

UNIVERSITY OF KALYANI



**NEP 2020 CURRICULUM FOR THREE/FOUR YEARS
UNDER-GRADUATE COURSE IN
ZOOLOGY (HONOURS)**

**– SYLLABUS OF COURSES TO BE OFFERED –
Discipline-specific Core (DSC),
Multidisciplinary Course (MDC),
Skill Enhancement Course (SEC), and
Value Added Course (VAC)**

**COURSES EFFECTIVE FROM THE ACADEMIC SESSION
2023-24**

Syllabus of 3-Year Degree/4-Year Honors in Zoology
National Education Policy-2020
With effect from 2023-2024

Semester 1: Total Credits – 20; Total Class Hours – 25; Total Award – 265.							
Course Code	Course title	Name of the course	Credit of course	Class hours/week	Evaluation	Internal Assessment	Total
ZOO-MJ-T-101	Taxonomy and Introduction to Non-chordates	Major (Theory)	4	4	40	15	75
ZOO-MJ-P-101	Taxonomy and Introduction to Non-chordates Lab	Major (Practical)	2	4	20		
ZOO-MI-T-101	Basic idea of animal diversity and taxonomy	Minor-1(Theory)	3	3	25	10	50
ZOO-MI-P-101	Basic idea of animal diversity and taxonomy Lab	Minor-1(Practical)	1	2	15		
ZOO-MDC-1	Biodiversity, Wildlife Conservation and Ecotourism	Multidisciplinary course	3	3	35	10 (Field Study)	45
ZOO-SEC-1	Introduction to Sericulture	Skill Enhancement course	3	3	35	10 (Field Study)	45
ZOO-VAC-1	Environmental Education	Value Added course	4	4	40	10	50
Total			20	25			265

Syllabus of 3-Year Degree/4-Year Honors in Zoology
National Education Policy-2020
With effect from 2023-2024

Semester 2: Total Credits – 20; Total Class Hours – 23; Total Award – 265.							
Course Code	Course title	Name of the course	Credit of course	Class hours/week	Evaluation	Internal Assessment	Total
ZOO-MJ-T-201	Introduction to Chordate Diversity and its zoogeographical distribution	Major (Theory)	4	4	40	15	75
ZOO-MJ-P-201	Introduction to Chordate Diversity and its zoogeographical distribution Lab	Major (Practical)	2	4	20		
ZOO-MI-T-201	Comparative anatomy, Developmental Biology and Ecology	Minor-2 (Theory)	3	3	25	10	50
ZOO-MI-P-201	Comparative anatomy, Developmental Biology and Ecology Lab	Minor-2 (Practical)	1	2	15		
ZOO-MDC-2	Economic Zoology and Entrepreneurship	Multidisciplinary course	3	3	35	10 (Field Study)	45
ZOO-SEC-2	Basic concept of Aquaculture, Induced breeding and Integrated fish farming	Skill Enhancement course	3	3	35	10 (Field Study)	45
AEC	Communicative English	Ability Enhancement course	4	4	40	10	50
Summer Course	Summer Internship	(Additional for Certificate/ Diploma)					
Total			20	23			265

Full marks of a course, having 6 credits/ 2credits, along with distribution of marks:

Full marks of each course of B.Sc. (Hons.), carrying **6 credits**, be **75**

Full marks of each course B.Sc. (Hons.), carrying **2 credits**, be **50**

For practical, distribution of 75 marks be as follows:

Class **Attendance cum Internal Assessment: 20% of 75 marks = 15 marks** of which 5 marks be reserved for theoretical class attendance in the following manner:

Attendance **50% & above but below 60%** - **2** marks

Attendance **60% & above but below 75%** - **3** marks

Attendance **75% & above but below 90%** - **4** marks

Attendance **90% & above** - **5** marks

and **10 marks** be reserved for **class test/ assignment/ seminar** (theoretical -5 & practical - 5).

Semester-end-Practical Examination of each course = **20 marks**, distribution of which may be as under:

a) Lab. Note Book = 05

b) Viva- voce = 05

c) Experiment = 10

Semester-end-Theoretical Examination of each course = **40 marks**, distribution of which may be as under:

a) Answer 05 questions out of 08 carrying 02 marks each = $05 \times 02 = 10$

b) Answer 02 questions out of 04 carrying 05 marks each = $02 \times 05 = 10$

c) Answer 02 questions out of 04 carrying 10 marks each = $02 \times 10 = 20$

However, questions, carrying 5 or 10 marks, need not necessarily to be a single question.

Distribution of 50 marks (for each SEC) be as follows:

Internal Assessment: 20% of 50 marks = **10 marks** be reserved for **class test/ assignment/ seminar**.

40 marks be allotted for Semester-end-Theoretical Examination of each course, distribution of which may be as under:

a) Answer 05 questions out of 08 carrying 02 marks each = $05 \times 02 = 10$

b) Answer 02 questions out of 04 carrying 05 marks each = $02 \times 05 = 10$

c) Answer 02 questions out of 04 carrying 10 marks each = $02 \times 10 = 20$

However, questions, carrying 5 or 10 marks, need not necessarily to be a single question.

ZOOL-MJ-T-101: 13 Modules, 4 Class Hours/week

Semester	Course Name	Course Detail	Credits	Total Award
I	ZOO-MJ-T-101	Taxonomy and Introduction to Non-chordates	4	40+20+15 = 75
	ZOO-MJ-P-101	Taxonomy and Introduction to Non-chordates Lab	2	

OBJECTIVES OF THE STUDY: The main objective of this syllabus is to acquaint the students about the taxonomy of animals and diversity and special features of invertebrates.

Module 1: Basics of Animal Classification

Classification, Systematics and Taxonomy; Hierarchy, Types, Nomenclature; Priority; Synonymy, Homonymy. Biological species concept. Basic principles of differentiating among animal phyla – body plan, symmetry, coelom, germ layers, metamerism, body temperature, mode of nutrition. Distinguishing features of major phyla (non-chordates) classes (Chordates), scheme of classification.

Module 2: Protista

Protozoa: General characteristics and schematic classification up to phylum (Levine et al. 1980); Locomotion in *Amoeba*, Conjugation in *Paramecium*.

Module 3: Porifera

General characteristics and schematic classification up to order (Hyman,1951); Canal system and spicules of sponges.

Module 4: Cnidaria

General characteristics and schematic classification up to class (Ruppert and Barnes.1994); Metagenesis of *Obelia*, Coral reef types and formation.

Module 5: Ctenophora

General characteristics and schematic classification up to class (Ruppert and Barnes.1994).

Module 6: Platyhelminthes

General characteristics and schematic classification up to class (Ruppert and Barnes.1994).

Module 7: Aschelminthes

General characteristics and schematic classification up to class (Ruppert and Barnes.1994).

Module 8: Annelida

General characteristics and schematic classification up to class (Ruppert and Barnes1994); Metamerism in Annelida; Nephridia: Structure and function.

Module 9: Arthropoda

General characteristics and schematic classification up to class (Ruppert and Barnes1994); Vision in insects, Metamorphosis in Lepidopteran insect.

Module 10: Onychophora

Evolutionary Significance.

Module 11: Mollusca

General characteristics and schematic classification up to class (Ruppert and Barnes1994); Modification of foot; Nervous system and torsion in Gastropoda.

Module 12: Echinodermata

General characteristics and schematic classification up to class (Ruppert and Barnes1994); Water vascular system of *Asteroidea*; Structure of tube feet.

Module 12: Echinodermata

General characteristics and schematic classification up to class (Ruppert and Barnes1994); Water vascular system of *Asteroidea*; Structure of tube feet.

Module 13: Hemichordata

General characteristics and schematic classification up to class (Ruppert and Barnes 1994); Relationship with nonchordates and chordates.

COURSE OUTCOME: Knowledge of Taxonomic principles and special features of non-chordates.

ZOOL-MJ-P-101: 4 Class Hours/week

Identification (upto subclass); Protista: *Amoeba*, *Euglena*, *Entamoeba*, *Opalina*, *Paramecium*, *Plasmodium vivax* and/or *Plasmodium falciparum* (from the prepared slides); Pseudocoelomata: *Sycon*, Neptune's Cup, *Obelia*, *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium*, *Pennatula*, *Fungia*, *Meandrina*, *Madrepora*; Coelomata: parasitic adaptations of adult *Fasciola hepatica*, *Taenia solium* and *Ascaris lumbricoides*.

Preparation of dichotomous key for identification of poisonous and non-poisonous snakes.

Staining/mounting of any protozoa/helminth from gut of cockroach.

References and Suggested Texts

1. Anderson, D. T. (Ed.) (2001). Invertebrate Zoology. 2nd Ed. Oxford University Press.
2. Barnes, R. D. and Ruppert, E. E., (1994). Invertebrate Zoology. 6th Ed. Brooks Cole.
3. Barrington, E. J. W. (1981). Invertebrate Structure and function. 2nd Ed. ELBS and Nelson.
4. Blackwelder, R. E., (1967). Taxonomy- A text and reference book. John Wiley and Sons.
5. Brusca, R. C. and Brusca, G. J. (2002). Invertebrates. 4th Ed. Sinauer Associates...
6. Dhami P.S and J.K. Dhami – Invertebrate Zoology – S. Chand and Co.
7. Hickman, C.P. Jr., F.M. Hickman and L.S. Roberts, 1984. Integrated Principles of Zoology, 7th Edition, Times Mirror/Mosby College Publication. St. Louis. 1065pp.
8. Hyman, L. H. (1951). The Invertebrates (Vol-I). McGraw-Hill Book Company.
9. Jordan, E. L. and Verma, P. S. (2006). Invertebrate Zoology. S. Chand and Company Ltd. New Delhi.
10. Kapoor, V. C. (2008). Theory and practice of animal taxonomy. 6th Ed. Oxford and IBH Pub
11. Kotpal, R.L., 1988 – 1992. (All Series) Protozoa, Porifera, Coelenterata, Annelida, Arthropoda, Mollusca, Echinodermata, – Rastogi Publications, Meerut – 250 002.
12. Mayr, E. (1969). Principles of Systematic Zoology. Tata McGraw-Hill.
13. Mayr, E. and Ashlock, P. D. (1991). Principles of Systematic Zoology. 2nd Ed., McGraw-Hill.
14. Meglitsch, P. A. and Schram, F. R. (1991). Invertebrate Zoology. Oxford University Press.
15. Chaki, Kundu, Sarkar. Introduction to General Zoology . Vol 1. New Central Book Agency (P) LTD.
16. Parker, T. J. and Haswell, W. (1972). Text Book of Zoology, Volume I. Macmillan Press, London.
17. Pechenik, J. A. (1998). Biology of the Invertebrates, 4th Ed. McGraw Hill..
18. Ruppert E. E., Fox, R. and Barnes R. D. (2003). Invertebrate Zoology: a Functional Evolutionary Approach. 7th Ed. Brooks Cole.
19. Sinha, K. S., Adhikari, S., and Ganguly, B. B. Biology of Animals. Vol. I. New Central Book Agency. Kolkata.

ZOOL-MI-T-101: 16 Modules, 3 Class Hours/week

Semester	Course Name	Course Detail	Credits	Total Award
I	ZOO-MI-T-101	Basic idea of animal diversity and taxonomy	3	25+15+10 = 50
	ZOO-MI-P-101	Basic idea of animal diversity and taxonomy Lab	1	

OBJECTIVES OF THE STUDY: The main objective of this syllabus is to acquaint the students about the taxonomy of animals and diversity and special features of invertebrates and chordates.

Module 1: Basics of Animal Classification

Systematics, taxonomy, classification; Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy.

Module 2: Protista

Protozoa. Outline of classification (salient features and classification scheme upto phylum only); Locomotion in *Amoeba*; Conjugation in *Paramecium*; Life cycle and pathogenicity of *Entamoeba histolytica*.

Module 3: Porifera

Outline of classification (salient features and classification scheme upto class only). Canal system in sponges.

Module 4: Cnidaria

Outline of classification (salient features and classification scheme upto class only).

Metagenesis in *Obelia*.

Module 5: Platyhelminthes

Outline of classification (salient features and classification scheme upto class only). Life cycle and pathogenicity and control measures of *Fasciola hepatica*.

Module 6: Nematoda

Outline of classification (salient features and classification scheme upto class only). Life cycle, and pathogenicity and control measures of *Ascaris lumbricoides*.

Module 7: Annelida

Outline of classification (salient features and classification scheme upto class only). Excretion in Annelida through nephridia.

Module 8: Arthropoda

Outline of classification (salient features and classification scheme upto class only). Social life in termite.

Module 9: Mollusca

Outline of classification (salient features and classification scheme upto class only). Respiration in *Pila*.

Module 10: Echinodermata

Outline of classification (salient features and classification scheme upto class only). Water-vascular system in Asteroidea.

Module 11: Protochordata

Retgressive metamorphosis in *Ascidia*.

Module 12: Pisces

Outline of classification (salient features and classification scheme upto subclass only). Swim bladder in fishes.

Module 13: Amphibia

Outline of classification (salient features and classification scheme upto order only). Parental care in Amphibia.

Module 14: Reptilia

Outline of classification (salient features and classification scheme upto order only). Poison apparatus and Biting mechanism in Snake.

Module 15: Aves

Outline of classification (salient features and classification scheme upto subclass only).
Exoskeleton and Migration in Birds.

Module 16: Mammalia

Outline of classification (salient features and classification scheme upto infraclass only).
Exoskeletal derivatives of mammals.

COURSE OUTCOME: Knowledge of the kinds and diversity of living organisms.

Classification scheme to be followed from Levine for Protozoa, Ruppert and Barnes for other Invertebrates and Young for Vertebrates.

References and Suggested Texts

1. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition
2. The Invertebrates: A New Synthesis, III Edition, Blackwell Science
3. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
4. Parker, T. J. & Haswell, W. (1972). Text Book of Zoology, Volume II: Marshall and Willam (Eds.) 7th Ed. Macmillan Press, London.
5. Jordan, E.L. & Verma, P.S. (2003). Chordate Zoology. S. Chand & Company Ltd. New Delhi.
6. Sinha, K. S., Adhikari, S., Ganguly, B. B. & Bharati Goswami, B. D. (2001). Biology of Animals. Vol. II. New Central Book Agency (P) Ltd.

ZOOL-MI-P-101: 2 Class Hours/week

1. Identification of:
 - a. Porifera - *Sycon*, *Obelia*, *Physalia*, *Corallium*, *Metridium*, *Pennatula*.
 - b. Annelids - *Nereis*, *Pheretima*, *Hirudinaria*.
 - c. Arthropods – *Limulus*, *Palaemon*, *Eupagurus*, *Scolopendra*, *Bombyx*, *Periplaneta*, termites and honey bees.
 - d. Onychophora – *Peripatus*.
 - e. Molluscs - *Pila*, *Sepia*.
 - f. Echinodermata - *Asterias*, *Echinus*.
 - g. Protochordata – *Balanoglossus*.
 - h. Fishes - *Sphyrna*, *Torpedo*, *Labeo*, *Exocoetus*, *Echeneis*, *Hippocampus*.
 - i. Amphibia - *Hyla*, *Tylotriton*.
 - j. Reptilia - *Trionyx*, *Hemidactylus*, *Chamaeleon*, *Draco*, *Naja*.
 - k. Mammalia: Bat
2. Pecten from Fowl head
3. Dissection of brain and pituitary of Rohu/Catla/Mrigal
4. Identification and significance of adult *Fasciola hepatica*, and *Ascaris lumbricoides*

Identification upto Subclass in invertebrates and upto Order in vertebrates, with labeled diagrams, systematic position and characters, in Lab Notebook.

ZOOL-MDC-1: 9 Modules, 3 Class Hours/week

Semester	Course Name	Course Detail	Credits	Total Award
I	ZOO-MDC-1	Biodiversity, Wildlife Conservation and Ecotourism	3	35+10 (Field Study) = 45

OBJECTIVES OF THE STUDY: The main objective of this syllabus is to acquaint the students about the importance of biodiversity and conservation and the need to promote sustainable ecotourism.

Module 1: Introduction to Biodiversity and Conservation

Biodiversity – definition, types and importance; Biodiversity hotspots – Global and Indian; Megabiodiversity countries; Biodiversity Act, Biopiracy and Bioprospecting; IPR; Convention on Biological Diversity; National Biodiversity Authority; Brief introduction to Conservation: Importance of conservation – *in-situ* and *ex-situ*; Causes of depletion.

Module 2: Evaluation and management of wild life

Habitat analysis: Physical parameters – Topography, soil and water; Biological Parameters – food and cover estimation; Brief idea on remote sensing and GIS in wildlife status estimation.

Module 3: Management of habitats

Setting back succession; Advancing the successional process; Cover construction; Restoration of degraded habitats.

Module 4: Population estimation

Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation; Faecal analysis of ungulates and carnivores; Pug marks and census method.

Module 5: Management planning of wild life in protected areas

Estimation of carrying capacity; Eco tourism / wild life tourism in forests.

Module 6: Man and Wildlife

Causes and consequences of human-wildlife conflicts.

Module 8: Protected areas

National parks & sanctuaries. Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve.

Module 9: Experiencing Wildlife

Visiting any National Park/Sanctuary/Reserve Forest/Zoo/Biodiversity Park.

COURSE OUTCOME: Idea of the biodiversity resources of our country.

References and Suggested Texts

1. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
2. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence? Cambridge University.
3. Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5 th edition. The Wildlife Society, Allen Press.
4. Sutherland, W.J. (2000). The Conservation Handbook: Research, Management and Policy. Blackwell Sciences
5. 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.

ZOOL-SEC-1: 5 Modules, 3 Class Hours/week

Semester	Course Name	Course Detail	Credits	Total Award
I	ZOO-SEC-1	Introduction to Sericulture	3	35+10 (Field Study) = 45

OBJECTIVES OF THE STUDY: The main objective of framing this new syllabus is to give the students a proper understanding of Sericulture. Students will get knowledge about mulberry plant cultivation, different silkworms, culture techniques, silk production, and the knowledge of diseases and enemies of silkworms. Students can utilize the knowledge in starting their own enterprise after completion of the course.

Module 1: Introduction

Types of silkworms, Distribution and Races; Exotic and indigenous races; Mulberry and non-mulberry Sericulture. Mulberry plant cultivation.

Module 2: Biology of Silkworm

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

Module 3: Rearing of Silkworms

Rearing house and rearing appliances; Disinfectants: Formalin, bleaching powder; Silkworm rearing technology: Early age and Late age rearing; Types of mountages; Spinning, harvesting and storage of cocoons.

Module 4: Pests and Diseases

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

Module 5: Entrepreneurship in Sericulture

Sericulture as a source of employment and livelihood; The role of Central Silk Board in supporting and guiding entrepreneurship; Visit to a sericulture farm and submission of report.

COURSE OUTCOME: Knowledge of sericulture as a livelihood.

ZOOL-MJ-T-201: 10 Modules, 4 Class Hours/week

Semester	Course Name	Course Detail	Credits	Total Award
II	ZOO-MJ-T-201	Introduction to Chordate Diversity and its zoogeographical distribution	4	40+20+15 = 75
	ZOO-MJ-P-201	Introduction to Chordate Diversity and its zoogeographical distribution Lab	2	

OBJECTIVES OF THE STUDY: This course is carefully drafted and tailor made to give a comprehensive knowledge of diversity of chordates along with their origin, key features, classification, distribution and functioning.

Module 1: Introduction to Chordates

General characteristics and outline classification of Phylum Chordata upto living subclasses.

Module 2: Origin of Chordata

Dipleurula concept and the Echinoderm theory of origin of chordates.

Module 3: Origin of Chordata

General characteristics and classification of sub-phylum Urochordata and Cephalochordata up to Classes; Retrogressive metamorphosis in *Ascidia*; Feeding mechanism in *Branchiostoma*.

Module 4: Agnatha

General characteristics and classification of cyclostomes up to subclass.

Module 5: Pisces

General characteristics and classification of Chondrichthyes and Osteichthyes up to Subclasses; Accessory respiratory organ and swim bladder in fishes; Migration and parental care in fishes.

Module 6: Amphibia

General characteristics and classification up to living Orders; Metamorphosis and parental care in Amphibia..

Module 7: Reptilia

General characteristics and classification up to living Orders; Poison apparatus and Biting mechanism in Snake.

Module 8: Aves

General characteristics and classification up to Sub-Classes; Migration in Birds; Principles and aerodynamics of flight.

Module 9: Mammals

General characters and classification up to living infra-class; Affinities of Prototheria; Echolocation in Micro chiropterans-

Module 10: Zoogeography

Zoogeographical realms; Plate tectonic and Continental drift theory; Distribution of birds and mammals in different realms

COURSE OUTCOME: With this course students will have idea about diversity, organization, adaptation and taxonomic status of chordates. The course will give the understanding of the affinities of chordates with other groups.

References and Suggested Texts

1. Young J. Z. (2004). The Life of Vertebrates. III Edition. Oxford University Press.
2. Pough H. Vertebrate life, VIII Edition, Pearson International.
3. Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.
4. Hall B.K. and Hallgrímsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
5. Parker, T. J. & Haswell, W. (1972). Text Book of Zoology, Volume II: Marshall and William (Eds.) 7th Ed. Macmillan Press, London.
6. Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata

McGraw Hill.

7. Kent, G. C. & Carr, R. K. (2001). Comparative anatomy of the Vertebrates. 9th ed., McGraw Hill.
8. Nelson, J.S., (2006) : Fishes of the World, 4th edn., Wiley.
9. Romer, A. S. & Parsons, T. S. (1986). The vertebrate body. 6th Ed. Saunders College Publishing.
10. Jordan, E.L. and Verma, P.S. (2003). Chordate Zoology. S. Chand & Company Ltd. New Delhi.
11. Sinha, K. S., Adhikari, S., Ganguly, B. B. & Bharati Goswami, B. C. (2001). Biology of Animals. Vol. II. New Central Book Agency (P) Ltd.
12. Futuyma, D. (1997). Evolutionary Biology. 3rd ed. Sinauer Associates, INC.

Note: Classifications to be followed from Young (1981).

ZOOL-MJ-P-201: 4 Class Hours/week

Identification of

1. Protochordata: *Balanoglossus*, *Branchiostoma*
2. Agnatha: *Petromyzon* or *Myxine*
3. Fishes: *Scoliodon*, *Sphyrna*, *Torpedo*, *Mystus*, *Heteropneustes*, *Labeo*, *Exocoetus*, *Echeneis*, *Anguilla*, *Hippocampus*, *Tetrodon/ Diodon*, *Anabas*, Flat fish
4. Amphibia: *Bufo*, *Hyla*, *Axolotl*, *Tylotriton*
5. Reptilia: *Chelone*, *Trionyx*, *Hemidactylus*, *Varanus*, *Chamaeleon*, *Ophiosaurus*, *Draco*, *Vipera*, *Naja*, *Crocodylus*; preparation of dichotomous key for identification of poisonous and non-poisonous snakes
6. Mammalia: Bat (Insectivorous and Frugivorous)
7. Dissection of brain and pituitary of Rohu/Catla/Mrigal
8. Power point presentation on study of any two animals from two different classes by students (may be included if dissections not given permission)

ZOOL-MI-T-201: 9 Modules, 4 Class Hours/week

Semester	Course Name	Course Detail	Credits	Total Award
II	ZOO-MI-T-201	Comparative anatomy and Developmental Biology	3	25+15+10 = 50
	ZOO-MI-P-201	Comparative anatomy and Developmental Biology Lab	1	

OBJECTIVES OF THE STUDY: This course is carefully drafted and tailor made to give a comprehensive knowledge of comparative anatomy, Developmental Biology and Ecology.

Module 1: Integumentary System

Structure, function and derivatives of integument in amphibian, birds and mammals.

Module 2: Skeletal System

Jaw suspension; structure of branchial and visceral arches.

Module 3: Digestive System

Comparative anatomy of stomach; dentition in mammals.

Module 4: Circulatory System

Comparative account of heart and aortic arches.

Module 5: Respiratory System

Respiratory organs in Pisces, Aves and Mammalia.

Module 6: Urinogenital System

Succession of kidney, Types of mammalian uteri.

Module 7: Nervous System

Cranial nerves in mammals.

Module 8: Sense Organs

Classification of receptors, Brief account of auditory receptors in vertebrate.

Module 9: Developmental Biology

Spermatogenesis; Oogenesis; egg types and cleavage; Fertilization.

COURSE OUTCOME: Idea of the basic tenets of relationships among animals.

References and Suggested Texts

- 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
Saxena, R.K. &Saxena, S.C.(2008) : Comparative Anatomy of Vertebrates, Viva Books Pvt. Ltd.
- Gilbert, S.F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
- Slack J.M.W, Essential Developmental Biology.
- 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
Saxena, R.K. &Saxena, S.C.(2008) : Comparative Anatomy of Vertebrates, Viva Books Pvt. Ltd.
- 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

ZOOL-MI-P-201: 2 Class Hours/week

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Study of disarticulated skeleton of Toad/Pigeon/Guineapig.
3. Demonstration of Carapace and plastron of turtle OR Identification of mammalian skulls: One herbivorous (Guineapig) and one carnivorous (Dog) animal.
4. Dissection of Tilapia/carp: Circulatory system/urinogenital system; brain/pituitary.
5. Study of whole mounts of developmental stages of chick through permanent slides: 24, 48, 72, and 96 hours of incubation.

Lab note book, with labelled diagrams and identifications, with reason.

Separate Lab Notebooks for Identification and Ecology.

Separate Field Notebook.

ZOOL-MDC-2: 7 Modules, 3 Class Hours/week

Semester	Course Name	Course Detail	Credits	Total Award
II	ZOO-MDC-2	Economic Zoology and Entrepreneurship	3	35+10 (Field Study) = 45

OBJECTIVES OF THE STUDY: Applied Zoology deals with the application of zoological knowledge for the benefit of mankind. It is a specialized branch of zoology which deals animal world associated with economy, health and welfare of humans. The undergraduate course deals with various topics in compliance with the multidisciplinary nature of economic zoology and with a scientific approach. Topics like fisheries, animal husbandry, pests, sericulture, apiculture, vermicompost shall be covered. This course is UGC approved curriculum for under graduate students of zoology and can also be opted by students of other streams too.

Module 1: Agricultural Entomology

Pest- definition and types (major and minor pests with example); Lifecycle, nature of damage and control of Pests: *Scirpophaga incertulus* of paddy, *Anomis sabulifera* of Jute, Bandicoota– stored house pest; Insect Pest control: Chemical, Mechanical, Cultural and Biological control measures; Integrated Pest Management (IPM).

Module 2: Sericulture

Types of Silkworms with special reference to their scientific name, geographical distribution and host plants; *Bombyx mori*: Silk gland, Composition of silk, Uses of silk; Lifecycle; Rearing, Extraction and Reeling of mulberry silk; Silkworm diseases, pests and their control.

Module 3: Apiculture

Various domesticated species of Honeybee; Social organization of Honeybee; Bee keeping: Langstroth Box for rearing of honey bee, Extraction and processing of honey; Composition of honey, apiculture by products and their uses; Pests and Diseases of bees and their control measures

Module 4: Vermiculture

Scope of Vermiculture; Habit categories of earthworms; methodology of vermicomposting: containers for culturing, raw materials required, preparation of bed, environmental prerequisites, feeding, harvesting and storage of vermicompost; Advantages of vermicomposting; Diseases and pests of earthworms.

Module 5: Aquaculture

Principles, definition and scope; Prawn culture: Penaeid and Palaemonid features with examples; Semi-intensive method of prawn culture; Application of prawn culture; Difference between major and minor carps with examples; Composite fish farming: General concepts, advantages and disadvantages; Induced breeding: method and advantages; Integrated fish farming.

Module 6: Live Stock Management

Dairy: Introduction to common dairy animals: Types of Cattle breeds and their distribution in India; Exotic cattle breeds; Artificial insemination and MOET in breeding; Cattle feed: Roughage and Concentrate; dairy by products, preservation and uses. Dairy pathology and vaccination programme. Poultry: Types of breeds (fowl) with features and examples; Rearing method: Deep litter system; feed formulation for chicks; poultry by products with economic importance; Diseases of poultry and their control measures.

Module 7: Entrepreneurship in Economic Zoology

Economic Zoology as a source of employment and livelihood - visit to a farm or start-up in the field of economic zoology and submission of report.

COURSE OUTCOME: This course offers students an understanding of experiential learning on the methodology of fish culture, sericulture, apiculture, vermicomposting and animal husbandry. This would promote community youth development by encouraging start-ups and enhancement of self-employment.

References and Suggested Texts

1. Atwal, A.S. (1986). Agricultural Pests of India and South-East Asia. 2nd Edition, Kalyani Publishers, New Delhi.
2. Pedigo, L.P. and Rice, M.E. (2009). Entomology and Pest Management. 6th Edition, Pearson Prentice Hall.
3. Shukla, A. (2009) A handbook on Economic Entomology. Daya Publishing House, Delhi
4. Chaudhuri, S. (2017) Economic Zoology, NCBS.
5. Sarkar, S., Kundu, G. Chaki, K.C. (2017) Introduction to Economic Zoology. NCBA
6. Khanna, S.S. and Singh, H.R. (2017) A Text Book of Fish Biology and Fisheries. Narendra Publishing House.
7. Menon, A.G.K. (1999) the Freshwater Fishes of India, A Handbook. Z.S.I
8. Das, M.K. and Das, R.K. (1997) Fish and Prawn Diseases in India- Diagnosis and Control. Inland Fisheries Society in India, Barrackpore, West Bengal.
9. Jhingran, V.G. (2007) Fish and Fisheries of India. Hindustan Publishing Corporation. 3rd Edition.
10. Dunham, R.A. (1985) Aquaculture and Fisheries Biotechnology. Genetic Approaches.
11. Banerjee, G. C. (2021) A Text Book of Animal Husbandry (8th Edition), Oxford and IBH Publishing, New Delhi

ZOOL-SEC-2: 6 Modules, 3 Class Hours/week

Semester	Course Name	Course Detail	Credits	Total Award
II	ZOO-SEC-2	Basic concept of Aquaculture, Induced breeding and Integrated fish farming	3	35+10 (Field Study) = 45

OBJECTIVES OF THE STUDY: To acquaint the students with the aquaculture methods, different systems, non-conventional aquaculture technology, induced breeding and fish pathology.

Module 1: Aquaculture methods

Concept and significance, Different systems of aquaculture for carps and shrimps: Extensive, Semi-intensive, Intensive.

Module 2: Different systems of aquaculture

Monoculture, polyculture; Definition, importance and types of Integrated fish farming.

Module 3: Non-conventional aquaculture technology

Raceways and recirculatory system, Cages and pen culture, Wastewater aquaculture Organic aquaculture, Aquaponics and hydroponics, Biofloc culture.

Module 4: Induced breeding

Induced breeding care of brood fish, secondary sex characters, hypophysation, HCG, pheromones, GnRH, LH-RH and their analogues, new generation drugs, induced breeding and multiple breeding, environmental factors, limitations-inbreeding depressions.

Module 5: Fish pathology

Environment and fish health; fin-fish diseases and their control. Control and prevention of pests and diseases.

Module 6: Entrepreneurship in Aquaculture

Aquaculture as a source of employment and livelihood - visit to an aquaculture farm/lab and submission of report.

Course outcome

1. Students will be exposed to the aquaculture methods, different systems, non-conventional and aquaculture technology.
2. They will get idea about the induced breeding and fish pathology.

References and Suggested Texts

1. Bardach, J. E. and Ryther, J. H. (1972). *Aquaculture*. John Wiley and Sons.
2. Jhingran, V. G. (1991). *Fish and Fisheries of India*. 3rd ed. industhanPub.Corp. John Wiley and Sons.
3. Lowe, H. (2005). *Beginner's Guide to Aquarium Fish and Fish Care*. Abhishek Press, New Delhi.
4. Pillay, T. V. R. and Kutty, M. N. (2005). *Aquaculture Principles and Practices*. 2nd ed. Blackwell Publishing Ltd.
5. De Silva, S. S. and Anderson, T. A. (1995). *Fish Nutrition in Aquaculture*. Chapman and Hall, London.
6. Merrifield, D. L. and Ringó, E. (2014). *Aquaculture Nutrition: Gut Health, Probiotics and Prebiotics*. Wiley-Blackwell.
7. Srivastava, C. B. L. (1999). *Fish Biology*. Narendra Publishing House. New Delhi.