit 8: Phylum Arthropoda

General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Type study: *Macrobrachium* (respiration and excretion)

Unit 9: Phylum Mollusca

General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Type study *Pila* sp. (Nervous system and respiratory) and *Octopus* sp. (Nervous system); Torsion in Gastropoda.

Unit 10: Phylum Echinodermata

General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Water vascular system in Starfish; Echinoderm larva and affinities with chordates.

Unit 11: Phylum Hemichordata

General characteristics of Phylum Hemichordata; Affinities and systematic position of Hemichordates.

Course outcome: By the end of the course, students will be able to apply zoological nomenclature rules (priority, synonymy) to classify organisms and interpret taxonomic hierarchies; differentiate protozoan locomotion (*Amoeba*) and reproduction (*Paramoecium*) from multicellular traits (coelom, cleavage patterns); explain canal systems in sponges, polymorphism in Siphonophora, and parasitic life cycles (*Fasciola, Ascaris*); describe metamerism (Annelida), water vascular systems (Echinodermata), and torsion (Gastropoda) with evolutionary context; debate the systematic position of Onychophora and hemichordate affinities to chordates using anatomical evidence; and relate coral reef formation/threats to cnidarian biology and conservation strategies.

Major Course: ZOO-M-101 (P): Non-Chordate Biology Lab **Credit 01 Marks: 20**

List of Practicals:

1. Identification and medical significance of *Entamoeba histolytica, Leishmania donovani, Paramecium, Plasmodium vivax* through permanent slides/microphotographs.

2. Identification of *Sycon, Neptune's Cup, Obelia, Physalia, Aurelia, Tubipora, Corallium, Gorgonia, Metridium, Pennatula, Fungia, Madrepora, Neries, Chaetopterus, Pheretima,*

Hirudinaria, Limulus, Palaemon, Balanus, Cancer, Eupagurus, Scolopendra, Bombyx, Periplanta, Apis, Chiton, Dentalium, Pila, Unio, Sepia, Octopus, Asterias, Ophiura, Echinus, Cucumaria, Antedon.

3. Identification and significance of adult *Fasciola hepatica, Taenia solium, Ascaris lumbricoides, Wuchereria bancrofti*.

4. Isolation, Fixation, Staining and Mounting of Protozoa and Helminth from gut of Cockroach (*Periplaneta americana*)

Minor Course: ZOO-Mi-101 (T): Diversity of the animal world Credit 03 Marks: 60

Course objectives: The course aims to develop a comprehensive knowledge of the general characteristics, classification, and unique biological features of major invertebrate phyla (Protista to Echinodermata); examine the evolutionary progression and classification of vertebrates (Agnatha to Mammalia), focusing on adaptations to diverse habitats; explore specialized structures and systems (e.g., canal systems in sponges, water vascular systems in echinoderms, osmoregulation in fish) and their physiological significance; investigate key adaptations such as polymorphism in cnidarians, metamorphosis in insects, flight in birds, and parental care in amphibians; and classify organisms using systematic criteria while interpreting life cycles (e.g., *Taenia solium*), phylogenetic relationships (protochordates), and ecological roles.

Unit I: Protista

- General characters and classification up to phyla.
- Locomotory organelles in Protozoa (structure only).

Unit II: Porifera

- General characters and classification up to classes.
- Canal system in *Sycon.*

Unit III: Cnidaria

- General characters and classification up to classes of Phylum Cnidaria.
- Polymorphism in *Obelia.*

Unit IV: Platyhelminthes and Nematoda

- General characters and classification up to classes.
- Life cycle of *Taenia solium* and its parasitic adaptations

Unit V: Annelida

- General characters and classification up to classes.
- Coelom and metamerism in Annelida.

Unit VI: Arthropoda

- General characters and classification up to classes.
- Metamorphosis in insects.

Unit VII: Mollusca

- General characters and classification up to classes.
- Respiration in *Pila.*

Unit VIII: Echinodermata

- General characters and classification up to classes.
- Water vascular system in *Asterias.*

Unit IX: Protochordates

General features and Phylogeny of Protochordata.

Unit X: Agnatha

General features of Agnatha and classification of cyclostomes up to classes.

Unit XI: Pisces

General features and Classification up to orders; Osmoregulation in Fishes.

Unit XII: Amphibia

General features and Classification up to orders; Parental care.

Unit XIII: Reptiles General features and Classification up to orders; Venomous and non-venomous snakes, Biting mechanism in snakes.

Unit XIV: Aves

General features and Classification up to orders; Flight adaptations in birds.

Unit XV: Mammals

Classification up to orders; Origin of mammals.

Course outcome: By the end of the course, students will be able to distinguish major invertebrate phyla (e.g., Porifera, Arthropoda) based on diagnostic characters (canal systems, metamerism) and classify them up to classes/orders; relate vertebrate traits (e.g., osmoregulation in fish, biting mechanisms in snakes, mammary glands in mammals) to their evolutionary success; describe specialized systems (respiration in *Pila*, water vascular system in *Asterias*) and their role in survival; illustrate parasitic adaptations (e.g., *Taenia solium*) and complex life cycles (metamorphosis in insects, polymorphism in *Obelia*); compare protochordate features with chordates and justify the origin of mammals from reptilian ancestors; and connect adaptations (flight in birds, venom in snakes) to ecological niches and conservation needs.

Minor Course: ZOO-Mi-101 (P): Diversity of the animal world lab Credit 01 Marks: 20

1. Study of the following specimens: *Amoeba, Plasmodium, Paramecium, Sycon, Euplectella, Obelia, Physalia, Aurelia, Tubipora, Metridium, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus, Scolopendra, Apis, Chiton, Pila, Unio, Loligo, Sepia, Octopus, Asterias, Ophiura, Echinus, Cucumaria and Antedon, Balanoglossus, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Naja, Crocodylus, Gavialis,* Any six common birds from different orders, Bat*, Funambulus.*

2. Study of the following permanent slides: Life history stages of *Taenia*, T.S. of male and female *Ascaris*.

3. Key for identification of venomous and non-venomous snakes.

Skill Enhancement Course: ZOO-SEC-101 (T): Sericulture Credit 02 Marks: 40

Course objectives: This course aims to provide knowledge of sericulture fundamentals including types of silkworms (mulberry and non-mulberry), exotic and indigenous races and their significance; examine the life cycle of *Bombyx mori*, silk gland structure and silk secretion mechanisms; teach mulberry cultivation, rearing house setup, disinfection methods and silkworm rearing technology (early/late age rearing, cocoon harvesting and storage); identify major pests (Uzi fly, dermestid beetles) and diseases (protozoan, viral, fungal, bacterial) with control measures; and analyze the economic potential of sericulture in India including employment opportunities and state-wise industry prospects.

Unit 1: Introduction

Sericulture: Definition, Types of silkworms, Exotic and indigenous races; Mulberry and non-mulberry.

Unit 2: Biology of Silkworm

Life cycle of *Bombyx mori*; Structure of silk gland and secretion of silk

Unit 3: Rearing of Silkworms

Selection of mulberry variety and establishment of mulberry garden; Rearing house and rearing appliances; Disinfectants; Silkworm rearing technology: Early age and Late age rearing; Types of mountages, Spinning, harvesting and storage of cocoons.

Unit 4: Pests and Diseases

Pests of silkworm: Uzi fly, dermestid beetles and vertebrates; Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial; Control and prevention of pests and diseases.

Unit 5: Entrepreneurship in Sericulture

Prospects of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture.

Course outcome: By the end of the course, students will be able to differentiate between mulberry and non-mulberry silkworms while explaining the importance of exotic and indigenous races; illustrate the life cycle of *Bombyx mori* and explain silk gland structure and secretion processes; establish a mulberry garden, manage rearing appliances, and perform early and late age silkworm rearing for optimal cocoon production; identify and manage pests (Uzi fly, beetles) and diseases (pebrine, flacherie) using preventive and curative measures; and assess the scope of sericulture in different Indian states while developing entrepreneurial strategies for mulberry and non-mulberry sericulture.

Skill Enhancement Course: ZOO-SEC-101 (P): Sericulture lab Credit 01 Marks: 20

- Identification of different stages of the life cycle of silk moth.
- Identification of the pests of the silkworm
- Identification of the diseased silkworm
- Project report on a visit to a sericulture institute/ farm.

Or,

- Sericulture training program (30 hrs) in CSR&TI

Skill Enhancement Course: ZOO-SEC-101 (T): Medical diagnostics Credit 02 Marks: 40

Course objective: This course aims to develop proficiency in clinical bacteriology including aseptic techniques, bacterial culturing, staining methods, and identification of Gram-positive/negative bacteria with proper specimen handling; teach virology fundamentals covering virus characteristics, transmission routes, inactivation methods, and diagnostic techniques; implement biomedical waste management through categorization and proper disposal protocols for infectious/hazardous materials; apply lab management and ethics by maintaining equipment, quality control, and following safety regulations (GCLP); perform basic lab procedures such as preparing sterile environments, solutions/reagents, and operating instruments; and analyze hematological disorders including hematopoiesis, blood diseases (anemia, leukemia), hemostasis, and coagulation tests (PT, APTT).

Bacteriology: Clinical Bacteriology: Laboratory Aseptic Techniques, Culturing and Staining Methods, Identification of Gram-Negative and Gram-Positive Bacteria, Collection, Transport & Examination of Specimen.

Virology: Introduction to Virus, General Characteristics common to Viruses, Methods of Inactivation of Viruses, General Transmission Routes for Viruses, Laboratory Diagnosis of Important Viruses

Bio-Medical Waste Disposal: Introduction to Bio-medical Waste Management, Categorizing Biomedical Waste, Appropriate Disposal of Urine and Stools, Disposal of Infectious Waste, Disposal of Hazardous Waste, Protocol to be followed in case of Exposure to Infectious or Hazardous Waste.

Lab Management and Ethics: Maintaining Equipment and Quality Control, Acts and Regulations, including Safety Protocols, Confidentiality Protocols, Guidelines for Good Clinical Laboratory Practices.

Basic Laboratory Principles and Procedures: Sterilization, Preparation of Solutions and Reagents, Basic Equipment & Instruments

Haematology& Coagulopathies: Introduction to Haematology, Haematological Diseases, Haemostasis, Coagulation and Routine Coagulation Tests.

Course outcome: By the end of this course, students will be able to perform Gram staining, culture isolation, and biochemical tests to differentiate Gram-positive and Gram-negative bacteria from clinical specimens; apply ELISA, PCR, or cell culture techniques to detect viruses while interpreting inactivation methods for lab safety; segregate biomedical waste into color-coded categories (yellow, red, blue bins) following WHO disposal protocols for infectious/hazardous materials; document quality control logs, calibrate equipment, and implement safety protocols (PPE, spill management) in compliance with regulatory frameworks (CLIA, HIPAA); sterilize equipment (autoclaving), prepare buffers/stains (e.g., Wright's stain), and operate laboratory instruments including microscopes, centrifuges, and spectrophotometers; and analyze CBC reports, identify coagulopathies (DIC, hemophilia) through PT/INR and APTT tests, while correlating results with clinical conditions.

Skill Enhancement Course:

ZOO-SEC-101 (P): Medical Diagnostics Lab — Credit 01 Marks: 20

1. Demonstration of the Culturing, Staining, and Identification of Bacteria
2. Demonstration of Appropriate Disposal of Urine and Stools
3. Demonstration on how to manage bio-medical waste in the workplace.
4. Demonstration of Various Laboratory Equipment & Instruments
5. Demonstration of the Preparation of Laboratory Solutions and Reagents.
6. Demonstration of identification of Human Blood Groups, Rhesus blood groups

Multidisciplinary Course: ZOO-MDC-101 — Credit 03 Marks: 60

Course objective: This course aims to help students define biodiversity, ecosystems, and sustainability while analysing their ecological, economic, and cultural significance; examine ecosystem structures, energy flow, and the role of keystone species in maintaining ecological balance; evaluate genetic, species, and ecosystem diversity using tools like the IUCN Red List; investigate threats to biodiversity (deforestation, pollution) and strategies for mitigation (pollution control, habitat restoration); classify waste types (solid, biomedical, nuclear) and implement disposal technologies for sewage, thermal power waste, and hazardous materials; and analyse greenhouse gas effects, ozone depletion, acid rain, and public health impacts while linking them to global conservation efforts.

Unit I: Introduction to Environment and Biodiversity

Key Concepts: Definitions of biodiversity, ecosystems, and sustainability. Ecological, economic, and cultural value of biodiversity.

Unit II: Ecological Foundations

Ecosystems, biomes, and energy flow. Keystone species and trophic cascades.

Unit III: Biodiversity

Genetic, species, and ecosystem diversity. Tools of biodiversity measurement, IUCN Red List.

Unit IV: Human Impacts on biodiversity

Deforestation, urbanization, and fragmentation. Air, water, noise and plastic pollution. Pollution sources and effects. Pollution control.

Unit V: Waste Management Technologies

Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, nuclear waste handling and disposal, Waste from thermal power plants.

Unit VI: Climate Change

Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health.

Course outcome: By the end of this course, students will be able to explain biodiversity, sustainability, and ecosystem services with real-world examples of their economic/cultural value; illustrate energy flow in biomes and predict impacts of keystone species loss on trophic cascades; apply tools (e.g., IUCN Red List) to assess genetic, species, and ecosystem diversity in conservation planning; propose solutions to deforestation, urbanization, and pollution (air, water, plastic) through policy and technology; select appropriate disposal methods for sewage, biomedical, and nuclear waste while adhering to safety protocols; and correlate greenhouse gases, acid rain, and ozone depletion with public health risks while advocating for mitigation strategies.

Semester - II

Major Course: ZOO-M-201 (T): Chordate Biology **Credit 03 Marks: 60**

Course objective: This course aims to examine the origin of chordates through key theories (Dipleurula concept, Echinoderm theory); study the general characteristics of protochordates and agnathans including pharyngeal structure (*Branchiostoma*) and retrogressive metamorphosis (*Ascidia*); compare Chondrichthyes and Osteichthyes adaptations such as swim bladders, gill structures, accessory respiration, and specialized organs (electric organs in Torpedo); trace tetrapod evolution while analyzing amphibian integument adaptations, paedomorphosis (Axolotl), and parental care strategies; classify reptiles with emphasis on differentiating venomous/non-venomous snakes and studying venom apparatus/bite management; relate avian exoskeleton features, air-sacs (Pigeon), and aerodynamics to flight efficiency; and classify mammals while analyzing dentition patterns, ruminant stomachs, and echolocation (Microchiropterans).

Unit 1: Introduction to Phylum Chordata

Theories of Origin of chordates with reference to Dipleurula concept and the Echinoderm theory; General characteristics and outline classification (J.Z. Young, 1981).

Unit 2: Protochordata, Agnatha:

Protochordata and Agnatha: General characters and classification up to class (J.Z. Young, 1981); Structure of pharynx and feeding in *Branchiostoma*; Retrogressive metamorphosis in *Ascidia*.

Unit 3: Pisces

General characters and classification of Chondrichthyes and Osteichthyes upto class (J.Z. Young, 1981); Swim bladder in fishes; Structure of gills in cartilaginous and bony fishes; Accessory respiratory organs; Olfactory apparatus in Tilapia; Electric organ in *Torpedo.*

Unit 4: Amphibia

Origin of Tetrapods (Evolution of terrestrial ectotherms); General characteristics and classification of Amphibia up to living Orders (J.Z. Young, 1981); Structure, function and derivatives of integument in amphibia; Paedomorphosis in *Axolotl*; Parental care in Amphibia.

Unit 5: Reptilia

General characteristics and classification of Reptilia (J.Z. Young, 1981)**;** Venomous and non-venomous snake; Venom apparatus and Biting mechanism and snake bite management.

Unit 6: Aves

General characteristics and classification of Aves up to living Sub-Classes (J.Z. Young, 1981); Exoskeleton in Birds; Air-sacs in Pigeon, Aerodynamics of flight mechanism in birds.

Unit 7: Mammalia

General characters and classification up to living orders (J.Z. Young, 1981); Exoskeleton derivatives of mammals; Dentition in mammals; Ruminant stomach; Echolocation in *Microchiropterans*.

Course outcome: Upon completing this course, students will demonstrate the ability to explain chordate origins through Dipleurula and Echinoderm theories; illustrate protochordate systems including Branchiostoma's pharyngeal feeding and ascidian metamorphosis; analyze piscine adaptations by comparing gill structures across fish groups and explaining swim bladder function; interpret amphibian terrestrialization through integument adaptations and paedomorphic cases like Axolotl; assess reptilian hazards by identifying venomous species and their bite management; explain avian flight mechanics through air-sac systems and exoskeletal adaptations; and classify mammalian diversity based on dental formulae, digestive specializations (ruminants), and sensory systems including chiropteran echolocation.

Major Course: ZOO-M-201 (P): Chordate Biology Lab **Credit 01 Marks: 20**

1. Protochordata: *Balanoglossus, Branchiostoma*
2. Agnatha: *Petromyzon, Myxine*
3. Fishes: *Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/ Diodon, Anabas,* Flat fish.
4. Amphibia: *Necturus, Bufo, Hyla, Alytes, Axolotl, Tylototriton*

5. Reptilia: *Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus*.
6. Key for Identification of venomous and non-venomous snakes.
7. Mammalia: Bat (Insectivorous and Frugivorous), *Funambulus*
8. Demonstration of brain and pituitary of Rohu fish/ Tilapia
9. Pecten from Fowl head/ Temporary staining and mounting of cycloid and ctenoid scales.
10. Power point presentation on study of any two animals from two different classes by students.

Minor Course: ZOO-Mi-101 (T): Diversity of the animal world Credit 03 Marks: 60

Course objectives: The course aims to develop a comprehensive knowledge of the general characteristics, classification, and unique biological features of major invertebrate phyla (Protista to Echinodermata); examine the evolutionary progression and classification of vertebrates (Agnatha to Mammalia), focusing on adaptations to diverse habitats; explore specialized structures and systems (e.g., canal systems in sponges, water vascular systems in echinoderms, osmoregulation in fish) and their physiological significance; investigate key adaptations such as polymorphism in cnidarians, metamorphosis in insects, flight in birds, and parental care in amphibians; and classify organisms using systematic criteria while interpreting life cycles (e.g., *Taenia solium*), phylogenetic relationships (protochordates), and ecological roles.

Unit I: Protista

- General characters and classification up to phyla.
- Locomotory organelles in Protozoa (structure only).

Unit II: Porifera

- General characters and classification up to classes.
- Canal system in *Sycon.*

Unit III: Cnidaria

- General characters and classification up to classes of Phylum Cnidaria.
- Polymorphism in *Obelia.*

Unit IV: Platyhelminthes and Nematoda

- General characters and classification up to classes.
- Life cycle of *Taenia solium* and its parasitic adaptations

Unit V: Annelida

- General characters and classification up to classes.
- Coelom and metamerism in Annelida.

Unit VI: Arthropoda

- General characters and classification up to classes.
- Metamorphosis in insects.

Unit VII: Mollusca

- General characters and classification up to classes.
- Respiration in *Pila.*

Unit VIII: Echinodermata

- General characters and classification up to classes.

• Water vascular system in *Asterias.*

Unit IX: Protochordates

General features and Phylogeny of Protochordata.

Unit X: Agnatha

General features of Agnatha and classification of cyclostomes up to classes.

Unit XI: Pisces

General features and Classification up to orders; Osmoregulation in Fishes.

Unit XII: Amphibia

General features and Classification up to orders; Parental care.

Unit XIII: Reptiles General features and Classification up to orders; Venomous and non-venomous snakes, Biting mechanism in snakes.

Unit XIV: Aves

General features and Classification up to orders; Flight adaptations in birds.

Unit XV: Mammals

Classification up to orders; Origin of mammals.

Course outcome: By the end of the course, students will be able to distinguish major invertebrate phyla (e.g., Porifera, Arthropoda) based on diagnostic characters (canal systems, metamerism) and classify them up to classes/orders; relate vertebrate traits (e.g., osmoregulation in fish, biting mechanisms in snakes, mammary glands in mammals) to their evolutionary success; describe specialized systems (respiration in *Pila*, water vascular system in *Asterias*) and their role in survival; illustrate parasitic adaptations (e.g., *Taenia solium*) and complex life cycles (metamorphosis in insects, polymorphism in *Obelia*); compare protochordate features with chordates and justify the origin of mammals from reptilian ancestors; and connect adaptations (flight in birds, venom in snakes) to ecological niches and conservation needs.

Minor Course: ZOO-Mi-101 (P): Diversity of the animal world lab Credit 01 Marks: 20

1. Study of the following specimens: *Amoeba, Plasmodium, Paramecium, Sycon, Euplectella, Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium, Male and female Ascaris lumbricoides, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus, Scolopendra, Apis, Chiton, Pila, Unio, Loligo, Sepia, Octopus, Asterias, Ophiura, Echinus, Cucumaria and Antedon, Balanoglossus, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Naja, Crocodylus, Gavialis,* Any six common birds from different orders, Bat*, Funambulus.*

2. Study of the following permanent slides: Life history stages of *Taenia*, T.S. of male and female *Ascaris*.

3. Key for identification of venomous and non-venomous snakes.

Skill Enhancement Course:

ZOO-SEC-201 (T): Apiculture: **Credit 02 Marks: 40**

Course objectives: This course aims to provide students with a comprehensive understanding of honey bee biology including classification, life cycle, social structure, and communication methods; teach practical beekeeping techniques such as artificial rearing (apiary), hive management (Newton/Langstroth hives), bee pasturage, and both indigenous and modern honey extraction methods; enable identification of bee enemies (wasps, hive beetles) and diseases (viral, bacterial, protozoan, fungal) along with their symptoms and treatments; explore the commercial applications of apiculture products (honey, beeswax, propolis, royal jelly, venom) across industries; and develop entrepreneurial skills by evaluating apiculture prospects, challenges, and modern innovations including horticultural pollination services.

Unit I: Biology of Bees

- Classification, Life cycle and social structure of honey bees
- Bee Communication.

Unit II: Rearing of Bees

- Artificial bee rearing (Apiary), beehives: Newton and Langstroth, bee pasturage.
- Selection of bee species for Apiculture.
- Bee keeping equipment.
- Methods of extraction of honey (indigenous and modern).

Unit III: Enemies and Diseases

- Enemies: Wasp and small hive beetle.
- Causative agents, symptoms and remedies of bee diseases: Viral (Sac-brood disease), bacterial (American foul brood), protozoan (Nosema), Fungal (Chalk brood).

Unit IV: Bee Economy

- Products of Apiculture Industry and its uses (Honey, Bees wax, Propolis, Pollen, Royal Jelly, Bee Venom).

Unit V: Entrepreneurship in Apiculture

- Resource available, prospects and problems.
- Bee keeping industry: Recent efforts and developments.
- Modern methods in employing artificial beehives for crosspollination in horticultural gardens.

Course outcome: By completing this course, students will be able to describe honey bee biology including classification, life stages, social hierarchy (queen/workers/drones), and communication (waggle dance); demonstrate practical beekeeping skills such as apiary setup, species selection, equipment use, and honey extraction (traditional/modern methods); identify disease-causing pathogens (Sac-brood, American foulbrood) and implement treatment protocols; process and commercialize bee products (beeswax, propolis) for various applications; and develop entrepreneurial apiculture business plans incorporating resource management, market trends, and horticultural pollination services.

Skill Enhancement Course:

ZOO-SEC-201 (P): Apiculture lab **Credit 01 Marks: 20**

- Identifying different castes (queen, worker, drone), studying the life cycle stages (egg, larva, pupa).
- Identification of the diseased honey bee (as per theory syllabus).
- Demonstration of different equipment required for bee keeping.
- Honey testing kit - Physical and chemical methods of analysis.
- Project report on a visit to a sericulture/apiculture farm.

ZOO-SEC-202 (T): Basic Entomology and Pest Management **Credit 02 Marks: 40**

Course objective: This course aims to provide students with a comprehensive understanding of insect morphology and physiology through the study of structural adaptations (head, antennae, mouthparts, wings) and physiological systems (digestive, respiratory, sensory); enable classification of major insect orders (Odonata to Hymenoptera) with representative examples using Imms' (1938) system; analyze pest dynamics including economic thresholds (EIL, ETL) and their impacts on crops (paddy, jute, brinjal) and stored grains; implement integrated pest management strategies combining chemical, mechanical, cultural, and biological control methods; and develop practical skills in operating pest control equipment (dusters, sprayers, granule applicators) for effective agricultural pest management.

Unit 1: Insect diversity and adaptation: Morphological adaptation of insects: Head and Antenna, Mouthparts, Thorax and thoracic appendages- legs and wings [General concept].

Unit 2: Physiological adaptation: Digestive system: Alimentary canal and digestive glands; Digestion; Respiratory organs and mechanism of gaseous exchange; Sense organs: compound eyes, chemoreceptors.

Unit 3: General Characteristics of Class Insecta and living orders with examples: Odonata, Orthoptera, Dictyoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera, Hymenoptera, Siphonaptera (Imms, A.D., 1938).

Unit 4: Concept of insect pest: Types; Economic Injury Level (EIL), Economic Threshold Level (ETL).

Unit 5: Pests of major crops (Life cycle, Nature of damage and control measures): Pests of Paddy, *Scirpophaga incertulus*; Pests of Jute, *Anomis sabulifera*; Pests of brinjal, *Leucinodes orbonalis*; Stored grain pest: *Sitophilus oryzae*; Invasive insect pests of India and their consequences.

Unit 5: Insect Pest control: Chemical, Mechanical, Cultural and Biological control measures; Integrated Pest Management (IPM)

Unit 6: Study of appliances used in pest control: Dusters; Sprayers- categories of sprayers, agricultural aircraft, Granule applicator, soil injectors.

Course outcome: This course will equip students to study insect anatomy (head, wings, mouthparts) and physiology (digestion, respiration); classify major orders (Odonata-Hymenoptera) per Imms (1938); assess pest impacts on crops (paddy, brinjal) using EIL/ETL thresholds; apply IPM combining biological, chemical and cultural controls; and operate pest control equipment (sprayers, dusters) for agricultural protection.

Skill Enhancement Course:

ZOO-SEC-202 (P): Basic Entomology and Pest Management lab Credit 01 Marks: 20

- Dissection and temporary mounting of: Antennae and mouth parts of Cockroach, House fly, and Mosquito.
- Dissection and Study of the digestive system of Cockroach
- Methods of collection, preservation and identification of economically important insects.
- Visit to Agricultural fields for on-spot study of pests and damage caused.
- Collection and Submission of agriculturally important insect pests.

Multidisciplinary Course: ZOO-MDC-101 Credit 03 Marks: 60

Course objective: This course aims to help students define biodiversity, ecosystems, and sustainability while analysing their ecological, economic, and cultural significance; examine ecosystem structures, energy flow, and the role of keystone species in maintaining ecological balance; evaluate genetic, species, and ecosystem diversity using tools like the IUCN Red List; investigate threats to biodiversity (deforestation, pollution) and strategies for mitigation (pollution control, habitat restoration); classify waste types (solid, biomedical, nuclear) and implement disposal technologies for sewage, thermal power waste, and hazardous materials; and analyse greenhouse gas effects, ozone depletion, acid rain, and public health impacts while linking them to global conservation efforts.

Unit I: Introduction to Environment and Biodiversity

Key Concepts: Definitions of biodiversity, ecosystems, and sustainability. Ecological, economic, and cultural value of biodiversity.

Unit II: Ecological Foundations

Ecosystems, biomes, and energy flow. Keystone species and trophic cascades.

Unit III: Biodiversity

Genetic, species, and ecosystem diversity. Tools of biodiversity measurement, IUCN Red List.

Unit IV: Human Impacts on biodiversity

Deforestation, urbanization, and fragmentation. Air, water, noise and plastic pollution. Pollution sources and effects. Pollution control.

Unit V: Waste Management Technologies

Sources of waste, types and characteristics, Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal, nuclear waste handling and disposal, Waste from thermal power plants.

Unit VI: Climate Change

Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health.

Course outcome: By the end of this course, students will be able to explain biodiversity, sustainability, and ecosystem services with real-world examples of their economic/cultural value; illustrate energy flow in biomes and predict impacts of keystone species loss on trophic cascades; apply tools (e.g., IUCN Red List) to assess genetic, species, and ecosystem diversity in conservation planning; propose solutions to deforestation, urbanization, and pollution (air, water, plastic) through policy and technology; select appropriate disposal methods for sewage, biomedical, and nuclear waste while adhering to safety protocols; and correlate greenhouse gases, acid rain, and ozone depletion with public health risks while advocating for mitigation strategies.

