MURSHIDABAD UNIVERSITY

CURRICULUM FOR FOUR YEARS

UNDER-GRADUATE COURSE IN ZOOLOGY

[NEP 2020]

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 Or, 2. Sericulture	Environment and Biodiversity		English Communi-cation
II	Chordate Biology	Diversity of the animal world	1. Basic Entomology & Pest Management Or, 2. Apiculture	Environment and Biodiversity		
III	Cell biology Molecular Biology	Cell biology and Biochemistry	1. Aquaculture and fish keeping. Or, 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	Ecology, Biodiversity and Conservation Biology				

	Biosystematics and Taxonomy					
VII	Endocrinology	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: 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-101 (T) (A) / (B)	1. Sericulture or 2. Medical Diagnostics	40	**02**	**02**
ZOO-SEC-101 (P) (A) / (B)	1. Sericulture Lab or 2. Medical Diagnostics Lab	20	**01**	**02**

Multidisciplinary Course: ZOO-MDC-101	Environment and Biodiversity	60	**03**	**03**
Value Added Course: VAC-101	Understanding India	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) (A) / (B)	1. Applied Entomology & Pest Management or 2. Apiculture	40	**02**	**02**
ZOO-SEC-201 (P) (A) / (B)	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	Environmental Science/Education	40	**02**	**02**
Ability Enhancement Course AEC-201	Bengali / Alternative English	80	**04**	**04**
Total		**400**	**20**	**23**

3rd Semester

Course Code	Subject	Marks	Credits	Hours/week
Major Course: ZOO-M-301 (T)	Cell Biology	60	**03**	**03**
ZOO-M-301 (P)	Cell Biology lab	20	**01**	**02**
Major Course: ZOO-M-302 (T)	Molecular Biology	60	**03**	**03**
ZOO-M-302 (P)	Molecular Biology Lab	20	**01**	**02**
Minor Course: ZOO-Mi-201 (T)	Cell biology and Biochemistry	60	**03**	**03**
ZOO-Mi-201 (P)	Cell biology and Biochemistry lab	20	**01**	**02**
Skill Enhancement Course: ZOO-SEC-301 (T) (A) / (B)	1. Aquaculture and fish keeping. or 2. Poultry farming and Animal Husbandry management	40	**02**	**02**
ZOO-SEC-301 (P) (A) / (B)	1. Aquaculture and fish keeping lab or 2. Poultry farming and Animal Husbandry management lab	20	**01**	**02**
Multidisciplinary Course: ZOO-MDC-101	Environment and Biodiversity	60	**03**	**03**
Value Added Course: VAC-301	Health & Wellness, Yoga Education, Sports and Fitness	40	**02**	**02**
Total		**400**	**20**	**24**

4th Semester

Course Code	Subject	Marks	Credits	Hours/week
Major Course: ZOO-M-401 (T)	Biochemistry	60	**03**	**03**
ZOO-M-401 (P)	Biochemistry Lab	20	**01**	**02**
Major Course: ZOO-M-402 (T)	Animal Physiology	60	**03**	**03**

ZOO-M-402 (P)	Animal Physiology Lab	20	**01**	**02**
Major Course: ZOO-M-403 (T)	Parasitology	60	**03**	**03**
ZOO-M-403 (P)	Parasitology Lab	20	**01**	**02**
Major Course: ZOO-M-404 (T)	Immunology	60	**03**	**03**
ZOO-M-404 (P)	Immunology Lab	20	**01**	**02**
Minor Course: ZOO-Mi-201 (T)	Cell biology and Biochemistry	60	**03**	**03**
ZOO-Mi-201 (P)	Cell biology and Biochemistry lab	20	**01**	**02**
Total		**400**	**20**	**24**

Examination pattern

Paper(s)	Internal Assessment	End Semester
Major Paper (80)	**20** (15 internal assessment + 5 class attendance)	**60** 40 (theory) + 20 (Practical)
Minor Paper (80)	**20** (15 internal assessment + 5 class attendance)	**60** 40 (theory) + 20 (Practical)
SEC Paper (60)	**15**	**45** 30 (theory) + 15 (Practical)
MDC Paper (60)	**15**	**45**
AEC Paper (80)	**20**	**60**
VAC Paper (40)	**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]
+
5 marks
class attendance</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>
<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)
5 marks
class attendance</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>

MDC Paper	
Internal assessment (15)	**Semester end term (45)**
For written tests/Viva/ project submission **10 marks** 1 x 10 = 10 marks (out of 15) class attendance = **5 marks**	For written tests **45 marks** 1 x 45 marks (MCQ) (Out of 50)

VAC Paper	
Internal assessment (10)	**Semester end term (30)**
For written tests **10 marks** 1 x 10 = 10 marks (out of 15)	For written tests **30 marks** 1 x 30 marks (MCQ) (Out of 35)

SEMESTER - I

Major Course: ZOO-M-101 (T)

NON-CHORDATE BIOLOGY

Credits: 03 (T) + 1 (P) **Full Marks: 80 = 20 (IA) + 40 (T) + 20 (P)**

Lectures: 45

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 I: Basics of Animal Classification (3 Lectures)

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

Unit II: Kingdom Animalia (4 Lectures)

- 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 III: Phylum Porifera (4 Lectures)

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

Unit IV: Phylum Cnidaria (4 Lectures)

- 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 V: Helminths (4 Lectures)

- 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 VI: Phylum Annelida (4 Lectures)

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

Unit VII: Phylum Onychophora (2 Lectures)

- Affinities and Systematic Position of Onychophorans

Unit VIII: Phylum Arthropoda (6 Lectures)

- General characteristics and Classification up to classes (Ruppert and Barnes, 1994); Respiration in Arthropods; Vision in Insecta; Metamorphosis in Arthropoda, hormonal control of metamorphosis.

Unit IX: Phylum Mollusca (5 Lectures)

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

Unit X: Phylum Echinodermata (6 Lectures)

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

Unit XI: Phylum Hemichordata (3 Lectures)

- 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 (Practical)

NON-CHORDATE BIOLOGY LAB
List of Practicals

1. Identification of *Entamoeba, Euglena, Paramecium, Plasmodium vivax* through permanent slides/microphotographs.

2. Identification of *Sycon, Neptune's Cup, Obelia, Physalia, Aurelia, Corallium, Gorgonia, Metridium, Neries, Pheretima, Hirudinaria, Daphnia, Limulus, Peripatus, Palaemon, Balanus,*

Cancer, Eupagurus, Scolopendra, Periplaneta, Apis, Chiton, Pila, Unio, Sepia, Octopus, Asterias, Echinus, Cucumaria, Antedon, Balanoglossus.

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

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

Or,

5. Mounting of *Cyclops, Daphnia, Cypris.*

Minor Course: ZOO-Mi-101 (T)

DIVERSITY OF THE ANIMAL WORLD

Credits: 03 (T) + 1 (P) **Full Marks: 80 = 20 (IA) + 40 (T) + 20 (P)**

Lectures: 45 (T) + 30 (P)

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 (3 Lectures)

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

Unit II: Porifera (3 Lectures)

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

Unit III: Cnidaria (3 Lectures)

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

Unit IV: Platyhelminthes and Nematoda (3 Lectures)

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

Unit V: Annelida (3 Lectures)

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

Unit VI: Arthropoda (3 Lectures)

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

Unit VII: Mollusca (3 Lectures)

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

Unit VIII: Echinodermata (3 Lectures)

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

Unit IX: Protochordates (3 Lectures)

- General features and Phylogeny of Protochordata.

Unit X: Agnatha (3 Lectures)

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

Unit XI: Pisces (3 Lectures)

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

Unit XII: Amphibia (3 Lectures)

- General features and Classification up to orders; Parental care.

Unit XIII: Reptilia (3 Lectures)

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

Unit XIV: Aves (3 Lectures)

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

Unit XV: Mammals (3 Lectures)

- 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 (Practical)

DIVERSITY OF THE ANIMAL WORLD LAB

List of Practicals

1. Study of the following specimens: *Amoeba, Plasmodium, Paramecium, Sycon, Obelia, Physalia, Aurelia, Metridium, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus, Scolopendra, Apis, Chiton, Pila, Sepia, Octopus, Asterias, Echinus, Antedon, Balanoglossus, Branchiostoma, Petromyzon, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Naja, Crocodylus.* Any four 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*.

Or,

3. Temporary mounts of aqueous eosin-stained placoid/cycloid/ctenoid scales.

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

Skill Enhancement Course: ZOO-SEC-101 (T) (A)

SERICULTURE

Credits: 02 (T) + 1 (P) **Full Marks: 60 = 15 (IA) + 30 (T) + 15 (P)**

Lectures: 30 (T) + 30 (P)

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 I: Introduction (6 Lectures)

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

Unit II: Biology of Silkworm (6 Lectures)

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

Unit III: Rearing of Silkworms (6 Lectures)

- 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 IV: Pests and Diseases (6 Lectures)

- 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 V: Entrepreneurship in Sericulture (6 Lectures)

- 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 (Practical) (A)

SERICULTURE LAB
List of practicals

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

Or,

5. Sericulture training program (30hrs) in CSR&TI (students can opt for [1,2,3,4] or 5)

Skill Enhancement Course: ZOO-SEC-101 (T) (B)

MEDICAL DIAGNOSTICS

Credits: 02 (T) + 1 (P) **Full Marks: 60 = 15 (IA) + 30 (T) + 15 (P)**

Lectures: 30 (T) + 30 (P)

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).

Unit I: Bacteriology (5 Lectures)

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

Unit II: Virology (5 Lectures)

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

Unit III: Bio-Medical Waste Disposal (5 Lectures)

- 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.

Unit IV: Lab Management and Ethics (5 Lectures)

- Maintaining Equipment and Quality Control, Acts and Regulations, including Safety Protocols, Confidentiality Protocols, Guidelines for Good Clinical Laboratory Practices.

Unit V: Basic Laboratory Principles and Procedures (5 Lectures)

- Sterilization, Preparation of Solutions and Reagents, Basic Equipment & Instruments

Unit VI: Hematology & Coagulopathies (5 Lectures)

- 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 (Practical) (B)

Medical Diagnostics Lab
List of Practicals

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

ENVIRONMENT AND BIODIVERSITY
Credits: 03 **Full Marks: 60 = 15 (IA) + 45 (T)**
Lectures: 45

Course objective: This course aims to help students define biodiversity, ecosystems, and sustainability while analyzing 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

Credits: 03 (T) + 1 (P) **Full Marks: 80 = 20 (IA) + 40 (T) + 20 (P)**

Lectures: 45

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 I: Introduction to Phylum Chordata (5 Lectures)

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

Unit II: Protochordata, Agnatha (6 Lectures)

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*. Ammocoete larva and its metamorphosis.

Unit III: Pisces (8 Lectures)

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; Scales in fishes; Migration of fishes; Electric organ in *Torpedo.*

Unit IV: Amphibia (6 Lectures)

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 V: Reptilia (6 Lectures)

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 VI: Aves (6 Lectures)

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 VII: Mammalia (8 Lectures)

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 (Practical)

CHORDATE BIOLOGY LAB
List of Practicals

1. Protochordata: *Branchiostoma*
2. Agnatha: *Petromyzon, Myxine*
3. Fishes: *Scoliodon, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Diodon, Anabas,* Flat fish.
4. Amphibia: *Necturus, Bufo / Duttaphrynus, Hyla, Ambystoma* (Axolotl), *Tylototriton*
5. Reptilia: *Trionyx, Hemidactylus, Varanus, Chamaeleon, Draco, Bungarus, Vipera, Naja, Hydrophis, Crocodylus*.
6. Key for Identification of venomous and non-venomous snakes.
7. Aves: *Columba, Psittacula, Passer, Bubo*.
8. Mammalia: Bat (Insectivorous and Frugivorous), *Funambulus*
9. Demonstration of brain and pituitary of Rohu fish/ Tilapia.
10. Pecten from Fowl head or Temporary staining and mounting of cycloid and ctenoid scales.
11. Study of disarticulated skeleton of Columba/Toad/Guineapig
12. 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

Credits: 03 (T) + 1 (P) **Full Marks: 80 = 20 (IA) + 40 (T) + 20 (P)**

Lectures: 45 (T) + 30 (P)

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 (3 Lectures)

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

Unit II: Porifera (3 Lectures)

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

Unit III: Cnidaria (3 Lectures)

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

Unit IV: Platyhelminthes and Nematoda (3 Lectures)

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

Unit V: Annelida (3 Lectures)

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

Unit VI: Arthropoda (3 Lectures)

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

Unit VII: Mollusca (3 Lectures)

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

Unit VIII: Echinodermata (3 Lectures)

- General characters and classification up to classes.

- Water vascular system in *Asterias.*

Unit IX: Protochordates (3 Lectures)

- General features and Phylogeny of Protochordata.

Unit X: Agnatha (3 Lectures)

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

Unit XI: Pisces (3 Lectures)

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

Unit XII: Amphibia (3 Lectures)

- General features and Classification up to orders; Parental care.

Unit XIII: Reptilia (3 Lectures)

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

Unit XIV: Aves (3 Lectures)

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

Unit XV: Mammals (3 Lectures)

- 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 (Practical)

Diversity of the animal world lab

List of Practicals

1. Study of the following specimens: *Amoeba, Plasmodium, Paramecium, Sycon, Obelia, Physalia, Aurelia, Metridium, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus, Scolopendra, Apis, Chiton, Pila, Sepia, Octopus, Asterias, Echinus, Antedon, Balanoglossus, Branchiostoma, Petromyzon, Pristis, Torpedo, Labeo, Exocoetus, Anguilla, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Naja, Crocodylus.* Any four 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*.

Or,

3. Temporary mounts of aqueous eosin-stained placoid/cycloid/ctenoid scales.

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

Skill Enhancement Course: ZOO-SEC-201 (T) (A)

APICULTURE

Credits: 02 (T) + 1 (P) **Full Marks: 60 = 15 (IA) + 30 (T) + 15 (P)**

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 (6 Lectures)

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

Unit II: Rearing of Bees (6 Lectures)

- 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 (6 Lectures)

- 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 (6 Lectures)

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

Unit V: Entrepreneurship in Apiculture (6 Lectures)

- 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 (Practical) (A)

APICULTURE LAB

List of Practicals

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

Skill Enhancement Course: ZOO-SEC-201 (T) (B)

BASIC ENTOMOLOGY AND PEST MANAGEMENT

Credits: 02 (T) + 1 (P) **Full Marks: 60 = 15 (IA) + 30 (T) + 15 (P)**

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 I: Insect diversity and adaptation (3 Lectures)

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

Unit II: Physiological adaptation (4 Lectures)

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

Unit III: General Characteristics of Class Insecta and living orders with examples (4 Lectures)

- Odonata, Orthoptera, Dictyoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera, Hymenoptera, Siphonaptera (Imms, A.D., 1938).

Unit IV: Concept of insect pest (4 Lectures)

- Types; Economic Injury Level (EIL), Economic Threshold Level (ETL).

Unit V: Pests of major crops (Life cycle, Nature of damage and control measures) (5 Lectures)

- 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 VI: Insect Pest control (5 Lectures)

- Chemical, Mechanical, Cultural and Biological control measures; Integrated Pest Management (IPM)

Unit VII: Study of appliances used in pest control (5 Lectures)

- 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-201 (Practical) (B)

Basic Entomology and Pest Management lab

List of Practicals

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

Multidisciplinary Course: ZOO-MDC-101

ENVIRONMENT AND BIODIVERSITY

Credits: 03 **Full Marks: 60 = 15 (IA) + 45 (T)**

Lectures: 45

Course objective: This course aims to help students define biodiversity, ecosystems, and sustainability while analyzing 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 - III

Major Course: ZOO-M-301 (T)

CELL BIOLOGY

Credits: 03 (T) + 1 (P) **Full Marks: 80 = 20 (IA) + 40 (T) + 20 (P)**

Lectures: 45

Course Objectives: This course aims to develop a comprehensive understanding of the structural and functional organization of eukaryotic cells; explain the molecular architecture and dynamics of biological membranes and intracellular organelles; examine mechanisms of membrane transport, protein targeting, intracellular trafficking and energy transduction; describe cytoskeletal organization, nuclear architecture, cell cycle regulation, programmed cell death and cellular signaling; introduce modern techniques employed in cell biology; and relate cellular processes to human health, disease and biotechnology.

Unit I. Introduction to Cell Biology (2 Lectures)

- Cell theory and evolution of the cell concept.
- Diversity of cells: Prokaryotic and Eukaryotic cells.
- Structural organization of animal cell.

Unit II. Plasma Membrane (7 Lectures)

- Physical and chemical composition of plasma membrane: Membrane lipids, cholesterol, Membrane proteins, Fluid Mosaic Model (Singer and Nicolson, 1972) and concept of lipid rafts.
- Glycocalyx concept.
- Membrane transport: Diffusion, Osmosis, Facilitated diffusion, Active transport, Endocytosis, Exocytosis, LDL receptor-mediated endocytosis
- Cell junctions: Tight junction, Adherens junction, Desmosomes, Gap junction.

Unit III. Endomembrane System (6 Lectures)

- Endoplasmic Reticulum: Structure and types, Protein synthesis on rough ER, Signal hypothesis, Protein folding and molecular chaperones, Protein targeting
- Golgi Apparatus: Structure, Protein glycosylation, Protein sorting, Vesicular transport, Secretory pathway
- Lysosome: Structure, Lysosomal enzymes, Biogenesis, Endocytosis, Autophagy, Lysosomal storage disorders (brief)
- Protein sorting: Basic concepts.

Unit IV. Cytoplasmic Organelles and Cytoskeleton (7 Lectures)

- Mitochondria: Ultrastructure, Semi-autonomous nature, Endosymbiotic theory, Electron transport chain, Chemiosmotic hypothesis, ATP synthesis

- Cytoskeleton: Microtubules, Microfilaments, Intermediate filaments, Molecular motors: Kinesin, Dynein and Myosin
- Extracellular matrix: Basic concepts.

Unit V. Nucleus and Chromatin (6 Lectures)

- Nuclear envelope and nuclear pore complex, Nucleolus.
- Chromatin organization and nucleosome concept.
- Euchromatin and heterochromatin.

Unit VI. Cell Cycle, Cell Division and Cell Death (8 Lectures)

- Cell Cycle: Phases of eukaryotic cell cycle, Cyclins and Cyclin-dependent kinases (CDKs), Maturation Promoting Factor (MPF), Cell cycle checkpoints, Cell cycle regulation.
- Cell Division: Mitosis, Meiosis.
- Cell Death: Necrosis and Apoptosis
- Cancer Biology: Characteristics of cancer cells, Types of cancer, Proto-oncogenes, Tumor suppressor genes, Ras, p53, Retinoblastoma (Rb), APC.

Unit VII. Cell Signalling (6 Lectures)

- Types of signalling: Autocrine, Paracrine, Endocrine, Juxtacrine
- Signalling molecules and receptors.
- G-protein coupled receptors (GPCRs), Second messengers: cAMP pathway, Calcium signalling, Receptor tyrosine kinase (RTK) pathway (Ras–MAPK), JAK–STAT pathway.

Unit VIII. Cell Biology Techniques and Applications (3 Lectures)

- Basic concepts of microscopy: Light microscope, Phase contrast microscope, Fluorescence microscope, Confocal microscope (basic principle), Electron microscopy: SEM and TEM
- Cell fractionation.
- Differential centrifugation and Ultracentrifugation.
- Basic concepts of animal cell culture: Primary culture, Cell line.

Major Course: ZOO-M-301 (Practical)

CELL BIOLOGY LAB
List of Practicals

1. Standardization of ocular and stage micrometer and measurement of any cell.
2. Preparation and staining of human squamous epithelial cells.
3. Cell viability assay using Trypan Blue exclusion method.
4. Observation of mitosis using onion root tip squash preparation.
5. Demonstration of differential centrifugation and cell fractionation (video/live demonstration).
6. Identification of different stages of mitosis and meiosis using permanent slides.

Course Outcomes: Upon successful completion of this course, students will be able to explain the structural organization and evolution of eukaryotic cells; describe the molecular architecture and transport functions of biological membranes; interpret intracellular protein trafficking through the endomembrane system; explain mitochondrial energy production, cytoskeletal organization, and nuclear architecture, including chromatin packaging; analyse the mechanisms regulating the cell cycle, apoptosis, and cancer; explain major cellular signalling pathways and receptor-mediated communication; and apply modern cell biological techniques and experimental approaches in research, diagnostics, and biotechnology.

Suggested Readings

1. Becker, W.M., et al. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Alberts, B., et al. (2008). Molecular Biology of the Cell. V Edition. Garland Publishing Inc., New York and London.
3. Agarwal, V.K. Cell Biology: Zoology for B.Sc. Students. S. Chand Publishing.
4. Cooper, G.M. (2018). The Cell: A Molecular Approach. VIII Edition. Sinauer Associates, Oxford University Press, New York.
5. Cooper, G.M. & Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press and Sinauer Associates.
6. Shome, S. Fundamental Zoology (Cell Biology) – Major/Minor. Santra Publications.
7. Iwasa, J. & Marshall, W. (2020). Karp's Cell and Molecular Biology: Concepts and Experiments. IX Edition. John Wiley & Sons.
8. Karp, G. (2009). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons.
9. Lodish, H., et al. (2010). Molecular Cell Biology. Scientific American & W.H. Freeman, New York.
10. Powar, C.B. (2019). Cell Biology. III Edition. Himalaya Publication.
11. Zoology for B.Sc. Students: Cytology, Genetics and Infectious Diseases (Common Minimum Syllabus for State Universities).

Major Course: ZOO-M-302 (T)

Molecular biology

Credits: 03 (T) + 1 (P) **Full Marks: 80 = 20 (IA) + 40 (T) + 20 (P)**

Lectures: 45 (T) + 30 (P)

Course Objective: The course is designed to provide a comprehensive understanding of the molecular organization, replication, expression, regulation, and maintenance of genetic material. It covers DNA and RNA structure, replication, transcription, RNA processing, translation, gene regulation, post-translational modification, and DNA repair in prokaryotes and eukaryotes. Students are introduced to key molecular biology techniques such as gel electrophoresis, blotting, PCR, and RT-PCR, along with their principles and applications. Practical training develops basic skills in DNA isolation, quantification, electrophoresis, and laboratory techniques, enabling students to relate molecular mechanisms to experimental approaches and modern biological applications.

Unit I: Nucleic Acids (6 Lectures)

Structure and composition of DNA: Chargaff's Rule; Watson and Crick Model of the Three-Dimensional Structure of DNA; Different forms of DNA-A, B and Z DNA (comparative overview); RNA as the Genetic Material, Types and Function.

Unit II: DNA Replication (6 Lectures)

Meselson-Stahl Experiment; DNA Replication in Prokaryotes; Enzymes/Proteins associated with Replication-Polymerase I, II & III, Primase, Helicase, SSB, DNA ligase; RNA priming; End replication Problem and Replication of telomeres in eukaryotes.

Unit III: Transcription (4 Lectures)

Transcription: RNA polymerases, transcription factors, initiation, elongation and termination of transcription in prokaryotes; Promoters and factors of class I, class II and class III genes of eukaryotes.

Unit IV: Post Transcriptional Modifications and Processing of Primary Transcripts (4 Lectures)

Capping and Poly A tail formation in mRNA; Concept of introns and exons and Split genes; Splicing mechanism (Intron Removal by Spliceosome); Alternative splicing, RNA editing (gRNA mediated).

Unit V: Translation (4 Lectures)

Genetic code: Degeneracy and Wobble hypothesis; Aminoacylation of a tRNA molecule; Mechanism of protein synthesis in prokaryotes.

Unit VI: Posttranslational Modification (5 Lectures)

Methylation, acetylation, phosphorylation, hydroxylation, glycosylation, ubiquitination.

Unit VII: Gene Regulation (7 Lectures)

Regulation of DNA replication in prokaryotes: DNA methylation; Regulation of transcription in prokaryotes: lac-operon and trp-operon (attenuation); Gene silencing (siRNA and miRNA-mediated).

Unit VIII: Molecular Techniques (9 Lectures)

Principle and use of Agarose Gel Electrophoresis; Principle and use of SDS PAGE; Blot Technique: Southern, Northern and Western Blot; PCR: Basic Principle, Reverse Transcriptase-PCR.

Major Course: ZOO-M-302 (Practical)

MOLECULAR BIOLOGY LAB
List of Practicals

1. Isolation of genomic DNA from any suitable source by phenol-chloroform method.
2. DNA quantification and purity assessment.
3. Agarose Gel Electrophoresis.
4. Demonstration of instruments and accessories used for the following techniques: PCR, SDS PAGE, Western Blot, Southern Blot.

Course Outcome: After successful completion of the course, students will be able to explain the structure and functions of DNA and RNA and the molecular mechanisms of replication, transcription, RNA processing, translation, gene regulation, post-translational modification, and DNA repair. They will understand the roles of key enzymes, proteins, and regulatory elements, and interpret major concepts such as the Meselson–Stahl experiment, genetic code, wobble hypothesis, lac and trp operons, RNA-mediated gene silencing, and DNA repair pathways. Students will also understand the principles and applications of major molecular biology techniques, including gel electrophoresis, blotting, PCR, and RT-PCR, and acquire basic practical skills in DNA isolation, quantification, electrophoresis, and laboratory procedures. The course will enable students to integrate theoretical and practical knowledge for applications in biological research.

Suggested Reading:

1. Allison, L. A. (2012). Fundamental Molecular Biology. John Wiley and Sons.
2. Bruce, A., Dennis, B., Julian, L., Martin, R., Keith, R. and Watson, J. (2022). Molecular Biology of the Cell, 7th Edition. W.W. Norton and Company, New York.
3. Cooper, G. M. and Kenneth, W. A. (2023). The Cell: A Molecular Approach. 9th Edition. Oxford University Press. Karp, G., Iwasa, J. and Marshall, W. (2019).
4. Karp's Cell and Molecular Biology. 9th Edition. John Wiley and Sons. Krebs, J. E., Goldstein, E. S. and Kilpatrick, S. T. (2018). Lewin's genes XII. Jones and Bartlett Learning.

5. Lackie, J. M., Coote, J. G., Lloyd, C. W. and Blackshaw, S. E. (2013). Dictionary of Molecular Biology. 5th Edition. Elsevier/Academic Press.
6. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K. C., Yaffe, M. and Amon, A. (2021). Molecular Cell Biology. 9th Edition. W.H. Freeman-Macmillan Learning.
7. Pollard, T. D., Earnshaw, W. C., Lippincott-Schwartz, J. and Johnson, G. (2022). Cell Biology. 4 th Edition. Elsevier.
8. Turner, P., McLennan, A., Bates, A. and White, M. (2005). BIOS Instant Notes in Molecular Biology. 3rd Edition. Taylor and Francis.
9. Twyman, R. (1998). Advanced Molecular Biology: A Concise Reference. 1st Edition. Garland Science.
10. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M. and Losick, R. (2014). Molecular Biology of the Gene. 8th Edition. Pearson.

Minor Course: ZOO-Mi-201 (T)

CELL BIOLOGY AND BIOCHEMISTRY

Credits: 03 (T) + 1 (P) **Full Marks: 80 = 20 (IA) + 40 (T) + 20 (P)**

Lectures: 45 (T) + 30 (P)

Course Objective: This course aims to provide students with a comprehensive understanding of the structural, functional, and biochemical organization of cells and biomolecules. It introduces the fundamental concepts of prokaryotic and eukaryotic cell organization, plasma membrane structure and transport mechanisms, cytoplasmic organelles, chromosome architecture, chromatin organization, and regulation of the cell cycle. The course further emphasizes cell signaling pathways, apoptosis, and necrosis, while developing a strong foundation in the chemistry and metabolism of carbohydrates, proteins, lipids, and nucleic acids. Students will acquire an integrated understanding of cellular structure, molecular interactions, and metabolic processes that govern normal cellular functions and provide the basis for advanced studies in cell biology, molecular biology, biochemistry, biotechnology, and biomedical sciences.

Unit I: The Cell:

Prokaryotic and eukaryotic cells.

Unit II: Cell Membrane:

Fluid mosaic model of plasma membrane; electrical properties of membrane, Transport across membrane: Active and passive transport, facilitated transport. Cell junctions.

Unit III: Cytoplasmic organelles:

Protoplasm; Mitochondria; ER; Golgi complex; Lysosome, Ribosome; Centriole; Nucleus

Unit IV: Chromosomes, chromatin and nucleosome:

Chromosome structure: centromere, telomere, Heterochromatin and euchromatin, Nucleosome model.

Unit V: Cell cycle and cell death

Stages of cell cycle, Mitotic and meiotic cell division; Regulation of cell cycle, Apoptosis and Necrosis.

Unit VI: Carbohydrate chemistry:

Classification of carbohydrates.

Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway.

Unit VII: Protein chemistry:

Classification and structural properties of amino acids. Levels of organization; Protein metabolism: Transamination, Deamination, Urea cycle.

Unit VIII: Lipid chemistry:

Classification and properties of lipids. Lipid metabolism: β-oxidation of fatty acids; Fatty acid biosynthesis.

Unit IX: Nucleic acid chemistry:

Nucleoside, nucleotide, Purines and pyrimidines, DNA, RNA.

Minor Course: ZOO-Mi-201 (Practical)

CELL BIOLOGY AND BIOCHEMISTRY LAB

List of Practicals

1. Demonstration of components of microscopes
2. Study various stages of mitosis by preparing temporary stained squash of onion root tip.
3. Measurement of pH.
4. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
5. Demonstration of proteins separation technique by SDS-PAGE.
6. LNB

Course outcome: Upon successful completion of this course, students will be able to explain the structural and functional organization of cells, membranes, organelles, chromosomes, and the nucleus, and describe the mechanisms regulating membrane transport, cell division, and intracellular signaling. They will demonstrate a thorough understanding of the classification, structure, properties, and metabolism of major biomolecules, including carbohydrates, proteins, lipids, and nucleic acids, and relate these concepts to cellular physiology and metabolic regulation. Students will be able to integrate knowledge of cell biology and biochemistry to interpret normal cellular processes, analyze the molecular basis of physiological and pathological conditions, and apply these principles in higher studies and research in life sciences, biotechnology, and health sciences.

Suggested reading

1. Lewin's Cells–Cassimeris/Lingappa/Plopper–Johns & Bartlett Publishers.

2. Biology of Cancer by Robert. A. Weinberg. 2nd edition.

3. Hardin, J., Bertoni, G. and Klein Smith, J. L. (2012). Becker's World of the Cell. 8th Edition. Pearson Benjamin Cummings, San Francisco.

4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.

5. Karp, G. (2008). Cell and Molecular Biology: Concepts and Applications. 5th Edition. John Wiley.

6. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K. C., Michael

7. Yaffe, M. and Amon, A. (2021). Molecular Cell Biology. 9th Edition. W.H. Freeman.

8. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James. Molecular Biology of the Cell, V Edition, Garland publishing Inc., New York and London.

9. Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H.Freeman and Co., New York.

10. Berg, J.M., Tymoczko, J.L. and Stryer, L.(2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.

11. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.

12. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.

13. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.

Skill Enhancement Course: ZOO-SEC-301 (T) (A)

AQUACULTURE AND FISH KEEPING

Credits: 02 (T) + 1 (P) **Full Marks: 60 = 15 (IA) + 30 (T) + 15 (P)**

Lectures: 30 (T) + 30 (P)

Course Objectives: The course aims to provide students with a basic understanding of aquaculture and fish keeping, including fish culture, breeding, nutrition, health, and water-quality management. It develops practical skills in aquarium setup and ornamental fish keeping, introduces modern and sustainable practices and promotes awareness of fish diversity, conservation and environmental responsibility. The course also provides field-based learning and introduces students to livelihood and entrepreneurship opportunities in aquaculture.

Unit I: Introduction to Aquaculture (6 Lectures)

- Basic concept, historical background, scope and importance of aquaculture
- Overview of freshwater, brackish-water, and marine aquaculture systems
- Extensive, semi-intensive, and intensive culture systems
- Monoculture, polyculture, and integrated fish farming practices
- Current status and future prospects of aquaculture in India

Unit II: Freshwater Fish Culture (5 Lectures)

- Selection of suitable sites and preparation of ponds for fish culture.
- Important indigenous, exotic and invasive fish species used in culture
- Fish seed stages: fry, fingerlings, and broodstock
- Methods of seed selection, transportation, acclimatization and stocking
- Stocking density, feeding practices and monitoring of fish growth
- Harvesting methods and basic post-harvest handling techniques

Unit III: Fish Breeding, Hatchery and Nutrition (5 Lectures)

- Natural and induced breeding techniques in fish
- Broodstock management, hatchery operations, and nursery rearing practices
- Natural and artificial feeds along with feeding strategies

Unit IV: Fish Health and Water Quality (6 Lectures)

- Key water quality parameters: temperature, pH, dissolved oxygen, ammonia, and nitrate.
- Importance of maintaining good water quality in aquaculture systems.

- Ich (White Spot Disease), Costiasis, Argulosis (Fish Louse Disease), Bacterial Hemorrhagic Septicemia, Bacterial Gill Disease, Vibriosis, Ulcer Disease, Saprolegniasis, Branchiomycosis (Gill Rot)

Unit V: Aquarium and Ornamental Fish Keeping (4 Lectures)

- Aquarium design, equipment, aqua scaping, and basic setup principles
- Identification, breeding methods, and disease prevention in common ornamental species

Unit VI: Sustainable Aquaculture and Entrepreneurship (4 Lectures)

- Sustainable and environment friendly aquaculture practices
- Introduction to aquaponics, biofloc systems and recirculating aquaculture systems (RAS)
- Effects of climate change and adaptive strategies in aquaculture
- Conservation of native fish diversity, entrepreneurship, and livelihood opportunities in aquaculture.

Skill Enhancement Course: ZOO-SEC-301 (Practical) (A)

AQUACULTURE AND FISH KEEPING LAB

List of Practicals:

1. Identification of Some Economically Important Fish Species:
   Catla catla, Labeo rohita, Cirrhinus mrigala, Hypophthalmichthys molitrix, Ctenopharyngodon idella, Cyprinus carpio, Labeo calbasu, Oreochromis spp. Pangasianodon hypophthalmus, Clarias batrachus, Heteropneustes fossilis, Ompok pabda, Anabas testudineus, Lates calcarifer, Tenualosa Ilisha
2. Basic water quality testing techniques - DO, Turbidity, Alkalinity, Hardness, free CO_2.
3. Demonstration of aquarium setup and its routine maintenance.
4. Field visit to a fish farm/ hatchery/ aquarium/ local fish market

Course Outcomes: After completing the course, students will be able to understand how fish are cultured, bred, fed, and cared for in different aquaculture systems. They will be able to maintain a basic aquarium, monitor simple water-quality parameters, identify common fish health problems, and apply basic fish-keeping practices. Students will also develop an appreciation for sustainable aquaculture, fish conservation, and the potential of fish farming and ornamental fish keeping as livelihood and entrepreneurial opportunities.

Suggested Readings:

1. Pillay, T.V.R. & Kutty, M.N. — *Aquaculture: Principles and Practices*. Wiley-Blackwell.
2. Jhingran, V.G. — *Fish and Fisheries of India*. Hindustan Publishing Corporation.
3. Stickney, R.R. — *Principles of Aquaculture*. Wiley.
4. Bardach, J.E., Ryther, J.H. & McLarney, W.O. — *Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms*. Wiley-Interscience.
5. Santhanam, R., Sukumaran, N. & Natarajan, P. — *A Manual of Freshwater Aquaculture*. Oxford & IBH.
6. Moyle, P.B. & Cech, J.J. — *Fishes: An Introduction to Ichthyology*. Pearson.

Skill Enhancement Course: ZOO-SEC-301 (T) (B)

POULTRY FARMING AND ANIMAL HUSBANDRY MANAGEMENT

Credits: 02 (T) + 1 (P) **Full Marks: 60 = 15 (IA) + 30 (T) + 15 (P)**

Lectures: 30 (T) + 30 (P)

Course Objective: The course provides students with fundamental knowledge of poultry farming and animal husbandry, focusing on scientific management, nutrition, breeding, disease control, and economic aspects of poultry and dairy production. It covers poultry breeds, housing, equipment, feeding, management of different production stages, and common diseases and vaccination. Students will also learn about cattle breeds, livestock nutrition, breeding methods, artificial insemination, MOET, milk composition, dairy products, and their economic importance. The course further introduces the status, prospects, opportunities, and challenges of the poultry and dairy industries in India, with emphasis on sustainable livestock production and management.

Unit I: Introduction to Poultry Farming (2 Lectures)

- General introduction to poultry farming.
- Characteristics of common fowl breeds: Indigenous, American, Asiatic, Mediterranean, English and exotic.
- Commercial strains of chickens: Broiler, Layer, Grower

Unit II: Rearing Methods in Poultry Housing and Equipment (4 Lectures)

- Essential of good housing; housing requirements.
- Poultry equipment (egg collector, incubator, chick cage).

- Housing systems: Free range system, semi-intensive system, Folding unit system, Deep litter system, Cage system (battery).

Unit III: Farm Management (3 Lectures)

- Nutrient requirements for different stages of layers and broilers.
- Methods of feeding.
- Management of chicks, growers, layers and broilers.

Unit IV: Poultry diseases (4 Lectures)

- Causative agents, symptoms and remedies of poultry diseases: Newcastle disease (Ranikhet disease, Avian influenza, Fowl cholera, Mycoplasmosis / Chronic respiratory disease, Coccidiosis, Histomoniasis (Blackhead disease), Candidiasis, Aspergillosis.
- Vaccination program.

Unit V: Economic Importance of Poultry Farming (2 Lectures)

- Present and future scenario of the poultry industry in India.
- Poultry by-products with economic importance.
- Size, growth and trends; poultry market opportunity and challenges.

Unit VI: Animal Husbandry and Its Management (3 Lectures)

- Introduction to common dairy animals.
- Important cattle breeds and their characteristics.
- Cattle breed in India, Cattle population, Milch breeds, Dual purpose breeds, Draught breed, Cross-breed cattle strain.

Unit VII: Breeding Programme (4 Lectures)

- Different methods of breeding in cattle.
- Artificial insemination and Multiple Ovulation and Embryo Transfer (MOET) in cattle breeding.

Unit VIII: Dairying and Importance of Dairy By-products (4 Lectures)

- Composition and nutritional constituents of milk.
- Major dairy products and their importance.
- Major dairy by-products, their preservation, utilization and economic importance.

Unit IX: Dairy Pathology and Disease Control (4 Lectures)

- Viral diseases, bacterial diseases, parasitic diseases of dairy animals.

- Vaccination programmes for the prevention and control of major infectious diseases in dairy animals.

Skill Enhancement Course: ZOO-SEC-301 (Practical) (B)

POULTRY FARMING AND ANIMAL HUSBANDRY LAB

List of Practical

1. Identification of following poultry breeds (only coloured photograph): Plymouth rock, Rhode Island red, New Hampshire, Cochin, Brahma, Leghorn, Cornish, Aseel, Kadaknath, Chittagong.
2. Identification of following cattle breeds (only coloured photograph): Sahiwal, Red Sindhi, Gir, Malvi, Hariana, Tharparkar, Jersey.
3. Visit to a poultry farm or animal husbandry and make a report on that study.

Course Outcomes: Upon successful completion of the course, students will be able to explain the principles and practices of poultry farming and animal husbandry; identify important poultry and cattle breeds; describe housing, equipment, feeding, and management practices; explain nutritional requirements and balanced feeding; describe cattle breeding methods, artificial insemination, and MOET; identify major viral, bacterial, protozoan, fungal, and parasitic diseases and their prevention, control, and vaccination; explain the composition, processing, preservation, and economic importance of milk and dairy products; and assess the status, prospects, opportunities, and challenges of the poultry and dairy industries in India.

Suggested Reading

1. Banerjee, T.K. (2016). Applied Zoology. New Central Book Agency (P) Ltd., Kolkata.
2. Chaudhuri, S. (2017). Economic Zoology. New Central Book Agency (P) Ltd., Kolkata.
3. Ghosh, N. (2015). Poultry Science and Practice. CBS Publishers & Distributors.
4. Hurd, L.M. (2003). Modern Poultry Farming. I Edition, International Book Distributing Company, Lucknow.
5. Jull, M.A. (2007). Successful Poultry Management. II Edition, Biotech Books, New Delhi.
6. Prasad, J. (2015). Poultry Production and Management. Kalyani Publishers.
7. Sreenivasaiah, P.V. (2015). Textbook of Poultry Science. I Edition, Write & Print Publications, New Delhi.
8. Banerjee, G. C. (2000) A Text Book of Animal Husbandry, 8th Edn., Oxford and IBH Publishing Company Pvt. Ltd., New Delhi
9. Pandey, D. N. (1995-1996) Animal Husbandry and Veterinary Science, 15th Edn., Published by Jai Prakash Nath and Company, Meerut.
10. Gupta, P. R. (2007) Dairy India Yearbook

SEMESTER - IV

Major Course: ZOO-M-401 (T)

BIOCHEMISTRY

Credits: 03 (T) + 1 (P) **Full Marks: 80 = 20 (IA) + 40 (T) + 20 (P)**

Lectures: 45 (T) + 30 (P)

Course objectives: This course is designed to provide students with a comprehensive understanding of the chemistry, structure, properties, and metabolism of the major biomolecules—carbohydrates, proteins, lipids, nucleic acids, and enzymes. Students will develop knowledge of the structural organization, stereochemistry, physicochemical properties, and biological functions of these biomolecules, along with the metabolic pathways involved in their synthesis, degradation, and regulation.

Unit I: Carbohydrate chemistry (10 Lectures)

- Classification and structural properties of carbohydrates with emphasis on stereoisomerism, optical isomerism, epimerization, mutarotation and reducing action of sugars.
- Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis.

Unit II: Protein chemistry (9 Lectures)

- Classification and structural properties of amino acids. Levels of organization with emphasis on stabilizing bonds formation.
- Protein metabolism: Transamination, Deamination, Urea cycle, Fate of C-skeleton of Glucogenic and Ketogenic amino acids.

Unit III: Lipid chemistry (8 Lectures)

- Classification and properties of lipids with emphasis on saponification number, iodine number, acetyl number, Reichert-Meissel number, hydrogenation and rancidity of fats.
- Lipid metabolism: β-oxidation of fatty acids; Fatty acid biosynthesis.

Unit IV: Nucleic acid chemistry (8 Lectures)

- Classification and structural properties of nucleoside, nucleotide,
- Purines and pyrimidines, DNA, RNA.

- Degradation of purine; Purine Salvage pathway and significance.

Unit V: Enzyme chemistry (10 Lectures)

- Nomenclature, classification and properties; Cofactors and coenzymes, Effect of Temperature, pH, substrate concentration, enzyme concentration on enzyme action, Isozymes and Proenzyme.
- Mechanism of enzyme action (Lock and key model, Induced fit model).
- Enzyme kinetics: Derivation of Michaelis-Menten equation with its significance, Lineweaver-Burk plot and its significance. Enzyme inhibition.

Course Outcome: Upon successful completion of this course, students will be able to explain the chemical structure, classification, and functional properties of carbohydrates, proteins, lipids, nucleic acids, and enzymes, and critically evaluate their roles in biological systems. They will be able to describe and integrate the major metabolic pathways of carbohydrates, proteins, lipids, and nucleotides, interpret enzyme kinetics and mechanisms of enzyme action, and analyze the effects of different factors and inhibitors on enzyme activity. The acquired knowledge will enable students to apply fundamental biochemical concepts to understand cellular metabolism, metabolic regulation, disease mechanisms, and applications in biomedical, environmental, and biotechnological research.

Major Course: ZOO-M-401 (Practical)

BIOCHEMISTRY LAB

List of Practicals

1. Measurement of pH of an unknown solution by pH meter
2. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
3. Beer – Lambert law, preparation of standard curve with spectrophotometry / colorimetry.
4. Quantitative estimation of proteins by Lowry Method.
5. Study of the enzymatic activity of Trypsin or Lipase.

Suggested Reading

1. Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H.Freeman and Co., New York.

2. Berg, J.M., Tymoczko, J.L. and Stryer, L.(2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.

3. Das, D. (2022). Biochemistry. Academic Publisher.

4. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well,

5. P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.

6. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.

7. Voet, D. and Voet, J. G. (2010). Biochemistry. 4th Edition. John Wiley and Sons, Inc. Zubay, G. L. (1998). Biochemistry. 4th Edition. McGraw-Hill.

8. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.

Major Course: ZOO-M-402 (T)

ANIMAL PHYSIOLOGY

Credits: 03 (T) + 1 (P) **Full Marks: 80 = 20 (IA) + 40 (T) + 20 (P)**

Lectures: 45 (T) + 30 (P)

Course Objectives: This course aims to develop a comprehensive understanding of the physiological organization and functional integration of major organ systems in animals; explain the mechanisms regulating digestion, respiration, circulation, excretion, neural coordination, muscle contraction, reproduction and sensory perception; examine the physiological basis of homeostasis and adaptation to different environments; introduce the endocrine regulation of body functions; and develop analytical and experimental skills through laboratory-based physiological investigations.

Unit I. Physiology of Digestion (4 Lectures)

- Digestion and absorption of carbohydrates, proteins and lipids.
- Regulation of digestive processes: Neural regulation, Gastrointestinal hormones, Regulation of pancreatic secretion and bile secretion and release.

Unit II. Physiology of Respiration (8 Lectures)

- Mechanism of respiration.
- Respiratory pigments.
- Respiratory volumes and capacities.
- Transport of oxygen and carbon dioxide; Oxygen dissociation curve and factors affecting it.

Unit III. Circulatory and Cardiovascular Physiology (8 Lectures)

- Composition and functions of blood.
- Haemostasis and blood coagulation.

- Haemopoiesis and its regulation.
- Structure of mammalian heart, conducting system, cardiac cycle and cardiac output.

Unit IV. Thermoregulation and Osmoregulation (5 Lectures)

- Homeostasis and thermoregulation.
- Endothermy and ectothermy.
- Osmoregulation in vertebrates.
- Extra-renal osmoregulatory organs in vertebrates.

Unit V. Renal Physiology (8 Lectures)

- Structure of kidney and nephron.
- Mechanism of formation of concentrated urine: Glomerular filtration, tubular reabsorption, tubular secretion and counter current mechanism.
- Juxtaglomerular apparatus and its functions.
- Regulation of acid-base balance.

Unit VI. Nervous Physiology (8 Lectures)

- Structure of neuron.
- Resting membrane potential, Action potential and impulse conduction.
- Synapse and synaptic transmission, Neuromuscular junction.
- Reflex action and its types.

Unit VII. Muscular Physiology (4 Lectures)

- Types of muscles.
- Ultrastructure of skeletal muscle.
- Sliding filament theory and molecular basis of muscle contraction.

Course Outcomes: Upon successful completion of this course, students will be able to explain the physiological mechanisms underlying digestion, respiration, circulation, excretion, neural coordination, muscle contraction, reproduction, thermoregulation and osmoregulation; describe the functional integration of major organ systems in maintaining homeostasis; correlate physiological processes with environmental adaptations and animal survival; and apply fundamental principles and basic laboratory techniques of animal physiology for experimental observation, analysis and interpretation.

Major Course: ZOO-M-402 (Practical):

ANIMAL PHYSIOLOGY LAB

List of Practicals

1. Estimation of haemoglobin using Sahli's haemoglobinometer.
2. Determination of Total RBC count.
3. Differential leucocyte count using Leishman stain.
4. Determination of bleeding time and clotting time.
5. Determination of erythrocyte sedimentation rate (ESR).
6. Study of metabolic rate/BMR using standard physiological calculations
7. Measurement of pulse rate and blood pressure.

Suggested Reading:

1. Guyton, A.C. & Hall, J.E. Textbook of Medical Physiology.
2. Moyes, C.D. & Schulte, P.M. Principles of Animal Physiology.
3. Hill, R.W., Wyse, G.A. & Anderson, M. Animal Physiology.
4. Eckert, R. Animal Physiology: Mechanisms and Adaptations.
5. Tortora, G.J. & Derrickson, B. Principles of Anatomy and Physiology.
6. Chatterjee, C.C. Human Physiology.

Major Course: ZOO-M-403 (T)

PARASITOLOGY

Credits: 03 (T) + 1 (P) **Full Marks: 80 = 20 (IA) + 40 (T) + 20 (P)**

Lectures: 45 (T) + 30 (P)

Course objective: The course is designed to provide students with a fundamental understanding of parasitism, host–parasite relationships, parasite biology, adaptation, transmission, and disease causation. It introduces students to important protozoan, helminth, and arthropod parasites, with emphasis on their morphology, life cycles, transmission, epidemiology, pathogenicity, diagnosis, prevention, and treatment. The course also familiarizes students with zoonotic and emerging parasitic diseases, the One Health approach, vector–parasite relationships, vector control, and the impact of climate change on vector-borne diseases. The practical component develops basic skills in the identification and study of parasites, vectors, and intermediate hosts through permanent slides and microphotographs, along with collection, preservation, mounting, and microscopic examination of parasites.

Unit I: General Parasitology (8 Lectures)

- Parasitism: parasite, parasitoid, host–parasite relationship, Types of hosts and vectors, Host specificity and parasite specificity, Modes of transmission, Reservoir host and carrier
- Zoonosis and emerging parasitic diseases, One Health approach.

Unit II: Parasite Biology and Adaptation (6 Lectures)

- Structural and physiological adaptations of parasites. Attachment and feeding mechanisms, Reproductive adaptations
- Immune evasion by parasites, Host–parasite co-evolution.

Unit III: Parasitic Protists (8 Lectures)

- Study of the morphology, life cycle, transmission, epidemiology, pathogenic effects, diagnosis, prevention and treatment of: *Entamoeba histolytica, Leishmania donovani, Trypanosoma gambiense, Plasmodium vivax.*

Unit IV: Parasitic Flatworms (8 Lectures)

- Study of the morphology, life cycle, transmission, epidemiology, pathogenicity, diagnosis, prevention and treatment of: *Schistosoma haematobium, Taenia solium*

Unit V: Parasitic Roundworms (7 Lectures)

- Study of the morphology, life cycle, transmission, epidemiology, pathogenicity, diagnosis, prevention and treatment of: *Ascaris lumbricoides, Wuchereria bancrofti*.

Unit VI: Parasitic Arthropods and Disease Vectors (8 Lectures)

- Biology and medical importance of ticks, mites and lice.
- Important vectors: *Aedes, Anopheles, Culex*
- Vector–parasite relationship and vector control.
- Impact of climate change on vector-borne diseases.

Course outcome: Upon successful completion of the course, students will be able to explain the fundamental concepts of parasitism, host–parasite relationships, host specificity, transmission, vectors, reservoirs, and zoonosis; describe the structural, physiological, reproductive, and immune-evasion adaptations of parasites; explain the morphology, life cycles, transmission, epidemiology, pathogenicity, diagnosis, prevention, and treatment of important protozoan and helminth parasites; describe the biology and medical importance of major arthropod vectors; explain vector–parasite relationships and principles of vector control; and discuss the One Health approach and the impact of climate change on emerging parasitic and vector-borne diseases.

Major Course: ZOO-M-403 (Practical)

PARASITOLOGY LAB

List of Practicals

1. **Protozoan Parasites** (through permanent slides/microphotographs)
   Entamoeba histolytica – cyst and trophozoite
   ***Plasmodium spp*.** – major stages in blood smear.

2. **Helminth Parasites** (through permanent slides/microphotographs)
   Ascaris lumbricoides – egg and adult.

Taenia spp. – egg, scolex and proglottid
Fasciola hepatica – egg and adult
Wuchereria bancrofti – microfilaria

3. **Vectors and Intermediate Hosts** (through permanent slides/microphotographs)
   Identification of ***Anopheles, Culex and Aedes*** mosquitoes, Study of mosquito larval and pupal stages.

4. **Basic Techniques:** Collection, preservation, mounting and microscopic examination of parasites from fish gill/skin/fin or from gut of Cockroach (*Periplaneta americana*)

Suggested Readings:

1. Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007). *Biology of Disease.* Taylor and Francis Group.
2. Arora, D. R. and Arora, B. (2001). *Medical Parasitology*. 2nd Edition. CBS Publications and Distributors.
3. Atkinson, P. W. (2014). *Vector Biology, Ecology and Control.* Springer.
4. Bose, M. (2008). *Parasitoses and Zoonoses.* 1st Edition. NCBA.
5. Chatterjee, K. D. (2009). *Parasitology: Protozoology and Helminthology.* 13th Edition. CBS Publishers & Distributors (P) Ltd.
6. Ichhpujani, R. L. and Bhatia, R. (2019). *Medical Parasitology.* 3rd Edition. Jaypee Brothers Medical Publishers (P) Ltd., New Delhi.
7. Mathews, G. (2011). *Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector-Borne Diseases.* Wiley-Blackwell.
8. Meyer, Olsen & Schmidt. *Essentials of Parasitology.* Murray, D. Dailey, W.C. Brown Publishers.
9. Noble, E. R. and Noble, G. A. (1982). *Parasitology: The Biology of Animal Parasites.* 5th Edition. Lea & Febiger.
10. Parija, S. C. *Textbook of Medical Parasitology, Protozoology & Helminthology (Text and Colour Atlas).* 2nd Edition. All India Publishers & Distributors, Medical Books Publishers, Chennai/Delhi.
11. Tyagi, B. K. (2022). *Medical Entomology.* 2nd Edition. Scientific Publishers.

Major Course: ZOO-M-404 (T)

IMMUNOLOGY

Credits: 03 (T) + 1 (P) **Full Marks: 80 = 20 (IA) + 40 (T) + 20 (P)**

Lectures: 45 (T) + 30 (P)

Course Objective: The course is designed to provide students with a comprehensive understanding of the fundamental principles of immunology, including the organization and functioning of the immune system, the mechanisms of innate and adaptive immunity, and the cellular and molecular basis of immune responses. It aims to familiarize students with the properties of antigens, antigen–antibody interactions, immunoglobulin structure and

functions, major histocompatibility complex (MHC) molecules, antigen processing and presentation, cytokines, and the complement system. The course also seeks to develop an understanding of immune-mediated disorders, particularly the different types of hypersensitivity, as well as the principles of vaccination and active and passive immunization. In addition, students will be introduced to important immunological techniques such as ELISA, radioimmunoassay (RIA), and monoclonal antibody production, enabling them to appreciate the applications of immunology in research, diagnosis, disease prevention, and biotechnology.

Unit I: Overview of Immune System (3 Lectures)

- Basic concepts of health and diseases, Cells and organs of the Immune system.

Unit II: Innate and Adaptive Immunity (10 Lectures)

- Innate immunology: Anatomical barriers, Inflammation.
- Adaptive immunology: Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Structure of T cell Receptor and its signalling. Killing Mechanisms by CTL and NK cells, Humoral Immune Response (Plasma and Memory cells).

Unit III: Antigens (6 Lectures)

- Antigenicity and immunogenicity, Factors influencing immunogenicity, T-dependent and T-independent antigens, Adjuvants and haptens, B and T-Cell epitopes, Antigen-antibody interactions, affinity and avidity, cross reactivity, factors affecting antigen-antibody reactions.

Unit IV: Immunoglobulins (6 Lectures)

- Structure and functions of different classes of immunoglobulins, deduction of antibody structure, Antigenic determinants on immunoglobulins (Isotype, Allotype and Idiotype).

Unit V: Major Histocompatibility Complex (4 Lectures)

- Organization of MHC locus (Human with brief comparison to mice); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways) with role of APC.

Unit VI: Cytokines (4 Lectures)

- Types, properties and functions of cytokines.

Unit VII: Complement System (4 Lectures)

- Components and pathways of complement activation.

Unit VIII: Hypersensitivity (2 Lectures)

- Gell and Coombs' classification and brief description of various types of hypersensitivities.

Unit IX: Vaccines (2 Lectures)

- Various types of vaccines. Active & passive immunization (Artificial and natural).

Unit X: Techniques (4 Lectures)

- Immunoassays (ELISA and RIA), Monoclonal antibody production.

Major Course: ZOO-M-404 (Practical)

IMMUNOLOGY LAB

List of Practicals

1. Demonstration of primary and secondary lymphoid organs.
2. Histological study of spleen, thymus and lymph nodes through permanent slides/ photographs
3. Determination of ABO Blood group.
4. Separate serum from the blood sample (demonstration).
5. Preparation of stained blood film to study various types of leukocytes
6. Lymphocyte separation from spleen.

Course Outcomes: Upon successful completion of the course, students will be able to explain the organization and functions of the immune system, distinguishing innate and adaptive immunity; describe the roles of major immune cells and organs and the mechanisms of inflammation, T-cell activation, cell-mediated and humoral immunity, and cytotoxicity; explain key concepts of antigens and antibodies, including immunogenicity, epitopes, haptens, affinity, and avidity; describe immunoglobulin classes, MHC molecules, antigen processing and presentation, cytokines, and complement pathways; classify major hypersensitivity reactions and explain vaccination and immunization principles; and describe the principles and applications of immunological techniques such as ELISA, RIA, and monoclonal antibody production in research, diagnosis, and biotechnology.

Suggested Reading

1. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). Immunology, VI Edition. W.H. Freeman and Company.
2. Abbas, K. Abul and Lechtman H. Andrew (2003.) Cellular and Molecular Immunology. V Edition. Saunders Publication.
3. Ashim Kumar Chakraborty (2005). Immunology and Immunotechnology. Oxford University Press
4. Delves, Peter J.; Martin, Seamus J.; Burton, Dennis R.; Roitt, Ivan M. (2011). Roitt, Essential Immunology. Hoboken, NJ: Wiley-Blackwell
5. David Male Jonathan Brostoff David Roth Ivan Roitt (2012). Immunology 8th Edition, Elsevier.

Minor Course: ZOO-Mi-201 (T)

CELL BIOLOGY AND BIOCHEMISTRY

Credits: 03 (T) + 1 (P) **Full Marks: 80 = 20 (IA) + 40 (T) + 20 (P)**

Lectures: 45 (T) + 30 (P)

Course Objective: This course aims to provide students with a comprehensive understanding of the structural, functional, and biochemical organization of cells and biomolecules. It introduces the fundamental concepts of prokaryotic and eukaryotic cell organization, plasma membrane structure and transport mechanisms, cytoplasmic organelles, chromosome architecture, chromatin organization, and regulation of the cell cycle. The course further emphasizes cell signaling pathways, apoptosis, and necrosis, while developing a strong foundation in the chemistry and metabolism of carbohydrates, proteins, lipids, and nucleic acids. Students will acquire an integrated understanding of cellular structure, molecular interactions, and metabolic processes that govern normal cellular functions and provide the basis for advanced studies in cell biology, molecular biology, biochemistry, biotechnology, and biomedical sciences.

Unit I: The Cell:

Prokaryotic and eukaryotic cells.

Unit II: Cell Membrane:

Fluid mosaic model of plasma membrane; electrical properties of membrane, Transport across membrane: Active and passive transport, facilitated transport. Cell junctions.

Unit III: Cytoplasmic organelles:

Protoplasm; Mitochondria; ER; Golgi complex; Lysosome, Ribosome; Centriole; Nucleus

Unit IV: Chromosomes, chromatin and nucleosome:

Chromosome structure: centromere, telomere, Heterochromatin and euchromatin, Nucleosome model.

Unit V: Cell cycle and cell death

Stages of cell cycle, Mitotic and meiotic cell division; Regulation of cell cycle, Apoptosis and Necrosis.

Unit VI: Carbohydrate chemistry:

Classification of carbohydrates.

Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway.

Unit VII: Protein chemistry:

Classification and structural properties of amino acids. Levels of organization; Protein metabolism: Transamination, Deamination, Urea cycle.

Unit VIII: Lipid chemistry:

Classification and properties of lipids. Lipid metabolism: β-oxidation of fatty acids; Fatty acid biosynthesis.

Unit IX: Nucleic acid chemistry:

Nucleoside, nucleotide, Purines and pyrimidines, DNA, RNA.

Minor Course: ZOO-Mi-201 (Practical)

CELL BIOLOGY AND BIOCHEMISTRY LAB
List of Practicals

1. Demonstration of components of microscopes
2. Study various stages of mitosis by preparing temporary stained squash of onion root tip.
3. Measurement of pH.
4. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
5. Demonstration of proteins separation technique by SDS-PAGE.

Course outcome: Upon successful completion of this course, students will be able to explain the structural and functional organization of cells, membranes, organelles, chromosomes, and the nucleus, and describe the mechanisms regulating membrane transport, cell division, and intracellular signaling. They will demonstrate a thorough understanding of the classification, structure, properties, and metabolism of major biomolecules, including carbohydrates, proteins, lipids, and nucleic acids, and relate these concepts to cellular physiology and metabolic regulation. Students will be able to integrate knowledge of cell biology and biochemistry to interpret normal cellular processes, analyze the molecular basis of physiological and pathological conditions, and apply these principles in higher studies and research in life sciences, biotechnology, and health sciences.

Suggested Readings

1. Lewin's Cells–Cassimeris/Lingappa/Plopper–Johns & Bartlett Publishers.
2. Biology of Cancer by Robert. A. Weinberg. 2nd edition.
3. Hardin, J., Bertoni, G. and Klein Smith, J. L. (2012). Becker's World of the Cell. 8th Edition. Pearson Benjamin Cummings, San Francisco.
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. Karp, G. (2008). Cell and Molecular Biology: Concepts and Applications. 5th Edition. John Wiley.
6. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K. C., Michael
7. Yaffe, M. and Amon, A. (2021). Molecular Cell Biology. 9th Edition. W.H. Freeman.

8. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James. Molecular Biology of the Cell, V Edition, Garland publishing Inc., New York and London.

9. Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H.Freeman and Co., New York.

10. Berg, J.M., Tymoczko, J.L. and Stryer, L.(2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.

11. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.

12. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.

13. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.

