

**Choice Based Credit System (CBCS)**

**NOWGONG COLLEGE  
(AUTONOMOUS)**



**SYLLABUS  
DEPARTMENT OF ZOOLOGY**

**Learning Outcomes-based Curriculum Framework (LOCF)  
of  
Undergraduate Programme (Honours)**

**BACHELOR OF SCIENCE IN ZOOLOGY**

**(Effective from Academic Year 2020-21)**

**Syllabus Approved in Academic Council  
Nowgong College (Autonomous)**

**SYLLABUS FOR B. Sc. (Honours) IN ZOOLOGY**  
**Course and Credit Structure**

Semester	Honours Core Course 14 × 6 = 84	Ability Enhancement Course 2 × 4 = 8	Skill Enhancement Course 2 × 4 = 8	Discipline Specific Elective Course 4 × 6 = 24	Honours Generic Elective 4 × 6 = 24
1 <sup>st</sup>	Course-I Course-II From Same Discipline <b>XXXX-HCC-1016,</b> <b>XXXX-HCC-1026</b>	Communicative English/Communicative MIL <b>ENGL-AEC-1014</b> <b>ASSA- AEC-1014</b> <b>HIND-AEC-1014</b> <b>BENG-AEC-1014</b>			One Course from any Discipline except Honours Discipline  <b>XXXX-HGE-1016</b>
2 <sup>nd</sup>	Course-I Course-II From Same Discipline <b>XXXX-HCC-2016</b> <b>XXXX-HCC-2026</b>	Environmental Studies  <b>ENST-AEC-2014</b>			One Course from any Discipline except Honours Discipline  <b>XXXX-HGE-2016</b>
3 <sup>rd</sup>	Course-I Course-II Course-III From Same Discipline <b>XXXX-HCC-3016</b> <b>XXXX-HCC-3026</b> <b>XXXX-HCC-3036</b>		<b>XXXX-SEC-3014</b>		<b>XXXX-HGE-3016</b>
4 <sup>th</sup>	Course-I Course-II Course-III From Same Discipline <b>XXXX-HCC-4016</b> <b>XXXX-HCC-4026</b> <b>XXXX-HCC-4036</b>		<b>XXXX-SEC-4014</b>		<b>XXXX-HGE-4016</b>
5 <sup>th</sup>	Course-I Course-II From Same Discipline <b>XXXX-HCC-5016</b> <b>XXXX-HCC-5026</b>			<b>XXXX-HDS-5016</b> <b>XXXX-HDS-5026</b>	
6 <sup>th</sup>	Course-I Course-II From Same Discipline <b>XXXX-HCC-6016</b> <b>XXXX-HCC-6026</b>			<b>XXXX-HDS-6016</b> <b>XXXX-HDS-6026</b>	

**SYLLABUS FOR B. Sc. (Honours) IN ZOOLOGY**  
**Course Name and Abbreviation**

<u>Name of courses</u>	<u>Abbreviation</u>
<b>Zoology</b>	<b>ZOOL</b>
 <b><u>Course Code</u></b>	
<u>Type of Course</u>	<u>Abbreviation</u>
Honours Core Course	HCC
Regular Core Course	RCC
Compulsory Core Course	CCC
Elective	HGE
 <b><u>Ability Enhancement Compulsory Course</u></b>	
Ability Enhancement Course	AEC
Skill	SEC

**B.SC. (HONOURS) IN ZOOLOGY**  
**SEMESTER: I**  
**CODE: ZOOL-HCC-1016**  
**NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES**  
**PAPER CREDIT: 6 (4T+2P)**  
**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: Internal Assessment, P: Practical**

**Objectives:**

The course would provide an insight to the learner about the existence of different life forms on the Earth, and appreciate the diversity of animal life. It will help the student to understand the features of Kingdom Animalia and systematic organisation of the animals based on their evolutionary relationships, structural and functional affinities. The course will also make the students aware about the characteristic morphological and anatomical features of diverse animals;

**Learning Outcome:**

Upon completion of the course, students should be able to:

- Learn about the importance of systematics, taxonomy and structural organization of animals.
- Appreciate the diversity of non-chordates living in varied habit and habitats.
- Understand evolutionary history and relationships of different non-chordates through functional and structural affinities.
- Critically analyse the organization, complexity and characteristic features of non-chordates making them familiarize with the morphology and anatomy of representatives of various animal phyla.

**COURSE CONTENT: THEORY**

**CREDITS: 4**

**Unit 1: Protista, Parazoa and Metazoa:** General characteristics and Classification up to classes Study of Euglena, Amoeba and Paramecium, Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica*. Locomotion and Reproduction in Protista Evolution of symmetry and segmentation of Metazoa

**Unit 2: Porifera** General characteristics and Classification up to classes. Canal system and spicules in sponges.

**Unit 3: Cnidaria:** General characteristics and Classification up to classes Metagenesis in Obelia Polymorphism in Cnidaria Corals and coral reefs, General characteristics of Ctenophora and its evolutionary significance.

**Unit 4: Helminthes:** General characteristics and Classification of platyhelminthes up to classes, Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium*.

General characteristics and Classification of nemathelminthes up to classes Life cycle and

pathogenicity of *Ascaris lumbricoides* and *Wuchereria bancrofti*. Parasitic adaptations in helminthes.

**Note:** Classification to be followed from “Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition”

### **COURSE CONTENT: PRACTICAL**

**CREDITS: 2**

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*, binary fission and conjugation in *Paramecium*
2. Examination of pond water collected from different places for diversity in Protista
3. Study of *Sycon* (T.S. and L.S.), *Hyalonema*, *Euplectella*, *Spongilla*.
4. Study of *Obelia*, *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium*, *Pennatula*, *Fungia*, *Meandrina*, *Madrepora*. One specimen/slide of any ctenophore
5. Study of adult *Fasciola hepatica*, *Taeniasolium* and *Ascaris lumbricoides* and their life cycles (slides/microphotographs)
6. To submit a Project Report on any related topic on life cycles.

**Note:** Classification to be followed from “Ruppert and Barnes (2006) *Invertebrate Zoology*, 8th edition, Holt Saunders International Edition”

### **SUGGESTED READINGS**

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science.
- Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson.

## **B.SC. (HONOURS) IN ZOOLOGY**

### **SEMESTER: I**

**CODE: ZOOL-HCC-1026**

**PRINCIPLES OF ECOLOGY**

**PAPER CREDIT: 6 (4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

### **Objectives:**

The primary aim of the syllabus is to sensitize the students about the paramount role and importance of nature. The study of Ecology imparts us the knowledge about the judicious use of existing ecological resources for sustainable development. The hands-on experiences of laboratory will also enable students to understand the ecosystem and ecology in a better way.

### **Learning Outcome:**

Upon completion of the course, students should be able to:

- Demonstrate an understanding of key concepts in ecology with emphasis on historical perspective, role of physical factors and concept of limiting factors.
- Comprehend the population characteristics, dynamics, growth models and interactions. Understand the community characteristics, ecosystem development and climax theories.
- Know about the types of ecosystems, food chains, food webs, energy models, and ecological efficiencies.

### **COURSE CONTENT: THEORY**

**CREDITS: 4**

**Unit 1: Introduction to Ecology:** History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical Factors

**Unit 2: Population:** Unitary and Modular populations, Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion Exponential and logistic growth, equation and patterns, r and K strategies Population regulation - density- dependent and independent factors. Population interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition and Predation, functional and numerical Responses

**Unit 3: Community:** Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Ecotone and edge effect; Ecological succession with one example Theories pertaining to climax community

**Unit 4: Ecosystem:** Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies Nutrient and biogeochemical cycle with one example of Nitrogen cycle Human modified ecosystem

## **Unit 5: Applied ecology: Ecology in Wildlife Conservation and Management**

### **COURSE CONTENT : PRACTICAL**

**CREDITS 2**

1. Calculation of Mean, Median, Mode, Standard deviation and Standard Error.
2. Graphical representation of data-Line diagram, Bar diagram and Pie diagram.
3. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.
4. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon- Weiner diversity index for the same community
5. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method).
6. Report on a visit to National Park/Biodiversity Park/Wildlife sanctuary

### **SUGGESTED READINGS:**

- Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
- Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
- Odum, E.P.,(2008).Fundamentals of Ecology. Indian Edition. Brooks/Cole
- Robert Leo Smith Ecology and field biology Harper and Row publisher
- Ricklefs, R.E., (2000). Ecology. V<sup>th</sup> Edition. Chiron Pres

**B.SC. (HONOURS) IN ZOOLOGY**  
**SEMESTER: II**  
**CODE: ZOOL-HCC-2016**  
**NON-CHORDATES II: COELOMATES**  
**PAPER CREDIT: 6 (4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:**

The course would provide an insight to the learner about the existence of different life forms on the Earth, and appreciate the diversity of animal life. It will help the student to understand the features of Kingdom Animalia and systematic organisation of the animals based on their evolutionary relationships, structural and functional affinities. The course will also make the students aware about the characteristic morphological and anatomical features of diverse animals.

**Learning Outcome:**

Upon completion of the course, students should be able to:

- Learn about the importance of systematics, taxonomy and structural organization of animals.
- Appreciate the diversity of non-chordates living in diverse habit and habitats.
- Understand evolutionary history and relationships of different non-chordates through functional and structural affinities.
- Critically think about the organization, complexity and characteristic features of nonchordates.
- Getting familiarized with the morphology and anatomy of representatives of various animal phyla.

**COURSE CONTENT: THEORY**

**CREDITS: 4**

**Unit: 1: Introduction to Coelomates:** Evolution of coelom and metamerism

**Unit: 2: Annelida:** General characteristics and Classification upto classes, Coelomoducts and Nephridia in Annelids

**Unit: 3: Arthropoda:** General characteristics and Classification upto classes, Vision and Respiration in Arthropoda, Metamorphosis in Insects, Social life in bees and termites.

**Unit: 4: Onychophora:** General characteristics and Evolutionary significance

**Unit:5: Mollusca:** General characteristics and Classification upto classes Respiration in Mollusca, Torsion and detorsion in Gastropoda, Pearl formation in bivalves, Evolutionary significance of trochophore larva

**Unit: 6: Echinodermata:** General characteristics and Classification upto classes Water-vascular system in Asteroidea Larval forms in Echinodermata, Affinities of Echinodermata with Chordates.



**Note:** Classification to be followed from “ Ruppert and Barnes (2006). *Invertebrate Zoology*, 8<sup>th</sup> edition, Holt Saunders International Edition”

## **COURSE CONTENT: PRACTICAL**

**CREDITS 2**

1. Study of following specimens:

Annelids-*Aphrodite*, *Nereis*, *Heteronereis*, *Sabella*, *Serpula*, *Chaetopterus*, *Pheretima*, *Hirudinaria*

Arthropods - *Limulus*, *Palamnaeus*, *Palaemon*, *Daphnia*, *Balanus*, *Sacculina*, *Cancer*, *Eupagurus*, *Scolopendra*, *Julus*, *Bombyx*, *Periplaneta*, Termites and Honey bees, Onychophora – (*Peripatus*)

Molluscs - *Chiton*, *Dentalium*, *Pila*, *Doris*, *Helix*, *Unio*, *Ostrea*, *Pinctada*, *Sepia*, *Octopus*, *Nautilus*

Echinodermates - *Pentaceros/Asterias*, *Ophiura*, *Chlypeaster*, *Echinus*, *Cucumaria* and *Antedon*

2. Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm

3. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm

4. Mount of mouth parts and dissection of digestive system and nervous system of *Periplaneta*\*

5. To submit a Project Report on life cycle of termite, ant, honey bee and silkworm or any other.

**Note:** Classification to be followed from “Ruppert and Barnes (2006) *Invertebrate Zoology*, 8th edition, Holt Saunders International Edition”

## **SUGGESTED READINGS:**

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
- Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson

**B.SC. (HONOURS) IN ZOOLOGY**

**SEMESTER: II**

**CODE: ZOOL-HCC-2026**

**CELL BIOLOGY**

**PAPER CREDIT: 6 (4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:** The objective of the course is to help the students to learn and develop an understanding of a cell as a basic unit of life. This course is designed to enable them to understand the functions of cellular organelles and how a cell carries out and regulates cellular functions.

**Learning Outcome:** Upon completion of the course, students should be able to:

- Understand fundamental principles of cell biology.
- Explain structure and functions of cell organelles involved in diverse cellular processes.
- Have an insight of how defects in functioning of cell organelles
- Appreciate how cells grow, divide, survive, die and regulate these important processes.
- Learn the advances made in the field of cell biology and their applications.

**COURSE CONTENT: THEORY**

**CREDITS: 4**

**Unit: 1: Overview of Cells:** Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions

**Unit: 2: Plasma Membrane:** Various models of plasma membrane structure, Transport across membranes: Active and Passive transport, Facilitated transport Cell junctions: Tight junctions, Desmosomes, Gap junctions

**Unit: 3: Endomembrane System** Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes

**Unit: 4: Mitochondria and Peroxisomes:** Mitochondria: Structure, Semi- autonomous nature, Endo symbiotic hypothesis Mitochondrial respiratory Chain, Chemi-osmotic hypothesis, Peroxisomes

**Unit: 5: Cytoskeleton:** Structure and Functions: Microtubules, Microfilaments and intermediate filaments

**Unit: 6: Nucleus:** Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus Chromatin: Euchromatin and heterochromatin and packaging (nucleosome)

**Unit: 7: Cell Division:** Mitosis, Meiosis, Cell cycle

## COURSE CONTENT: PRACTICAL

(CREDITS 2)

1. Preparation of temporary stained slide of onion root tip/tadpole larva/lizard tail to study various stages of mitosis.
2. Study of various stages of meiosis
3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheekcells.
4. Preparation of permanent slide to demonstrate:
  - a. DNA by Feulgen reaction
  - b. Muco-polysaccharides by PAS reaction
  - c. Proteins by Mercuric bromophenol blue/FastGreen

### SUGGESTED READINGS:

- Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons, Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- 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.
- Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Albert, Bray Dennis, Lewis Julian, Raff Martin, Roberts Keith and Watson James (2008). *Molecular Biology of the Cell*, V Edition, Garland publishing Inc., New York and London.

**B.SC. (HONOURS) IN ZOOLOGY**  
**SEMESTER: III**  
**CODE: ZOOL-HCC-3016**  
**DIVERSITY OF CHORDATA**  
**PAPER CREDIT: 6 (4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:**

The course is designed with an aim to provide scope and historical background of chordates. It will impart knowledge regarding basic concepts of origin of chordates and make the students understand the characteristics and classification of animals with notochord.

**Learning Outcome:** Upon completion of the course, the students will be able to

- Understand different classes of chordates, level of organization and evolutionary relationship between different subphyla and classes, within and outside the phylum.
- Study about diversity in animals making students understand about their distinguishing features.
- Appreciate similarities and differences in life functions among various groups of animals in Phylum Chordata.

**COURSE CONTENT: THEORY**

**CREDITS: 4**

**Unit: 1: Chordata:** General characteristics and outline classification of Chordata, Dipleurula concept of origin of chordate, General characteristics and classification of Protochordata. (Hemichordata, Urochordata and Cephalochordata);

Retrogressive metamorphosis in Urochordata, Affinities of Hemichordata, Advanced features of vertebrates over Protochordata.

**Unit: 2: Agnatha:** General characteristics and classification of cyclostomes up to class.

**Unit: 3: Pisces:** General characteristics of Chondrichthyes and Osteichthyes, classification upto order, Migration, Parental care in fishes.

**Unit: 4: Amphibia:** Origin of Tetrapoda, General characteristics and classification upto order; Parental care in Amphibians

**Unit: 5: Reptilia:** General characteristics and classification up to order; Affinities of Sphenodon; Poison apparatus and biting mechanism in snakes

**Unit: 6: Aves:** General characteristics and classification up to order, Archaeopteryx- a connecting link; flight mechanism, Perching mechanism, flight adaptations and air sacs in birds.

**Unit: 7: Mammals:** General characters and classification up to order; affinities of Prototheria

## COURSE CONTENT: PRACTICAL

(CREDITS 2)

- 1. Protochordata:** *Balanoglossus*, *Herdmania*, *Branchiostoma*, Colonial Urochordata  
Sections of *Balanoglossus* through proboscis and branchio genital regions,  
Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions.  
Permanent slide of *Herdmania* spicules
- 2. Agnatha:** *Petromyzon*, *Myxine*
- 3. Fishes:** *Scoliodon*, *Sphyrna*, *Pristis*, *Torpedo*, *Chimaera*, *Mystus*, *Heteropneustes*,  
*Labeo*, *Exocoetus*, *Echeneis*, *Anguilla*, *Hippocampus*, *Tetrodon/ Diodon*,  
*Anabas*, Flat fish
- 4. Amphibia:** *Ichthyophis/Ureotyphlus*, *Necturus*, *Bufo*, *Hyla*, *Alytes*, *Salamandra*
- 5. Reptilia:** *Chelone*, *Trionyx*, *Hemidactylus*, *Varanus*, *Uromastix*,  
*Chamaeleon*, *Ophiosaurus*, *Draco*, *Bungarus*, *Vipera*, *Naja*, *Hydrophis*,  
*Zamenis*, *Crocodylus* Key for Identification of poisonous and non-poisonous snakes
- 6. Aves:** Study of six common birds from different orders. Types of beaks and claws
- 7. Mammalia:** *Sorex*, Bat (Insectivorous and Frugivorous), *Funambulus*,  
*Loris*, *Herpestes*, *Erinaceous*.
- 8. Dissection:** Mount of weberian ossicles of *fish*
- 9.** Power point presentation on study of any two animals from two different classes  
by students (may be included if dissections not given permission)

*Classification from Young, J. Z. (2004) to be followed*

### SUGGESTED READINGS:

- Young, J.Z.(2004).TheLifeofVertebrates.IIIEdition. Oxford university press.
- Pough H. Vertebrate life, VIII Edition, Pearson International.
- Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.
- Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution, IV Edition. Jones and Bartlett Publishers Inc

**B.SC. (HONOURS) IN ZOOLOGY**  
**SEMESTER: III**  
**CODE: ZOOL-HCC-3026**  
**ANIMAL PHYSIOLOGY AND HISTOLOGY**  
**PAPER CREDIT: 6 (4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:**

Physiology is the study of life, specifically, how cells, tissues and organ function. It is a core and fundamental scientific discipline that underpins the health and well-being of living organisms. Besides satisfying a natural curiosity about how our body systems function, it gives us knowledge about the functions of all the parts and systems of the body. The course has been designed to extend the fundamental or coherent understanding of the subject to related disciplinary areas/subjects through understanding of normal body functions.

**Learning Outcome:** Upon completion of the course, students will be able to:

- Know the basic fundamentals and understand advanced concepts so as to develop a strong foundation
- Recognize and explain how all physiological systems work in unison to maintain homeostasis in the body and use of feedback loops to control the same
- Learn an integrative approach to understand the interactions of various organ systems resulting in the complex overall functioning of the body.
- Know the role of regulatory systems viz. endocrine and nervous systems and their amalgamation in maintaining various physiological processes.

**COURSE CONTENT: THEORY**

**CREDITS: 4**

**Unit: 1: Tissues:** Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue

**Unit: 2: Bone and Cartilage:** Structure and types of bones and cartilages, Ossification, bone growth and desorption

**Unit: 3: Nervous system:** Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and nonmyelinated nerve fibers; Types of synapse and synaptic transmission, Neurotransmitter, Neuromuscular junction; Types of Reflexes, reflex arc; Physiology of vision and hearing.

**Unit: 4: Muscle:** Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twist; Motor unit.

**Unit: 5: Endocrine system:** parathyroid, pancreas, adrenal, gonads; hormones secreted by them and their functions, Classification of hormones; Regulation of hormone secretion; Mechanism of Hormone action, Signal transduction pathways for steroidal and non steroidal hormones; Hypothalamus (Neuroendocrine gland)-principal nuclei involved in neuroendocrine control of anterior pituitary and endocrines system;

Placental hormones, Role of hormones in puberty and in reproductive cycle, Chemical methods of contraception.

**COURSE CONTENT:**

**PRACTICAL**

**CREDITS:**

**2**

\*1. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)

2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells

3. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid

4. Microtomy: Preparation of permanent slide of any five mammalian (Fish/amphibian/bird /Goat/ rat/mice).

5. Study of blood parameters

**(\*Subject to UGC guidelines)**

**SUGGESTED READINGS:**

- Guyton, A.C. &Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hecourt Asia PTE Ltd. /W.B. Saunders Company.
- Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
- Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W &Wilkins.



**B.SC. (HONOURS) IN ZOOLOGY**  
**SEMESTER: III**  
**CODE: ZOOL-HCC-3036**  
**FUNDAMENTALS OF BIOCHEMISTRY**  
**PAPER CREDIT: 6 (4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:** Biochemistry is to understand the core biological phenomena at the molecular level. The aim of the course is to comprehend the fundamental principles of chemistry that govern complex biological systems. The program is designed to enable a student acquire sound knowledge of biochemistry and its practicable applicability.

**Learning Outcome:** Upon completion of the course, students should be able to

- Gain knowledge and skill in the fundamentals of biochemical sciences, interactions and interdependence of physiological and biochemical processes.
- Demonstrate foundation knowledge in biochemistry; synthesis of proteins, lipids, nucleic acids, and carbohydrates; and their role in metabolic pathways along with their regulation.

**COURSE CONTENT: THEORY**

**CREDITS: 4**

**Unit: 1: Carbohydrates:** Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates

**Unit: 2: Lipids:** Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids

**Unit: 3: Proteins: Amino acids:** Structure, Classification and General properties of  $\alpha$ - amino acids; Physiological importance of essential and non- essential  $\alpha$ - amino acids, Bonds stabilizing protein structure; Levels of organization in proteins; Denaturation; simple and conjugated proteins

**Immunoglobulins:** Basic Structure, Classes and Function of Immunoglobulin

**Unit:4:NucleicAcids:**Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleicacids Cotcurves: Base pairing, Denaturation and Renaturation of DNA types of DNA and RNA,

Complementarity of DNA.

**Unit: 5: Enzymes:** Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of  $K_m$  and  $V_{max}$ , Lineweaver- Burk plot; Multi-substrate reactions; Enzyme inhibition; Allosteric enzymes; Regulation of enzyme action.

### **COURSE CONTENT: PRACTICAL**

**CREDITS: 2**

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Paper chromatography of amino acids.
3. Action of salivary amylase under optimum conditions.
4. Effect of pH, temperature on the action of salivary amylase.
5. Demonstration of proteins separation by SDS-PAGE.

### **SUGGESTED READINGS:**

- Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
- 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.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.
- 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.

**B.SC. (HONOURS) IN ZOOLOGY**

**SEMESTER: IV**

**CODE: ZOOL-HCC-4016**

**COMPARATIVE ANATOMY OF VERTEBRATES**

**PAPER CREDIT: 6(4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:**

A study of vertebrate structure, function and evolution. Relationships between the structural and functional adaptations of the different vertebrate groups and their environment.

**Learning Outcome:**

After completing the syllabus the students will have:

- an understanding of the characteristics of vertebrates which makes both chordates and vertebrates unique among animals.
- an understanding of the evolutionary history of vertebrates and the evolutionary relationships among different groups of vertebrates.
- learn to compare and contrast the many physiological, ecological, adaptations of the different groups of vertebrates, the external anatomy, skeletal features, and internal organ systems of the different groups of vertebrates.
- learn to observe and discuss field and laboratory techniques used in the study of vertebrates.

**COURSE CONTENT: THEORY**

**CREDITS: 4**

**Unit 1: Integumentary System**

Structure, functions and derivatives of integument

**Unit 2: Skeletal System**

Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches

**Unit 3: Digestive System**

Alimentary canal and associated glands, dentition

**Unit 4: Respiratory System**

Skin, gills, lungs and air sacs; Accessory respiratory organs

### **Unit 5: Circulatory System**

General plan of circulation, evolution of heart and aortic arches

### **Unit 6: Urinogenital System**

Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri

### **Unit 7: Nervous System**

Comparative account of brain : Autonomic nervous system, Spinal cord, Cranial nerves in mammals

### **Unit 8: Sense Organs**

Classification of receptors, Brief account of visual and auditory receptors in man

## **COURSE CONTENT: PRACTICAL**

**CREDITS: 2**

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Disarticulated skeleton of Frog, Fowl, Rabbit
3. Carapace and plastron of turtle/tortoise
4. Mammalian skulls: One herbivorous and one carnivorous animal
5. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted)
6. Project on skeletal modifications in vertebrates (may be included if dissection not permitted)

## **SUGGESTED READING**

- Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution.IV Edition. McGraw-Hill Higher Education
- Kent, G.C. and Carr R.K. (2000).Comparative Anatomy of the Vertebrates.IX Edition. The McGraw-Hill Companies
- Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons  
Walter ,H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House

**B.SC. (HONOURS) IN ZOOLOGY**  
**SEMESTER-IV**  
**PAPER CODE: ZOOL- HCC-4026**  
**ANIMAL PHYSIOLOGY: LIFE SUSTAINING SYSTEMS**  
**PAPER CREDIT: 06(4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:**

- To develop basic concept and Knowledge among undergraduate students about the structure and functioning of different systems in body.
- This course gives in depth instructions in the organization, structures and functions of different organ systems in the body and will be able to know how these different systems interrelate to maintain homeostasis.

**Learning Outcomes:**

After completing the syllabus the students will be able to

- comprehend some of the vital processes like circulation of blood and its coagulation processes, digestion, excretion.
- analyze the role of the respiratory systems, endocrine glands in body

**COURSE CONTENT: THEORY**

**CREDITS: 4**

**Unit 1: Physiology of Digestion**

Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Hormonal control of secretion of enzymes in Gastro intestinal tract.

**Unit 2: Physiology of Respiration**

Histology of trachea and lung; Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves and the factors influencing it; Carbon-monoxide poisoning; Control of respiration

**Unit 3: Renal Physiology**

Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance

## **Unit 4: Blood**

Components of blood and their functions; Structure and functions of haemoglobin  
Homeostasis: Blood clotting system, Kallikrein-Kininogen system, Complement system  
& Fibrinolytic system, Haemopoiesis Blood groups: Rh factor, ABO and MN

## **Unit 5: Physiology of Heart**

Structure of mammalian heart; Coronary circulation; Structure and working of conducting myocardial fibers. Origin and conduction of cardiac impulses. Cardiac cycle; Cardiac output and its regulation, Frank-Starling Law of the heart, nervous and chemical regulation of heart rate. Electrocardiogram, Blood pressure and its regulation

### **COURSE CONTENT: PRACTICAL**

**CREDITS: 2**

1. Determination of ABO Blood group
2. Enumeration of red blood cells and white blood cells using haemocytometer
3. Estimation of haemoglobin using Sahli's haemoglobinometer
4. Preparation of haemin crystals.
5. Recording of blood pressure using a sphygmomanometer
6. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney

### **SUGGESTED READINGS:**

- Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. X I Edition. Hecourt Asia PTE Ltd. W.B. Saunders Company.
- Tortora, G.J. & Grabowski, S.(2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
- Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
- Sebulingam, K and Sebulingam, P. (2012). Essentials of Medical Physiology .XI. Edition. Jaypee Brothers medical Publishers (P) LTD.

**B.SC. (HONOURS) IN ZOOLOGY**  
**SEMESTER-IV**  
**PAPER CODE: ZOOL- HCC-4036**  
**BIOCHEMISTRY OF METABOLIC PROCESSES**  
**PAPER CREDIT: 06(4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:**

- Provide exposure to the students about the metabolic processes of the body and how the cells extract and utilize energy through numerous enzyme-catalyzed reactions.
- To provide the undergraduate students an in-depth knowledge on metabolism of macromolecular structures and their energy budgets and about the enzymes involved in oxidation and synthesis processes, their sources and the process of liberation of energy through Electron transport system and all the components of these systems.

**Learning Outcome:**

On completion of the course students will be able to:

- recognize how the catabolic breakdown of the substances is associated with release of energy.
- assess the crucial role of different enzymes and cofactors with regard to the integration of metabolic pathways.
- learn about the different systems and factors involved in transport of electrons derived from our biomolecules through electron transport chain.

**COURSE CONTENT: THEORY**

**CREDITS: 4**

**Unit 1: Overview of Metabolism**

Catabolism vs Anabolism, Stages of catabolism, Compartmentalization of metabolic pathways, Shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; coupled reactions; Use of reducing equivalents and cofactors; Intermediary metabolism and regulatory mechanisms

**Unit 2: Carbohydrate Metabolism**

Sequence of reactions and regulation of glycolysis, Citric acid cycle, Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis

### **Unit 3: Lipid Metabolism**

$\beta$ -oxidation and omega-oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis

### **Unit 4: Protein Metabolism**

Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids

### **Unit 5: Oxidative Phosphorylation**

Redox systems; Review of mitochondrial respiratory chain,  
Inhibitors and un-couplers of Electron Transport System

## **COURSE CONTENT: PRACTICAL**

**CREDITS: 2**

1. Estimation of total protein in given sample/tissues by Lowry's method/Bradford's method.
2. Detection of SGOT and SGPT in serum/tissue
3. To study the enzymatic activity of Trypsin and Lipase.
4. Study of biological oxidation (SDH) [goat liver]
5. To perform the Acid and Alkaline phosphatase assay from serum/tissue.
- 6 Study of Enzyme kinetics and determination of  $K_m$  value

## **SUGGESTED READINGS**

- Cox, M.M and Nelson, D.L. (2008). Lehninger Principles of Biochemistry, V Edition, W.H. Freeman and Co., NewYork.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
- 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.
- Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.



**B.SC. (HONOURS) IN ZOOLOGY  
SEMESTER-V**

**PAPER CODE: ZOOL- HCC-5016**

**MOLECULAR BIOLOGY**

**PAPER CREDIT: 06(4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:**

- To impart knowledge of genetic materials, their structures, expression and regulation

**Learning Outcome:**

- Students will understand the scientific process, in the context of learning the fundamental biological and chemical facts of molecular biology.

**COURSE CONTENT: THEORY**

**CREDITS: 4**

**Unit 1: Nucleic Acids**

Salient feature of DNA and RNA Watson and Crick model of DNA

**Unit 2: DNA Replication**

DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative, bidirectional and semi- discontinuous replication, RNA priming, Replication of circular and linear *ds*-DNA, replication of telomeres

**Unit3:Transcription**

RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors

**Unit4: Translation**

Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation

**Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA**

Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA

**Unit 6: Gene Regulation**

Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from *lac* operon and *trp* operon; Transcription regulation in eukaryotes, Activators, repressors, enhancers, silencer elements; Gene silencing, Genetic imprinting

## Unit 7: DNA Repair Mechanism

Pyrimidine dimerization and mismatch repair

## Unit 8: Regulatory RNAs

Ribo-switches, RNA interference, miRNA, siRNA

### COURSE CONTENT: PRACTICAL

CREDITS: 2

1. Study of Polytene chromosomes from Chironomous / Drosophila larvae
2. Preparation of liquid culture medium (LB) and raise culture of *E. coli*
3. Estimation of the growth kinetics of *E. coli* by turbidity method
4. Extraction of DNA and RNA from animal tissue
5. Quantitative estimation DNA using colorimeter (Diphenylamine reagent)
6. Quantitative estimation of RNA using Orcinol reaction

### SUGGESTED READINGS

- Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G.P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: *Molecular Biology of the Cell*, IV Edition.
- Cooper, G.M. and Robert E. Hausman R. E. *The Cell: A Molecular Approach*, V Edition, ASM Press and Sinauer Associates.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons, Inc.
- Lewin B. (2008). *Gene XI*, Jones and Bartlett McLennan A., Bates A., Turner, P. and White M. (2015). *Molecular Biology* IV Edition. GS, Taylor and Francis Group, New York and London.

**B.SC. (HONOURS) IN ZOOLOGY  
SEMESTER-V**

**PAPER CODE: ZOOL- HCC-5026**

**PRINCIPLES OF GENETICS**

**PAPER CREDIT: 06(4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:**

- Completion of this subject is expected to enhance a student's ability to understand the fundamental principles of genetics and to describe the experiments used to establish them.

**Learning Outcome:** Upon successful completion of the course students will

- have in depth knowledge on classical to molecular genetics

**COURSE CONTENT: THEORY**

**CREDITS: 4**

**Unit 1: Mendelian Genetics and its Extension**

Principles of inheritance, Incomplete dominance and co- dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sex- influenced and sex-limited characters of inheritance.

**Unit 2: Linkage, Crossing Over and Chromosomal Mapping**

Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses, Interference and coincidence, Somatic cell hybridization.

**Unit 3: Mutations**

Types of gene mutations (Classification), Types of chromosomal aberrations, Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached *X* method.

**Unit 4: Sex Determination**

Chromosomal mechanisms of sex determination in *Drosophila* and Man

**Unit 5: Extra-chromosomal Inheritance**

Criteria for extra-chromosomal inheritance, Antibiotic resistance in *Chlamydomonas*, Mitochondrial mutations in *Saccharomyces*, Infective heredity in *Paramecium* and Maternal effects

## Unit 6: Polygenic Inheritance

Polygenic inheritance; simple numericals based on it.

## Unit 7: Recombination in Bacteria and Viruses

Conjugation, Transformation, Transduction, Complementation test in Bacteriophage

## Unit 8: Transposable Genetic Elements

Transposons in bacteria, Ac-Ds element in maize and P elements in *Drosophila*,  
Transposons in humans

## COURSE CONTENT: PRACTICAL

CREDITS: 2

1. Culture of *Drosophila*
2. To study the Mendelian laws and gene interactions.
3. Chi-square analyses using seeds/beads/*Drosophila*.
4. Linkage maps based on data from conjugation, transformation and transduction.
5. Linkage maps based on data from *Drosophila* crosses.
6. Study of human karyotype by buccal epithelial cells (normal and abnormal).
7. Pedigree analysis of some human inherited traits/mammalian inherited traits.

## SUGGESTED READINGS

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India
- Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc Klug, W.S., Cummings, M.R., Spencer, C.A. (2012).
- *Concepts of Genetics*. X Edition. Benjamin Cummings Russell, P. J. (2009). *Genetics- A Molecular Approach*. III Edition. Benjamin Cummings
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co
- Fletcher H. and Hickey I. (2015). *Genetics*. IV Edition. GS, Taylor and Francis Group, New York and London

**B.SC. (HONOURS) IN ZOOLOGY**  
**SEMESTER: V**  
**CODE: ZOOL-HDS-5016**  
**VERTEBRATE ENDOCRINOLOGY**  
**PAPER CREDIT: 6 (4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:**

- The main objective of the course is to discuss the molecular, biochemical and physiological effects of different hormones of our body along with their mechanism of action and regulation.

**Learning outcome:** Upon completion of the course students will be able to

- give detail account of all the hormones of our body, regulation of their secretion and functions
- learn hypothalamic control of hormone secretion

**COURSE CONTENT: THEORY**

**CREDITS: 4**

**Unit 1: Introduction to Endocrinology**

History of endocrinology, Classification, Characteristic and Transport of Hormones, Neuro secretions and Neuro hormones

**Unit 2: Epiphysis, Hypothalamo-hypophysial Axis**

Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction.

Structure of hypothalamus, Hypothalamic nuclei and their functions, Regulation of neuroendocrine glands, Feed back mechanisms

Structure of pituitary gland, Hormones and their functions, Hypothalamo hypophysial portal system, Disorders of pituitary gland.

**Unit3: Peripheral Endocrine Glands**

Structure, Hormones, Functions and Regulation of Thyroid gland, Parathyroid, Adrenal, Pancreas, Ovary and Testis

Hormones in homeostasis, Disorders of endocrine glands

**Unit4: Regulation of Hormone Action**

Hormone action at Cellular level: Hormone receptors, transduction and regulation

Hormone action at Molecular level: Molecular mediators, Genetic control of hormone action

**COURSE CONTENT: PRACTICAL**

**CREDITS:2**

1. Study of endocrine glands in laboratory model system/vertebrate
2. Preparation of histological slides and study of endocrine glands
3. Demonstration of Castration/ovariectomy in laboratory bred rat\*
4. Designing of primers of any hormone

\*subject to UGC guidelines

**SUGGESTED READINGS**

- General Endocrinology C. Donnell Turner Pub- Saunders Toppan
- Endocrinology: An Integrated Approach; Stephen Nussey And Saffron Whitehead. Oxford: BIOS Scientific Publishers; 2001.
- Hadley, M.E. and Levine J.E. 2007. Endocrinology, 6th Edition. Pearson Prentice-Hall, Pearson Education Inc., New Jersey.
- Vertebrate Endocrinology by David O. Norris,

**B.SC. (HONOURS) IN ZOOLOGY**

**SEMESTER: V**

**CODE: ZOOL-HDS-5026**

**PARASITOLOGY**

**PAPER CREDIT: 6(4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:**

- To provide students with knowledge concerning biological, epidemiological and ecological aspects of parasites causing diseases to humans.
- To enable students to understand the pathogenesis, clinical presentations and complications of parasitic diseases.
- To enable students to reach diagnosis and know the general outline parasitic arthropod and parasitic vertebrates

**Learning Outcome:** Students will be able to learn

- the important groups of parasite and their infections including epidemiology.
- the common parasitic diseases and life-threatening conditions caused by helminthes and protozoa as regards etiology and life cycle of parasites of medical importance.
- common diseases caused by arthropods of medical interest as regards etiology, pathogenesis, clinical features.

**COURSE CONTENT: THEORY**

**CREDITS: 4 Unit**

**I: Introduction to Parasitology**

Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector) Host parasite relationship

**Unit II: Parasitic Protists**

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Entamoeba histolytica*, *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani*, *Plasmodium vivax*

**Unit III: Parasitic Platyhelminthes**

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Fasciolopsis buski*, *Schistosoma haematobium*, *Taenia solium* and *Hymenolepis nana*

#### Unit IV: Parasitic Nematodes

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis*. Study of structure, life cycle and importance of *Meloidogyne* (root knot nematode), *Pratylenus* (lesion nematode)

#### Unit IV: Parasitic Arthropoda

Biology, importance and control of ticks, mites, *Pediculus humanus* (head and body louse), *Xenopsylla cheopis* and *Cimex lectularius*

#### Unit V: Parasitic Vertebrates

A brief account of parasitic vertebrates; Cookicutter Shark, Candiru, Hood Mockingbird and Vampire bat

#### COURSE CONTENT: PRACTICAL

CREDITS: 2

1. Study of life stages of *Entamoeba histolytica*, *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani* and *Plasmodium vivax* through permanent slides/microphotographs
2. Study of adult and life stages of *Fasciolopsis buski*, *Schistosoma haematobium*, *Taenia solium* and *Hymenolepis nana* through permanent slides/microphotographs
3. Study of adult and life stages of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis* through permanent slides/microphotographs
4. Study of *Pediculus humanus* (Head louse and Body louse), *Xenopsylla cheopis* and *Cimex lectularius* through permanent slides/photographs
5. Study of monogenea from the gills of fresh/marine fish [Gills can be procured from fish market as by product of the industry]
6. Study of nematode/cestode parasites from the intestines of Poultry bird [Intestine can be procured from poultry/market as a byproduct]
7. Collection and study of ectoparasites from different vertebrate species

#### SUGGESTED READINGS

- Arora, D. R and Arora, B. (2001) *Medical Parasitology*. II Edition. CBS Publications and Distributors
- Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributors, Medical Books Publishers, Chennai, Delhi
- Rattan Lal chhujani and Rakesh Bhatia. *Medical Parasitology*, III Edition, Jaypee



- Brothers Medical Publishers (P) Ltd., NewDelhi
- Meyer, Olsen & Schmidt's Essentials of Parasitology, Murray, D. Dailey, W.C. Brown Publishers
  - K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd

**B.SC. (HONOURS) IN ZOOLOGY**

**SEMESTER: VI**

**CODE: ZOOL-HCC-6016**

**DEVELOPMENTAL BIOLOGY**

**PAPER CREDIT: 6 (4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:**

- To provide the undergraduate students an in-depth knowledge on the embryonic and post embryonic developmental processes.
- To explain the basic principles and concepts underlying the developmental processes at the cellular and molecular level.
- To understand morphogenesis
- To study different types of eggs, cleavage patterns and various morphogenetic movements during gastrulation leading to formation of germ layers and their fate

**Learning outcome:**

On completion of the course, students should be able to:

- understand the events that lead to formation of a multicellular organism from a single fertilized egg, the zygote.
- acquire basic knowledge of the cellular processes of development and the molecular mechanisms underlying these.
- describe the general patterns and sequential developmental stages during embryogenesis; and understand how the developmental processes lead to establishment of body plan of multicellular organisms.
- discuss the general mechanisms involved in morphogenesis and to explain how different cells and tissues interact in a coordinated way to form various tissues and organs. • Understand about the evolutionary development of various animals.
- know the process of ageing leading to interventions that can improve the overall health and quality of life in aged people.
- learn the importance of latest techniques like stem cell therapy, in vitro fertilization and amniocentesis etc. to be applied for human welfare.
- develop the skill to raise and maintain culture of model system; *Drosophila* in the laboratory.

**COURSE CONTENT: THEORY****CREDITS: 4****UNIT 1: Introduction**

Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division

**UNIT 2: Early embryonic development**

Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polysemy; Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques); early development of frog and chick up to gastrulation; Embryonic induction and organizers

**UNIT 3: Late embryonic development**

Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)

**UNIT 4: Post embryonic development**

Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration; Ageing: Concepts and Theories

**UNIT 5: Implications of developmental biology**

Teratogenesis: Teratogenic agents and their effects on embryonic development; In vitro fertilization, Stem cell (ESC), Amniocentesis

**COURSE CONTENT: PRACTICAL****CREDITS: 2**

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)
2. Study of whole mounts of developmental stages of chick/duck.
3. Study of permanent slides: chick/duck, of different developmental stages. Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
4. Study of the developmental stages and life cycle of *Drosophila* from stock culture
5. Study of different sections of placenta (photo micrograph/slides)
6. Project report on *Drosophila* culture/chick embryo development

### **SUGGESTED READINGS:**

- Gilbert, S. F. (2010). *Developmental Biology*, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
- Balinsky B. I. and Fabian B. C. (1981). *An Introduction to Embryology*, V Edition, International Thompson Computer Press
- Carlson, R. F. Patten's *Foundations of Embryology* Kalthoff (2008). *Analysis of Biological Development*, II Edition, McGraw-Hill Publishers
- Lewis Wolpert (2002). *Principles of Development*. II Edition, Oxford University Press.
- Veer Bala Rastogi (2016). *Chordate Embryology*. II Edition, Kedar Nath Ram Nath Publishers.

**B.SC. (HONOURS) IN ZOOLOGY**  
**SEMESTER: VI**  
**CODE: ZOOL-HCC-6026**  
**EVOLUTIONARY BIOLOGY**  
**PAPER CREDIT: 6 (4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:**

- To learn an understanding of life and natural world
- To study the development of evolutionary thought by dealing in general with the process and pattern of biological evolution
- To learn about deciphering evidences ranging from fossil records to molecular data and arranges them to establish phylogenetic relationships of species, while, on the other, it provides a platform to understand various forces which bring about variations among populations of a species and cause them to diversify into new species.

**Learning outcome:**

On completion of the course, students should be able to:

- acquire problem solving and high order analytical skills by attempting numerical problems as well as performing simulation studies of various evolutionary forces in action.
- apply knowledge gained, on populations in real time, while studying speciation, behaviour and susceptibility to diseases.
- gain knowledge about the relationship of the evolution of various species and the environment they live in.
- get motivated to work towards mitigating climate change so that well adapted species do not face extinction as a result of sudden drastic changes in environment.
- use knowledge gained from study of variations, genetic drift to ensure that conservation efforts for small threatened populations are focused in right direction.
- predict the practical implication of various evolutionary forces acting on the human population in the field of human health, agriculture and wildlife conservation.
- use various software to generate interest towards the field of bioinformatics and coding used in programming language

**COURSE CONTENT: THEORY****CREDITS: 4 UNIT****1: Life's beginnings**

Chemogeny, RNA world, Biogeny, Evolution of eukaryotes; Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism

**UNIT 2: Evidences of evolution**

Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse). Neutral theory of molecular evolution, molecular clock

**UNIT 3: Population genetics**

Hardy-Weinberg Law (statement and derivation of equation) Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, selection coefficient)

**UNIT 4: Product of evolution**

Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches); Extinctions, Background and mass extinctions (causes and effects), detailed example of K-T extinction

**UNIT 5: Origin and evolution man**

Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from Dryopithecus leading to *Homo sapiens*,

**UNIT 5: Sources of variations and phylogeny**

Introduction to heritable variations and their role in evolution, Concept of Phylogenetic trees, multiple sequence alignment

**COURSE CONTENT: PRACTICAL****CREDITS: 2**

1. Study of fossils from models/pictures
2. Study of homology and analogy from suitable specimens
3. Study and verification of Hardy-Weinberg Law by chi square analysis
4. Graphical representation and interpretation of data of height/weight of a sample of 100 humans in relation to their age and sex.
5. Construction of phylogenetic trees with the help of bioinformatics tools (Clustal X, Phylip, NJ) and its interpretation.

## **SUGGESTED READINGS**

- Ridley, M (2004) Evolution III Edition Blackwell publishing
- Hall, B.K. and Hallgrimson, B (2008). Evolution. IV Edition. Jones and Barlett Publishers.
- Campbell, N.A. and Reece J.B (2011). Biology. IX Edition.
- Pearson, Benjamin, Cummings. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
- Pevsner, J (2009). Bioinformatics and Functional Genomics. II Edition Wiley- Blackwell
- Veer Bala Rastogi (2008). Organic Evolution. XII Edition, M/S KedarNath Ram Nath Publishers.

**B.SC. (HONOURS) IN ZOOLOGY  
SEMESTER: VI  
CODE: ZOOL-HDS-6016**

**WILD LIFE CONSERVATION AND MANAGEMENT THEORY  
PAPER CREDIT: 6 (4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:**

- The aim to establish Institute for Wildlife Sciences is a multi-disciplinary integrated approach for wildlife biodiversity conservation. Train personnel at various levels for conservation and management of Biodiversity and wildlife.
- Build up scientific acquaintance on wildlife and Biodiversity resources.

**Learning Outcome:** On completion of the course, students should be able to:

- describe the diversity of wildlife and their management practices.
- interpret ecological concepts and/or models in wildlife.
- learn about various methods of wildlife survey and population estimation.
- know about various rules and regulations for wildlife protection in India.

**COURSE CONTENT: THEORY**

**CREDITS: 4**

**Unit 1: Introduction to Wild Life**

Values of wildlife positive and negative; Conservation ethics; Concept of Conservation, Importance of conservation; Causes of depletion; World conservation strategies.

**Unit 2: Evaluation and management of wildlife**

Habitat analysis, Physical parameters: Topography, Geology, Soil and water; Biological Parameters: food, cover, forage, browse and cover estimation; Standard evaluation procedures: use of remote sensing and GIS.

**Unit 3: Management of habitats**

Setting back succession; Grazing logging; Mechanical treatment; Advancing the successional process; Cover construction; Preservation of general genetic diversity; Restoration of degraded habitats

**Unit 4: Population estimation**

Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation; Faecal analysis of ungulates and carnivores: Faecal samples, Hair

identification, Pug marks and census method.

#### **Unit 5: Management planning of wild life in protected areas**

Estimation of carrying capacity; Ecotourism/wildlife tourism in forests; Concept of climax persistence; Ecology of perturbation.

#### **Unit 6: Management of excess population**

Bio-telemetry; Care of injured and diseased animal; Quarantine; Common diseases of wild animal

#### **Unit 7: Protected areas**

National parks & sanctuaries, Community reserve; important features of protected areas in India; Tiger conservation-Tiger reserves in India; Management challenges in Tiger reserve.

#### **COURSE CONTENT: PRACTICAL**

**CREDITS: 2**

1. Identification of flora, mammalian fauna, avian fauna, herpeto-fauna.
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses)
3. Familiarization and study of animal evidences in the field; Identification of animals through pugmarks, hoofmarks, scats, pellet groups, nest, antlers etc.
4. Field visit and demonstration of different field techniques for data collection of flora and fauna (Preparation of report of field visit).
5. Slide preparation from samples collected from faecal matters,

#### **SUGGESTED READINGS**

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



**B.SC. (HONOURS) IN ZOOLOGY**  
**SEMESTER: VI**  
**CODE: ZOOL-HDS-6026**  
**(Dissertation)**  
**PAPER CREDIT: 6**  
**Total Marks: 100 (W80+P20)**

1. Scientific Research paper study and communications with authors
2. Basics of Statistical Analysis
3. Experiment/Survey Design
4. Concept of Plagiarism & citation
5. Dissertation of Zoology Specific study areas.

**Report Preparation**

A report of dissertation work shall be prepared following heads given below (as applicable) –

Title

Abstract

Keywords

Introduction

Review of Literature

Materials & Methods / Methodology

Result / Experimental Findings

Discussion

or - Result and Discussion

Photo plates

Conclusion

Summary

Acknowledgement

References/ Bibliography

\*\*\*\*\*

## SYLLABUS FOR B. Sc. (Regular/Generic) IN ZOOLOGY

### Course and Credit Structure

Semester	Regular Core Course 12 × 6 = 72	Ability Enhancement Course 2 × 4 = 8	Skill Enhancement Course 4 × 4 = 16	Discipline Specific Elective Course 6 × 6 = 36
1 <sup>st</sup>	Course:1 XXXX-RCC-1016 Course:2 XXXX-RCC-1016 Course:3 XXXX-RCC-1016	Communicative English/Communicative MIL ENGL-AEC-1014 ASSA-AEC-1014 HIND-AEC-1014 BENG-AEC-1014		
2 <sup>nd</sup>	Course:1 XXXX-RCC-2016 Course:2 XXXX-RCC-2016 Course:3 XXXX-RCC-2016	ENST-AEC-2014		
3 <sup>rd</sup>	Course:1 XXXX-RCC-3016 Course:2 XXXX-RCC-3016 Course:3 XXXX-RCC-3016		XXXX-SEC-3014	
4 <sup>th</sup>	Course:1 XXXX-RCC-4016 Course:2 XXXX-RCC-4016 Course:3 XXXX-RCC-4016		XXXX-SEC-4014	
5 <sup>th</sup>			XXXX-SEC-5014	Course:1 XXXX-RDS-5016 Course:2 XXXX-RDS-5016 Course:3 XXXX-RDS-5016
6 <sup>th</sup>			XXXX-SEC-6014	Course:1 XXXX-RDS-6016 Course:2 XXXX-RDS-6016 Course:3 XXXX-RDS-6016

## Course Name and Abbreviation

<u>Name of courses</u>	<u>Abbreviation</u>
<b>Zoology</b>	<b>ZOOL</b>
 <b><u>Course Code</u></b>	
<u>Type of Course</u>	<u>Abbreviation</u>
Honours Core Course	HCC
Regular Core Course	RCC
Compulsory Core Course	CCC
Elective	
Compulsory Core Course	HGE
 <b>Ability Enhancement Compulsory Course</b>	
Ability Enhancement Course	AEC
Skill	SEC

**B.SC. (REGULAR/GENERIC) IN ZOOLOGY**

**SEMESTER-I**

**ANIMAL DIVERSITY**

**PAPER CODE: ZOOL- HGE/RCC-1016**

**PAPER CREDIT: 06 (4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:**

This course gives a framework for understanding the diversity within different groups, and interrelationship among different species and genera within each group.

1. To understand the importance of animal kingdom in context to hierarchy, body plan and their role in ecological development. This course provides an overview of the invertebrate and vertebrate animals, including sponges, cnidarians, flatworms, nematodes, annelids, molluscs, arthropods, echinoderms, invertebrate chordates, fishes, amphibians, reptiles, birds, and mammals. This paper comprises of 15 units.
2. To provide knowledge of coelom formation, different level of organization, different modes of living, evolutionary changes of Non-chordates and their salient features.

**Learning outcome:**

On completion of the course, students will be able to:

- Distinguish between major phyla of animals through a demonstrated understanding of their taxonomic classification and diversity.
- Understand the fundamental differences among animal body plans and relate them to function, taxonomic classification, and evolutionary relationships among phyla.
- Illustrate lifecycles, structure, function and reasons for importance of few representative organisms from different groups of animals.
- Observe living animals in the environment and relate observations to theory from the course.
- Recognize major animal phyla and animals on the basis of their external characteristics.

**COURSE CONTENT: THEORY**

**CREDITS: 4**

**UNIT 1: KINGDOM PROTISTA**

General characters and classification up to classes; locomotion in Protozoa

**UNIT 2: PHYLUM PORIFERA**

General characters and classification up to classes; Canal System in *Sycon*

**UNIT 3: PHYLUM CNIDARIA**

General characters and classification up to classes; Polymorphism in Hydrozoa

**UNIT 4: PHYLUM PLATYHELMINTHES**

General characters and classification up to classes; Life history of *Taeniasolium*

**UNIT 5: PHYLUM NEMATHELMINTHES**

General characters and classification up to classes; Life history of *Ascaris lumbricoides* and its parasitic adaptations

## **UNIT 6: PHYLUM ANNELIDA**

General characters and classification up to classes; Metamerism in Annelida

## **UNIT 7: PHYLUM ARTHROPODA**

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

## **UNIT 8: PHYLUM MOLLUSCA**

General characters and classification up to classes; Torsion in gastropods

## **UNIT 9: PHYLUM ECHINODERMATA**

General characters and classification up to classes; Water-vascular system in Asteroidea

## **UNIT 10: PROTOCHORDATES**

General features and Phylogeny of Protochordata

## **UNIT 11: AGNATHA**

General features of Agnatha and classification of cyclostomes up to classes

## **UNIT 12: PISCES**

General features and Classification up to orders; Osmoregulation in Fishes

## **UNIT 13: AMPHIBIA**

General features and Classification up to orders; Parental Care

## **UNIT 14: REPTILES**

General features and Classification up to orders; Poisonous and non-poisonous snakes, Biting mechanism in snakes

## **UNIT 15: AVES**

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

## **UNIT 16: MAMMALIA**

General features and Classification up to orders.

**Note:** Classification of Unit 1-9 to be followed from "Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition"

## **COURSE CONTENT: PRACTICAL**

**CREDITS: 2**

1. Study of the following specimens: *Amoeba*, *Euglena*, *Plasmodium*, *Paramecium*, *Sycon*, *Hyalonema*, and *Euplectella*, *Obelia*, *Physalia*, *Aurelia*, *Tubipora*, *Metridium*, *Taenia solium*, Male and female *Ascaris lumbricoides*, *Aphrodite*, *Nereis*, *Pheretima*, *Hirudinaria*, *Palaemon*, *Cancer*, *Limulus*, *Palaemon*, *Scolopendra*, *Julus*, *Periplaneta*, *Apis*, *Chiton*, *Dentalium*, *Pila*, *Unio*, *Loligo*, *Sepia*, *Octopus*, *Pentaceros*, *Ophiura*, *Echinus*, *Cucumaria* and *Antedon*, *Balanoglossus*, *Herdmania*, *Branchiostoma*, *Petromyzon*, *Sphyrna*, *Pristis*, *Torpedo*, *Labeo*, *Exocoetus*, *Anguilla*, *Ichthyophis/Ureotyphlus*, *Salamandra*, *Bufo*, *Hyla*, *Chelone*, *Hemidactylus*, *Chamaeleon*, *Draco*, *Vipera*, *Naja*, *Crocodylus*, *Gavialis*, Any six common birds from different orders, *Sorex*, Bat, *Funambulus*, *Loris*
2. Study of the following permanent slides: T.S. and L.S. of *Sycon*, Study of life history stages of *Taenia*, T.S. of Male and female *Ascaris*
3. Key for Identification of poisonous and non-poisonous snakes
4. An "animal album" containing photographs, cut outs, with appropriate write up about the

above mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose.

**SUGGESTED READINGS:**

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
- Barnes, R. S. K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science.
- Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
- Pough H. *Vertebrate life*, VIII Edition, Pearson International.
- VasantikaKashyap (2020). A Text Book of Non-Chordata II (Coelomates). I Edition, KedarNath Ram Nath Publication, Meerut.
- Nayan Jyoti Das (2020). Animal Diversity. I Edition, Mahaveer Publications, Dibrugarh.

**B.SC. (REGULAR/GENERIC) IN ZOOLOGY**  
**SEMESTER-II**  
**COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF**  
**VERTEBRATES**

**PAPER CODE: ZOOL- HGE/RCC-2016**

**PAPER CREDIT: 06 (4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:**

This course aims to provide the undergraduate students a thorough knowledge of structural details and comparative account of the different organ systems of the body from lower to higher vertebrates, and protochordates, thus enabling them to appreciate the incredible vertebrate diversity. The course furnishes an understanding of evolutionary basis of morphological and anatomical differences as well as similarities that occur among vertebrates. It helps students propose possible homology between structures, and understand how they evolved as the vertebrates dwelled different habitats.

**Learning outcome:**

On completion of the course, students will be able to:

- Explain comparative account of the different vertebrate systems
- Understand the pattern of vertebrate evolution, organisation and functions of various systems.
- Learn the comparative account of integument, skeletal components, their functions and modifications in different vertebrates.
- Understand the evolution of heart, modification in aortic arches, structure of respiratory organs used in aquatic, terrestrial and aerial vertebrates; and digestive system and its anatomical specializations with respect to different diets and feeding habits.
- Learn the evolution of brain, sense organs and excretory organs to a complex, highly evolved form in mammals;
- Learn to analyze and critically evaluate the structure and functions of vertebrate systems, which helps them to discern the developmental, functional and evolutionary history of vertebrate species.
- Understand the importance of comparative vertebrate anatomy to discriminate human biology.

**COURSE CONTENT: THEORY**

**CREDITS: 4**

**UNIT 1:INTEGUMENTARY SYSTEM**

Derivatives of integument w.r.t. glands and digital tips

## **UNIT 2: SKELETAL SYSTEM**

Visceral arches in vertebrates.

## **UNIT 3: DIGESTIVE SYSTEM**

Brief account of alimentary canal and digestive glands

## **UNIT 4: RESPIRATORY SYSTEM**

Different types of respiratory organs in vertebrates

## **UNIT 5: CIRCULATORY SYSTEM**

Evolution of heart and aortic arches

## **UNIT 6: URINOGENITAL SYSTEM**

Succession of kidney, Evolution of urinogenital ducts

## **UNIT 7: NERVOUS SYSTEM**

Comparative account of brain

## **UNIT 8 SENSE ORGAN**

Types of receptors

## **UNIT 9: EARLY EMBRYONIC DEVELOPMENT**

Gametogenesis: Spermatogenesis and oogenesis  
w.r.t. mammals, vitellogenesis in birds.

Fertilization: external (amphibians), internal (mammals),  
blocks to polyspermy

Early development of frog and mammal (structure of mature egg and its membranes, patterns of cleavage, up to formation of gastrula.

**UNIT 10: LATE EMBRYONIC DEVELOPMENT** Implantation of embryo in mammal, Formation of placenta and its functions, different types of placenta, Metamorphic events in frog life cycle and its hormonal regulation.

## **UNIT 11: CONTROL OF DEVELOPMENT**

Fundamental processes in development (brief idea) – Gene activation, determination, induction, differentiation, morphogenesis,



## COURSE CONTENT: PRACTICAL

CREDITS: 2

### 1. Osteology:

- a) Disarticulated skeleton of fowl and rabbit
- b) Carapace and plastron of turtle/tortoise
- c) Mammalian skulls: One herbivorous and one carnivorous animal.

2. Frog - Study of developmental stages - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.

3. Developmental stages of chick embryo in laboratory incubating the fertilized egg

4. Study of the different types of placenta---through permanent slides or photomicrographs.

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

### SUGGESTED READINGS

- Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill HigherEducation.
- Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-HillCompanies.
- Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley andSons.
- Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, KhoslaPublishingHouse.
- Gilbert, S. F. (2006). *Developmental Biology*, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
- Balinsky, B.I. (2008). *An introduction to Embryology*, International Thomson Computer Press.
- Carlson, Bruce M (1996). *Patten's Foundations of Embryology*, McGraw Hill, Inc.

**B.SC. (REGULAR/GENERIC) IN ZOOLOGY**

**SEMESTER-III**

**PHYSIOLOGY AND BIOCHEMISTRY**

**PAPER CODE: ZOOL- HGE/RCC-3016**

**PAPER CREDIT: 06 (4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:**

Physiology is the study of life, specifically, how cells, tissues and organ function. It is a core and fundamental scientific discipline that defines the health and well-being of living organisms. Besides satisfying a natural curiosity about how our body systems function, it gives us knowledge about the functions of all the parts and systems of the body. It is also of central importance in medicine and health sciences. The course has been designed to apply the theoretical concept to the laboratory exercises for acquiring skills. The students will be equipped with skill-based knowledge to help them undertake further studies in physiology and related areas as well as in multidisciplinary subjects.

**Learning outcome:**

On completion of the course, students will be able to:

- Have a clear knowledge of basic fundamentals and understanding of advanced concepts so as to develop a strong foundation that will help them to acquire skills and knowledge to pursue advanced degree courses.
- Comprehend and analyze problem-based questions on physiological aspects.
- Recognize and explain how all physiological systems work in unison to maintain homeostasis in the body; and use of feedback loops to control the same.
- Learn an integrative approach to understand the interactions of various organ systems resulting in the complex overall functioning of the body.
- Gain knowledge and skill in the interactions and interdependence of physiological and biomolecules

**COURSE CONTENT: THEORY**

**CREDITS: 4**

**UNIT 1: NERVE AND MUSCLE**

Structure of neuron, conduction of nerve impulse through myelinated and non myelinated nervefibres, Ultrastructure of skeletal muscle and mechanism of muscle contraction, neuromuscular junction.

**UNIT 2: DIGESTION**

Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids

**UNIT 3: RESPIRATION**

Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood

#### **UNIT 4: EXCRETION**

Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism

#### **UNIT 5: CARDIOVASCULAR SYSTEM**

Composition of blood, Hemostasis, Structure of Heart, Origin and conduction of the cardiac impulse, Cardiac cycle

#### **UNIT 6: ENDOCRINE SYSTEM**

Structure and functions of endocrine glands-Pituitary, thyroid, parathyroid, pancreas, adrenal and gonads

Hormonal control of spermatogenesis and oogenesis, hormonal control of menstrual cycle

#### **UNIT 7: CARBOHYDRATE METABOLISM**

Glycolysis, Krebs cycle, pentose phosphate pathway, gluconeogenesis

#### **UNIT 8: ENZYMES**

Introduction, mechanism of enzyme action and inhibition and regulation

#### **COURSE CONTENT: PRACTICAL**

**CREDITS: 2**

1. Preparation of haemin crystals
2. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland
3. Study of permanent slides of spinal cord, duodenum, liver, lung, kidney, bone, cartilage
4. Qualitative tests to identify functional groups of carbohydrates in given solutions (Glucose, Fructose, Sucrose, Lactose)
5. Estimation of total protein in given solutions by Lowry's/Bradford method.
6. Study of activity of salivary amylase under optimum conditions

#### **SUGGESTED READINGS:**

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

**B.SC. (REGULAR/GENERIC) IN ZOOLOGY  
SEMESTER-IV**

**GENETICS AND EVOLUTIONARY BIOLOGY**

**PAPER CODE: ZOOL- HGE/RCC-4016**

**PAPER CREDIT: 06 (4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:**

- The objective of this course is to enable the students to learn the classical genetics along with inheritance pattern and genetic variations and their causes. To provide detail understanding of genetic traits and their inheritance, gene interactions and their phenotypic effects.
- This course also provides the students in depth knowledge of origin of life and evolution of different life forms. To explore salient features of various theories of evolution. To develop comprehensive knowledge regarding various sources of variations and their role in speciation. To give detail account of Extinctions and their types.

**Learning Outcomes:**

**After completion of the course students will learn:**

- to develop comprehensive knowledge on molecular evolution, macro evolutionary changes, sources of variations, different theories imparted by evolutionist.
- most of the essential aspects of Evolutionary biology in detail which will help them in acquiring better understanding regarding the subject.

**COURSE CONTENT: THEORY**

**CREDITS: 4**

**UNIT 1: INTRODUCTION TO GENETICS**

Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information

**UNIT 2: MENDELIAN GENETICS AND ITS EXTENSION**

Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, sex linked inheritance, extra-chromosomal inheritance

### **UNIT 3: LINKAGE, CROSSING OVER AND CHROMOSOMAL MAPPING**

Linkage and crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics – an alternative approach to gene mapping

### **UNIT 4: MUTATIONS**

Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations

### **UNIT 5: SEX DETERMINATION**

Chromosomal mechanisms, dosage compensation

### **UNIT 6: HISTORY OF LIFE**

Origin of life, chemical evolution

### **UNIT 7: INTRODUCTION TO EVOLUTIONARY THEORIES**

Lamarckism, Darwinism, Neo-Darwinism

### **UNIT 8: DIRECT EVIDENCES OF EVOLUTION**

Types of fossils, Dating of fossils, Phylogeny of horse

### **UNIT 9: PROCESSES OF EVOLUTIONARY CHANGE**

Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection, Artificial selection

### **UNIT 10: SPECIES CONCEPT**

Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric)

### **UNIT 11: EXTINCTION**

Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution

## **COURSE CONTENT: PRACTICAL**

**CREDITS: 2**

1. Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.
2. Study of Linkage, recombination, gene mapping using the data.
3. Study of Human Karyotypes (normal and abnormal).
4. Study of fossil evidences from plaster cast models and pictures
5. Study of homology and analogy from suitable specimens/pictures
6. Charts:
  - a) Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors
  - b) Darwin's Finches with diagrams/ cut outs of beaks of different species
7. Visit to Museums (Preferably natural history) /submission of report

## **SUGGESTED READINGS**

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics.VIII Edition.WileyIndia.
- Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics.V Edition.John Wiley and SonsInc.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. BenjaminCummings.
- Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition. Benjamin Cummings.
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introduction to Genetic Analysis. IX Edition. W. H. Freeman andCo.
- Ridley, M. (2004). Evolution.III Edition. Blackwell Publishing
- Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H.(2007).Evolution. Spring, Harbour Laboratory Press.
- Hall, B. K. and Hall grimsson, B. (2008). Evolution.IV Edition. Jones and Bartlett Publishers
- Campbell, N. A. and Reece J. B. (2011). Biology. IX Edition, Pearson, Benjamin,Cummings.
- Douglas, J. Futuyama (1997). Evolutionary Biology. Sinauer Associates

**B.SC. (REGULAR) IN ZOOLOGY**

**SEMESTER-V**

**APPLIED ZOOLOGY**

**PAPER CODE: ZOOL- HGE/RCC -5016**

**PAPER CREDIT: 06 (4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

**Objectives:**

It will provide an insight to the learner about Parasitology, Epidemiology, insects of economic and medical importance, animal husbandry and technology involved in pisciculture industry

**Learning outcome:**

- In parasitology part, life cycles of zoonotic parasites and the role of parasites in global public health is discussed.

Attain a solid foundation in insect biology and animal husbandry basics

**COURSE CONTENT: THEORY**

**CREDITS: 4**

**UNIT 1: INTRODUCTION TO HOST-PARASITE RELATIONSHIP**

Host-Types, Definitive host, Intermediate host, Reservoir host, Parasitism, Symbiosis, Commensalism, Zoonosis

**UNIT 2: EPIDEMIOLOGY OF DISEASES**

Transmission, Prevention and control of diseases: Tuberculosis, typhoid

**UNIT 3: RICKETTSIAE AND SPIROCHAETES**

Brief account of *Rickettsia prowazekii*, *Borrelia recurrentis* and *Treponema pallidum*

**UNIT 4: PARASITIC PROTOZOA**

Life history and pathogenicity of *Entamoeba histolytica*, *Plasmodium vivax* and *Trypanosoma gambiense*

**UNIT 5: PARASITIC HELMINTHES**

Life history and pathogenicity of *Ancylostoma duodenale* and *Wuchereria bancrofti*

**UNIT 6: INSECTS OF ECONOMIC IMPORTANCE**

Biology, Control and damage caused by *Helicoverpa armigera*, *Pyrilla perpusilla* and

*Papilio demoleus, Callosobruchus chinensis, Sitophilus oryzae and Tribolium castaneum*

#### **UNIT 7: INSECTS OF MEDICAL IMPORTANCE**

Medical importance and control of *Pediculus humanus corporis*,  
*Anopheles*, *Culex*, *Aedes*, *Xenopsylla cheopis*

#### **UNIT 8: ANIMAL HUSBANDRY**

Preservation and artificial insemination in cattle; Induction of early puberty and synchronization of estrus in cattle

#### **UNIT 9: POULTRY FARMING**

Principles of poultry breeding, Management of breeding stock and broilers, Processing and preservation of eggs

#### **UNIT 10: FISH TECHNOLOGY**

Genetic improvements in aquaculture industry; Induced breeding and transportation of fish seed

#### **COURSE CONTENT: PRACTICAL**

**CREDITS: 2**

1. Study of *Plasmodium vivax*, *Entamoeba histolytica*, *Trypanosoma gambiense*, *Ancylostoma duodenale* and *Wuchereria bancrofti* and their life stages through permanent slides/photomicrographs or specimens.
2. Study of arthropod vectors associated with human diseases: *Pediculus*, *Culex*, *Anopheles*, *Aedes* and *Xenopsylla*.
3. Study of insect damage to different plant parts/stored grains through damaged products/photographs.
4. Identifying feature and economic importance of *Helicoverpa (Heliothis) armigera*, *Papilio demoleus*, *Pyrilla perpusilla*, *Callosobruchus chinensis*, *Sitophilus oryzae* and *Tribolium castaneum*
5. Visit to poultry farm or animal breeding centre. Submission of visit report
6. Maintenance of fresh water aquarium
7. Collection of local ornamental fishes, agricultural pests,



## SUGGESTED READINGS

- Park, K. (2007). *Preventive and Social Medicine*. XVI Edition. B.B Publishers.
- Arora, D. Rand Arora,B.(2001).*Medical Parasitology*. II Edition. CBS Publications and Distributors.
- Kumar and Corton. *Pathological Basis of Diseases*.
- Atwal, A.S. (1986). *Agricultural Pests of India and South East Asia*, Kalyani Publishers.
- Dennis, H. (2009). *Agricultural Entomology*. Timber Press (OR).
- Hafez,E.S.E.(1962). *Reproduction in Farm Animals*. Lea & Fabiger Publisher
- Dunham R.A. (2004). *Aquaculture and Fisheries Biotechnology Genetic Approaches*.

**B.SC. (REGULAR) IN ZOOLOGY**  
**SEMESTER-VI**  
**INSECT, VECTORS AND DISEASES**  
**PAPER CODE: ZOOL- HGE/RCC -6016**  
**PAPER CREDIT: 06 (4T+2P)**

**Total Marks: 100 (T60+IA20+P20) T: Theory, IA: internal Assessment, P: Practical**

### Objectives:

- The main objective of this course is to strengthen the knowledge of undergraduate students on emerging vector born diseases, vectors and their role in transmission and measures to control their populations to mitigate the spread of these diseases.

### LEARNING OUTCOMES:

After completion of this course students will be able to

- describe about of different groups like dipteran, siphonaptera, sipunculata, hemiptera and the diseases transmitted by them.
- describe about vector adaptations, host vector relationship, vectorial capacity etc.

### COURSE CONTENT: THEORY

**CREDITS: 4**

#### UNIT I: INTRODUCTION TO INSECTS

General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts with respect to feeding habits

## **UNIT II: CONCEPT OF VECTORS**

Brief introduction of Carrier and Vectors (mechanical and biological vector), Reservoirs, Host-vector relationship, vectorial capacity, Adaptations as vectors, Host Specificity

## **UNIT III: INSECTS AS VECTORS**

Classification of insects up to orders, detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera

## **UNIT IV: DIPTERAN AS DISEASE VECTORS**

Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies; Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis; Control of mosquitoes, Study of sand fly-borne diseases – Visceral Leishmaniasis, Cutaneous Leishmaniasis, Phlebotomus fever; Control of Sand fly, Study of house fly as important mechanical vector, Myiasis, Control of house fly

## **UNIT V: SIPHONAPTERA AS DISEASE VECTORS**

Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases– Plague, Typhus fever; Control of fleas

## **UNIT VI: SIPHUNCULATA AS DISEASE VECTORS**

Human louse (Head, Body and Pubic louse) as important insect vectors; Study of louse-borne diseases –Typhus fever, Relapsing fever, Trench fever, Vagabond's disease, Phthiriasis; Control of human louse

## **UNIT VII: HEMPIPTERA AS DISEASE VECTORS**

Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures

## **COURSE CONTENT: PRACTICAL**

**CREDITS: 2**

1. Study of different kinds of mouth parts of insects
2. Study of following insect vectors through permanent slides/ photographs: *Aedes*, *Culex*, *Anopheles*, *Pediculus human uscapitis*, *Pediculus human uscorporis*, *Phithirus pubis*, *Xenopsylla cheopis*, *Cimex lectularius*, *Phlebotomus argentipes*, *Musca domestica*, through permanent slides/ photographs
3. Study of different diseases transmitted by above insect vectors

4. Collection and submission of disease vectors with special reference to insects
5. Submission of a project report on any one of the insect vectors and disease transmitted

### **SUGGESTED READINGS**

- Imms, A.D. (1977). A General Text Book of Entomology. Chapman & Hall, UK
- Chapman, R.F. (1998). The Insects: Structure and Function. IV Edition, Cambridge University Press, UK
- Pedigo L.P. (2002). Entomology and Pest Management. Prentice Hall Publication
- Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell SK

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## **SKILL ENHANCEMENT COURSE**

### **SEMESTER-IV**

#### **PAPER CODE: ZOOL-SEC-3014 (ORNAMENTAL FISH & FISHERIES)**

**Paper Credit: 4**

**Total no. of Lectures (L+P): 60**

**Total Marks: 100 (T60+A20 + P20)**

#### **Objectives:**

1. To make students learn about the potential of ornamental fish industry
2. To explore taxonomy, management and biology of ornamental fishes

**Learning outcome:** Students will be able to-

1. Identify ornamental fishes of the region and set up and maintain aquarium
2. Prepare food and culture of ornamental fishes
3. Explore business opportunities with ornamental fishes from Assam

#### **CONTENTS – THEORY:**

**UNIT 1:** Ornamental Fish Diversity of North East India.

**UNIT 2:** Aquarium plant diversity in the wetland of Assam.

**UNIT 3:** Construction and management of Home Aquarium.

**UNIT 4:** Natural feed of Ornamental Fish

**UNIT 5:** Strategies for maintenance of natural colour of Ornamental Fish

**UNIT 6:** Natural Breeding of Tricogaster species

**UNIT 7:** Health management of Ornamental Fish

**UNIT 8:** Feed formulation of Ornamental Fish

**UNIT 9:** Development of Biological filtration in Aquarium

**UNIT 10:** Pure culture of planktons

**UNIT 11:** Ornamental fish culture and entrepreneurship development

#### **PRACTICAL:**

**UNIT 1:** Identification of Ornamental Fish

**UNIT 2:** Culture of Indigenous ornamental fish in Aquarium

**UNIT 3:** Estimation of Physico-chemical characteristics of Aquarium water

**UNIT 4:** Biological filter for removal of Ammonia from Aquarium

**UNIT 5:** Culture of Planktons

**UNIT 6:** Culture of Tubifex

## SUGGESTED READINGS:

- Handbook of Fisheries and Aquaculture, ICAR, New Delhi.
- Ornamental Aquarium Fish of India by [Kishori Tekriwal](#), [Andrew Arunava Rao](#), [John Dawes](#), Kingdom Books.
- A Text book of Fish Biology and Fisheries, S.S. Khanna and H.R. Singh, Narendra Publishing House.
- Fish and Fisheries of India, V. G. Jhingran, Hindustan pub. Corp.
- A Handbook of Fish Biology and Indian Fisheries, R.P. Parihaar, Central Publishing House.

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## SKILL ENHANCEMENT COURSE

**SEMESTER-IV**  
**PAPER CODE: ZOOL-SEC-4014**  
**NON-MULBERRY SERICULTURE**  
**Paper Credit: 4**

**Total no. of Lectures (L+P): 60      Total Marks: 100 (T60+A20 + P20)**

### Objectives:

1. Learning history and present status of Mulberry and Non-Mulberry Sericulture, varieties of silk.
2. Learning biology, life history, food plants and rearing of non-mulberry silkworms.
3. Acquainting pests and diseases of silkworm.
4. Learning non-mulberry silk products and Entrepreneurship development.

### Learning outcome:

Students will learn about:

1. Non-mulberry silk worm diversity and rearing.
2. Non-mulberry silkworm food plants cultivation.
3. Management of Pests and diseases of non-mulberry silk worm.
4. Various process involved in non-mulberry silk production.

## **CONTENTS – THEORY:**

**UNIT 1: Introduction:** Sericulture, Definition, history and present status of Mulberry and Non-Mulberry Sericulture; Silk route, Varieties of Silk; Types and distribution of non-mulberry or wild or vanyasericigenous insects in N-E India

**UNIT 2: Biology of Non-mulberry Silkworm:** Life cycle of silkworm: Eri and Muga  
Structure of silk gland and Nature of Silk

**UNIT 3: Rearing of Silkworms (Eri and Muga Silkworm):** Food plants of Eri and Muga Silkworm; **Rearing Operation:** Rearing house/Site and rearing appliances. **Disinfectants:** Formalin, bleaching powder. **Rearing technology:** Early age and Late age rearing Environmental conditions in rearing-Temperature, Humidity, Light and Air Types of mountages. Harvesting and storage of cocoons Spinning and Reeling of silk.

**UNIT 4: Pests and Diseases:** Pests of eri and muga silkworm, Pathogenesis of eri and muga silkworm diseases: Protozoan, viral, fungal and bacterial; Prevention and control measures of pests and diseases.

**UNIT 5: Entrepreneurship in Non-Mulberry Sericulture:** Varieties of Non-Mulberry Silk products and economics in India, Prospects of Non-Mulberry Sericulture in India: Non-Mulberry Sericulture industry in different states, employment generation and potential.

## **PRACTICAL:**

**UNIT 1:** Identification of larval and adult stages of different varieties of silkworms

**UNIT 2:** Study the life history of silkworms (Eri and Muga)

**UNIT 3:** Study the primary and secondary food plants of silkworm (Eri & Muga)

**UNIT 4:** Study the different diseases of silkworm through permanent slide/model/photographs

**UNIT 5:** Study the pest, predator and parasitoids of silkworm.

**UNIT 6:** Study the silk gland of silkworm through model/photographs (Dissection of the silk gland of eri and mulberry silkworm if specimens are available)

**UNIT 7:** Visit to Govt. /Private sericulture farm and preparation of report.

## **SUGGESTED READINGS:**

- Jolly, M. S., S. K. Sen, T.N. Sonwalkar and G.K. Prashad 1979. Non-Mulberry Sericulture. in: Manual of Sericulture, Rome, FAO, 4 (29)

- Chowdhury, S.N. 1981. Muga Silk Industry. Directorate of Sericulture, Govt. of Assam, Guwahati 781005, Assam.
- Chowdhury, S.N. 1982. Eri Silk Industry. Directorate of Sericulture, Govt. of Assam, Guwahati 781005, Assam.
- Chowdhury, S.N. 1992. Silk and Sericulture. Directorate of Sericulture and Weaving, Govt. of Assam, Guwahati-781005, Assam
- Chutia, B. C., Rajkhowa, R. and Goswami, B. 2020. Non-Mulberry Sericulture, Assam Book Depot (p) ltd. Assam

## **SKILL ENHANCEMENT COURSE**

### **SEMESTER-IV** **PAPER CODE: ZOOL-SEC-6014** **(APICULTURE)** **Paper Credit: 4**

**Total No. of Lectures (L+P): 60**

**Total Marks: 100 (T60+A20 + P20)**

#### **Objectives:**

2. To inoculate the importance of honey bee & honey bee culture along with the different products of honey bee in relation to entrepreneurship development.
3. To give students knowledge about various techniques of bee keeping and modern methods of honey extraction and honey keeping to make them self sustainable after graduation.
4. To teach techniques of bee hive construction and maintenance
5. To make aware of health issues of honey bee.

#### **Learning outcome:**

Students will learn about:

5. Biology and social organization of honey bee, selection of bee species & methods of bee rearing and necessary equipments.
6. Diseases, health issues & enemies of honey bee.
7. Bee hive construction and maintenance, honey extraction & preservation.
8. Different byproducts of bee industry and modern methods of bee culture for development of entrepreneurship.

## **CONTENTS – THEORY:**

**UNIT 1: Biology of Bees:** History, Classification and Biology of Honey Bees, Social organization of Bee colony

**UNIT 2: Rearing of Bees:** Artificial Bee rearing (Apiary), Beehives-Newton and Langstroth Bee Pasturage, Selection of Bee species for Apiculture, Bee keeping Equipment Methods of extraction of Honey (Indigenous and modern)

**UNIT 3: Diseases and Enemies** Bee diseases and enemies  
Control and preventive measures

**UNIT 4: Bee Economy** Products of Apiculture industry and its uses (Honey, Bees Was, Propolis), pollen etc.

**UNIT 5: Entrepreneurship in Apiculture** Bee keeping Industry-Recent efforts, Modern methods in employing artificial Beehives for cross pollination in horticultural gardens

## **PRACTICAL:**

**UNIT 1:** Identification of different cultivable species of honey bee in North East India

**UNIT 2:** Identification of different castes of honey bee

**UNIT 3:** Slide preparation: Antennae, legs, mouthparts of honey bee

**UNIT 4:** Dissection and temporary mounting-Salivary gland of honey bee

**UNIT 5:** Dissection: Sting apparatus in honey bee

**UNIT 6:** Construction and maintenance of honey bee hive

## **SUGGESTED READINGS:**

- Prost, P.J. (1962). *Apiculture*. Oxford and IBH, New Delhi
- Bisht, D.S., *Apiculture*, ICAR Publication
- Singh S., *Bee keeping in India*, ICAR, New Delhi
- Rahman Atuar., *Apiculture in India*, ICAR New Delhi
- Rao, S.K. & Rawat, Sanjana., *Economic Importance of Apiculture*, Campus Books International

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