

# UNIVERSITY OF KALYANI



**CURRICULUM BASED ON NEP-2020 GUIDELINES  
FOR THREE/FOUR YEARS  
UNDER-GRADUATE COURSE  
IN ZOOLOGY**

**– SYLLABUS OF COURSES TO BE OFFERED –**

**Major (MJ)**

**Minor (MI)**

**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 as  
per guidelines of National Education Policy-2020  
With effect from 2023-2024**

<b>Semester 1: Total Credits – 20; Total Class Hours – 25; Total Marks – 265.</b>							
<b>Course Code</b>	<b>Course title</b>	<b>Name of the course</b>	<b>Credit of course</b>	<b>Class hours/week</b>	<b>End-Term</b>	<b>Internal Assessment</b>	<b>Total Marks</b>
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	Animal diversity and taxonomy	Minor-1(Theory)	3	3	25	10	50
ZOO-MI-P-101	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	Sericulture	Skill Enhancement course	3	3	35	10 (Field Study)	45
ZOO-VAC-1	Environmental Education	Value Added course	4	4	40	10	50
<b>Total</b>			<b>20</b>	<b>25</b>			<b>265</b>

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

Semester 2: Total Credits – 20; Total Class Hours – 23; Total Marks – 265.							
Course Code	Course title	Name of the course	Credit of course	Class hours/week	End-Term	Internal Assessment	Total Marks
ZOO-MJ-T-201	Chordate Diversity & Zoogeographical Distribution	Major (Theory)	4	4	40	15	75
ZOO-MJ-P-201	Chordate Diversity & Zoogeographical Distribution Lab	Major (Practical)	2	4	20		
ZOO-MI-T-201	Animal diversity and taxonomy	Minor- 1 (Theory)	3	3	25	10	50
ZOO-MI-P-201	Animal diversity and taxonomy Lab	Minor- 1 (Practical)	1	2	15		
ZOO-MDC-2	Economic Zoology and Entrepreneurship	Multidisciplinary course	3	3	35	10 (Field Study)	45
ZOO-SEC-2	Aquaculture	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)	4	(Additional, from external agency/MOOC)			
<b>Total</b>			<b>20</b>	<b>23</b>			<b>265</b>

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

Semester 3: Total Credits – 20; Total Class Hours – 23; Total Marks – 265.							
Course Code	Course title	Name of the course	Credit of course	Class hours/week	End-Term	Internal Assessment	Total Marks
ZOO-MJ-T-301	Ecology and Wildlife Biology	Major (Theory)	4	4	40	15	75
ZOO-MJ-P-301	Ecology and Wildlife Biology Lab	Major (Practical)	2	4	20		
ZOO-MI-T-301	Comparative anatomy, Developmental Biology and Ecology	Minor-2 (Theory)	3	3	25	10	50
ZOO-MI-P-301	Comparative anatomy, Developmental Biology and Ecology Lab	Minor-2 (Practical)	1	2	15		
ZOO-MDC-3	Medical Zoology and Public Health	Multidisciplinary course	3	3	35	10 (Field Study)	45
ZOO-SEC-3	Statistical and Computational Biology	Skill Enhancement course	3	3	35	10	45
AEC	Communicative English	Ability Enhancement course	4	4	40	10	50
<b>Total</b>			<b>20</b>	<b>23</b>			<b>265</b>

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

Semester 4: Total Credits – 20; Total Class Hours – 25; Total Marks – 265.							
Course Code	Course title	Name of the course	Credit of course	Class hours/week	End-Term	Internal Assessment	Total Marks
ZOO-MJ-T-401	Cell Biology	Major 1 (Theory)	4	4	40	15	75
ZOO-MJ-P-401	Cell Biology Lab	Major 1 (Practical)	2	4	20		
ZOO-MJ-T-401	Biochemistry	Major 2 (Theory)	4	4	40	15	75
ZOO-MJ-P-401	Biochemistry Lab	Major 2 (Practical)	2	4	20		
ZOO-MI-T-401	Comparative anatomy, Developmental Biology and Ecology	Minor-2 (Theory)	3	3	25	10	50
ZOO-MI-P-401	Comparative anatomy, Developmental Biology and Ecology Lab	Minor-2 (Practical)	1	2	15		
AEC	Communicative English	Ability Enhancement course	4	4	40	10	50
Summer Course	Summer Internship	(Additional for Certificate/ Diploma)	4	(Additional, from external agency/MOOC)			
<b>Total</b>			<b>20</b>	<b>25</b>			<b>265</b>

**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 **4 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.

**Summer Course/ Internship:**

Summer Course/internship is necessary for exit after either one-year or two-year study. Student should complete an internship of 4 credits for a duration of 1 or 2wks. Hands-on training in any reputed Institute/ Laboratory or any Govt. / Regd. Farm is ideal but equivalence may be granted to completion certificates of online/offline Add-On course/ MOOC/SWAYAM.

**Ability Enhancement Course (AEC):**

Two AEC Courses of 4 credits each need to be completed by the student. Course structure, examination and evaluation will be as communicated by the University.

**ZOO-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.

**Module 2: Protozoa**

**Protozoa:** General characteristics and schematic classification at phylum level; Locomotion in *Amoeba*, Conjugation in *Paramecium*.

**Module 3: Porifera**

General characteristics and schematic classification; Canal system and spicules of sponges.

**Module 4: Cnidaria**

General characteristics and schematic classification; Metagenesis of *Obelia*, Coral reef types and formation.

**Module 5: Ctenophora**

General characteristics and schematic classification.

**Module 6: Platyhelminthes**

General characteristics and schematic classification. Parasitic adaptations.

**Module 7: Nematoda**

General characteristics and schematic classification. Life history of *Ascaris*.

**Module 8: Annelida**

General characteristics and schematic classification; Metamerism in Annelida; Nephridia: Structure and function.

**Module 9: Arthropoda**

General characteristics and schematic classification; Vision in insects, Metamorphosis in Lepidopteran insect.

**Module 10: Onychophora**

Evolutionary Significance.

**Module 11: Mollusca**

General characteristics and schematic classification; Modification of foot; Nervous system in Mollusca and torsion in Gastropoda.

**Module 12: Echinodermata**

General characteristics and schematic classification; Water vascular system of *Asteroidea*; Structure of tube feet.

**Module 13: Hemichordata**

General characteristics and schematic classification; Relationship with nonchordates and chordates.

Classification of Protozoa upto Phylum rank; Classification of Arthropoda upto Class rank; classification of all others upto Subclass rank wherever possible; all classification schemes as per Ruppert and Barnes, 1994.

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



## ZOO-MJ-P-101: 4 Class Hours/week

Identification (rank and scheme as per theoretical syllabus);

Protozoa: *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: Annelids - *Nereis*, *Pheretima*, *Hirudinaria*. Arthropods – *Limulus*, *Palaemon*, *Eupagurus*, *Scolopendra*, *Bombyx*, *Periplaneta*, *termites and honey bees*. Onychophora – *Peripatus*.

Molluscs - *Chiton*, *Unio Pila*, *Sepia*. Echinodermata - *Asterias*, *Echinus*, *Antedon* Hemichordata: *Balanoglossus*

Compilation of Dichotomous key with arthropods.

Adaptations: parasitic adaptations of adult *Fasciola hepatica*, *Taenia solium* and *Ascaris lumbricoides*.

Study of digestive system and nervous system of Earthworm/*Periplaneta*.

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

Submission of Laboratory Note Book.

## 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. Dhama P.S and J.K. Dhama – 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.

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

Semester	Course Name	Course Detail	Credits	Total Award
<b>I</b>	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 non-chordates 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 Ruppert and Barnes for 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.

### ZOO-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. Demonstration of brain and pituitary of Rohu/Catla/Mrigal
4. Identification and significance of adult *Fasciola hepatica*, and *Ascaris lumbricoides*

Identification (rank and scheme as per theoretical syllabus), with labeled diagrams, systematic position and characters, in Lab Notebook.

### ZOO-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.

**ZOO-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.

**ZOO-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).

### ZOO-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*, *Tylototriton*
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. Demonstration 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)

**ZOO-MI-T-201: 16 Modules, 3 Class Hours/week**

Semester	Course Name	Course Detail	Credits	Total Award
<b>II</b>	ZOO-MI-T-201	Basic idea of animal diversity and taxonomy	3	25+15+10 = 50
	ZOO-MI-P-201	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 non-chordates 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**

Retrogressive 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. & BharatiGoswami, B. D. (2001). *Biology of Animals*. Vol. II. New Central Book Agency (P) Ltd.

### ZOO-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.

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 grain and 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

**ZOO-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 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. Hindustan Pub. Corp.
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.

**ZOO-MJ-T-301: 5 Modules, 4 Class Hours/week**

Semester	Course Name	Course Detail	Credits	Total Award
III	ZOO-MJ-T-301	Ecology and Wildlife Biology	4	40+20+15 = 75
	ZOO-MJ-P-301	Ecology and Wildlife Biology Lab	2	

**OBJECTIVES OF THE STUDY:** This course is aimed at introducing the student to the basic principles that govern interrelationships among living organisms and their environment.

**Module 1: Introduction to Ecology**

Levels of organization, Laws of limiting factors, Scope of ecology.

**Module 2: Ecosystem**

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.

**Module 3: Community**

1. Community characteristics: species diversity, abundance, dominance, richness, Vertical stratification, Ecotone and edge effect,
2. Community interactions: Gause's Principle with laboratory and field examples; Lotka-Volterra equation for competition.
3. Ecological succession and Habitat management: Nudation, Pioneer, Seral stages, Climax concept, Modes of succession (in Hydrosere). Setting back succession.

**Module 4: Population**

1. Unique and group attributes of population: Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation; Demographic factors, life tables, fecundity tables, survivorship curves.
2. Geometric, exponential and logistic growth, equation, r and K strategies Population regulation - density-dependent and independent factors.

**Module 5: Conservation biology**

1. Wildlife Conservation; *in-situ* and *ex-situ* conservation. Faecal analysis of ungulates and carnivores; Pug mark census method.
2. Management strategies and challenges for tiger and elephant conservation; Wild life protection acts and amendments (upto 2024) of India.
3. Brief idea on remote sensing and GIS in wildlife status estimation.
4. Causes and consequences of human-wildlife conflicts (emphasis on tiger and elephant related issues in India).
5. Protected areas: National parks & sanctuaries, Hotspots & Biosphere reserves.

**COURSE OUTCOME:** This course offers students an understanding of the intricacies of how the environmental changes govern the lifestyles of organisms, and how organisms interact within themselves as groups and individuals, to maximize their chances of survival and reproduction. Students are also introduced to the idea of protection and sustainable exploitation of natural resources like wildlife.

## Reference Books

1. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
2. Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
3. Robert Leo Smith, Ecology and field biology Harper and Row publisher
4. Sharma, P. D., Ecology and Environment. Rastogi Publications
5. Caughley, G., Fryxell, J.M., and Sinclair, A.R.E. (2006). Wildlife Ecology, Conservation and Management. Willey-Blackwell Science.
6. Singh, S.K., (2020). Textbook of Wildlife Management. CBS Publishers
7. Reena Mathur, Wildlife Conservation and Management. Rastogi Publications
8. Gautam Kr. Saha & Subhendu Mazumdar, Wildlife Biology-an Indian Perspective. PHI

### ZOO-MJ-P-301: 4 Class Hours/week

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.
2. Setting quadrat, pitfall/light traps and recording results from collections therein: determination of population density, faunal abundance, species richness, importance value index, and calculation of Shannon-Weiner diversity index from the results.
3. Study of aquatic ecosystem: Zooplankton, determination of pH, Dissolved Oxygen content (Winkler's method), and Free CO<sub>2</sub>.
4. Observation and description (Original photograph, systematic position, character and habitat description in LNB) of local wild flora, birds, butterflies, mammals (any 2 groups; 5 examples from both).
5. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary OR Study visit to a marine ecosystem.

#### 6: Major excursion.

N.B. Animals collected from traps should be released back into their own habitat as far as possible; only pictures/sketches and descriptions should be retained and submitted. Nests/eggs should not be disturbed/collected unless abandoned. In no case should wildlife be harmed – only noninvasive recording and data collection is permitted.

**ZOO-MI-T-301: 9 Modules, 4 Class Hours/week**

Semester	Course Name	Course Detail	Credits	Total Award
III	ZOO-MI-T-301	Comparative anatomy and Developmental Biology	3	25+15+10 = 50
	ZOO-MI-P-301	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 in detail; Oogenesis in detail; egg types; cleavage and gastrulation in chick; Fertilization in detail.

**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

**ZOO-MI-P-301: 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.



### ZOO-MDC-3: 5 Modules, 3 Class Hours/week

Semester	Course Name	Course Detail	Credits	Total Award
III	ZOO-MDC-3	Medical Zoology and Public Health	3	35+10 (Internal Assessment) = 45

**OBJECTIVES OF THE STUDY:** The present course attempts to provide an interdisciplinary understanding of human public health issues with a more detailed understanding of the areas pertaining to medical zoology and epidemiology. Some overview of the communicable and non-communicable diseases that impact public health and the scope of medical zoology in these respects have been included. Molecular diagnosis, preventive health checkup, case studies and the statistical analysis of public health data will also be taught. The specific objectives of the course are to provide a basic understanding of the scope of medical zoology in public health issues, particularly related to parasitic, vector borne and zoonotic diseases. Being interdisciplinary in its nature and scope, the course will be equally engaging and beneficial for students of all subject streams. After completing the course, the students can also apply for some higher-level courses in different areas of medical zoology and public health as the course helps in building a basic understanding on different aspects related to public health and the importance of medical zoology in this respect.

#### **Module 1: Introduction to Medical Zoology and Public Health**

Concept of health and diseases. Scope and importance of Medical Zoology in public health. Major communicable and non-communicable diseases of humans, their pathogenicity and prevention. Zoonotic diseases.

#### **Module 2: Parasitology (Protozoology & Helminthology)**

Protozoan infection: malaria, amoebiasis; Helminth infection: taeniasis and ascariasis-their infection, transmission, symptoms and prevention.

#### **Module 3: Vector biology**

Insects as mechanical and biological vectors. Brief discussion on house flies and mosquitoes as important insect vectors. Role of rats in transmission of diseases. Control of vector borne diseases by integrated vector management systems.

#### **Module 4: Non-communicable diseases**

Lifestyle disease or non-communicable diseases- consequence of imbalanced nutrition, environmental and psychological stresses; General concept of etiology and management of diseases like Obesity, Diabetes mellitus, and Cardiovascular disorders.

#### **Module 5: Application of Zoology in Medicine and Health**

Molecular diagnosis process of diseases. Preventive health checkups (PHC)- important parameters/biomarkers; relevance of PHC in health and disease prevention/early diagnosis.

#### **COURSE OUTCOME:**

1. Students will get a holistic overview of the interdisciplinary nature of Medical Zoology and Public health.
2. The course will help students to explore the dynamics of diseases that can be transmitted between animals and humans (zoonoses), including their epidemiology, transmission cycles, and impact on public health.
3. They will understand important parasitic diseases caused by protozoans and helminths-their transmission, symptoms and prevention.
4. The students will also get an understanding of the vector borne diseases and the role of insect and mammalian vectors in transmission of diseases as well as integrated vector management systems.
5. They will also be able to understand different lifestyle diseases and the impact of imbalanced nutrition, environmental and psychological stresses in generating these diseases and what preventive measures to be taken to control these diseases.
6. The students will get an insight on the modern molecular diagnosis process of diseases as well as scope and importance of preventive health check up.
7. The course is expected to foster critical thinking and research skills in the field of medical zoology and public health, encouraging students to explore innovative approaches to disease prevention and control.

### ZOO-SEC-3: 5 Modules, 3 Class Hours/week

Semester	Course Name	Course Detail	Credits	Total Award
III	ZOO-SEC-3	Statistical and Computational Biology	3	35+10 (Internal Assessment) = 45

**OBJECTIVES OF THE STUDY:** This course is to provide a basic idea and understanding of the elementary concepts of statistics. This is designed to acquaint the students with the preliminary knowledge of descriptive and inferential statistics. It will also make students equipped with the basic knowledge of bioinformatics such biological database, data retrieval and sequence alignment.

#### Module 1: Introduction to Biostatistics

Data, population, sample and sampling, frequency distribution, measures of central tendency, frequency distribution curve, measures of dispersion.

#### Module 2: Testing of Hypotheses

Null Hypothesis, Level of significance, Error of interference and degrees of freedom, Chi-square test for goodness of fit, Student 't' distribution.

#### Module 3: Correlations and Regression

Basic concept of correlation, linear regression.

#### Module 4: Introduction to Bioinformatics

Aims and scope of bioinformatics, Introduction to biological databases (nucleic acid, protein databases).

#### Module 5: Basic concept of data retrieval and sequence alignment

Sequence submission tools, sequence file format, data retrieval system (Entrez, SRS), Types of sequence alignment, method of sequence alignment (BLAST)

**Course outcome:** By the end of the course students will be able to work with sample data. They will be able to analyse and make inference about the data. The basic knowledge of biological databases, sequence submission tools, sequence alignment help them to pursue their future study and research work as well.

### References and Suggested Texts

1. Fundamentals of biostatistics.-7 th ed./Bernard Rosner
2. Principles of Biostatistics/Marcello Pagano/Duxbury Press 1993
3. Basic Biostatistics and its application, Animesh kumar Dutta, New Central Book Agency (P) Ltd.
4. Basic bioinformatics, 2<sup>nd</sup> ed., S Ignacimuthu Sj Narosa
5. Introduction To Bioinformatics 1St Edition 2007 by Attwood t k et al, Pearson india 6.

**ZOO-MJ-T-401: 8 Modules, 4 Class Hours/week**

Semester	Course Name	Course Detail	Credits	Total Award
IV	ZOO-MJ-T-401	Cell Biology	4	40+20+15 = 75
	ZOO-MJ-P-401	Cell Biology Lab	2	

**OBJECTIVES OF THE STUDY:** Students will gain knowledge and insights into fundamental cellular processes and their implications in biological systems.

**Module 1: Overview of Cells**

Basic structure of prokaryotic and eukaryotic cells, viruses.

**Module 2: Plasma Membrane**

Ultra structure and composition of plasma membrane, fluid mosaic model. Transport across membrane: Active and passive transport, facilitated transport. Cell junctions: Tight junctions, Gap junctions, Desmosomes.

**Module 3: Cytoplasmic organelles I**

Structure and Functions: Endoplasmic Reticulum, Golgi apparatus, lysosome. Protein sorting.

**Module 4: Cytoplasmic organelles II**

Mitochondria: Structure, semi-autonomous nature endosymbiotic hypothesis, mitochondrial respiratory chain, chemiosmotic hypothesis.

**Module 5: Cytoskeleton**

Type, structure and functions of cytoskeleton.

**Module 6: Nucleus**

Chromatin: Euchromatin and heterochromatin and packaging (nucleosome).

**Module 7: Cell cycle and Cancer biology**

Cell cycle and its regulation, Cancer (Concept of oncogenes and tumor suppressor genes with special reference to p53, Retinoblastoma and Ras and APC).

**Module 8: Cell Signaling**

Cell signaling transduction pathways (GPCR, RTK and JAK-STAT); Types of signaling molecules and receptors. GPCR and Role of second messenger (cAMP). Apoptosis and Necrosis.

**COURSE OUTCOME:** to provide students a comprehensive understanding of the principles and concepts basic structure of cells. They gain a knowledge about various components of cells, including organelles, cytoskeletons, and cell membranes, and to explore their roles in cell biology. Additionally, the course aims to familiarize students with key processes such as the cell cycle, cell adhesion, extracellular matrix, and the development and progression of cancer.

**References and Suggested Texts**

- Lewin's Cells – Cassimeris/Lingappa/Plopper – Johns & Bartlett Publishers.
- Biology of Cancer by Robert. A. Weinberg. 2nd edition.
- 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.
- Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James. Molecular Biology of the Cell, V Edition, Garland publishing Inc., New York and London.

**ZOO-MJ-P-401: 2 Class Hours/week**

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis.
2. Preparation of various stages of meiosis from temporary stained squash of grasshopper testes.
3. Temporary preparation to demonstrate:
  - a) DNA by Feulgen reaction.

b) Cell viability by Trypan Blue staining.

Either 3a or 3b.

Lab note book, with drawing and labelling; methods where applicable.

**ZOO-MJ-T-402: 8 Modules, 4 Class Hours/week**

Semester	Course Name	Course Detail	Credits	Total Award
IV	ZOO-MJ-T-402	Biochemistry	4	40+20+15 = 75
	ZOO-MJ-P-402	Biochemistry Lab	2	

**OBJECTIVES OF THE STUDY:** To comprehensively study cellular metabolism and biomolecular interactions, focusing on key biochemical pathways and enzymatic processes essential for understanding biological systems.

**Module 1: Carbohydrates**

Molecular structure and classification of Carbohydrates. Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis.

**Module 2: Lipids**

Molecular structure and classification of Lipids. Lipid metabolism:  $\beta$ -oxidation of fatty acids; Fatty acid biosynthesis.

**Module 3: Amino acids and Proteins**

Amino acids: Structure, Classification, General and Electro chemical properties of  $\alpha$ -amino acids; Physiological importance of essential and non-essential amino acids. Proteins: Bonds stabilizing protein structure; Levels of organization; Protein metabolism: Transamination, Deamination, Urea cycle, Fate of C-skeleton of Glucogenic and Ketogenic amino acids.

**Module 4: Nucleic acids**

Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids. Types of DNA and RNA, complementarity of DNA, Hypo- and Hyperchromaticity of DNA.

**Module 5: Enzymes**

Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Derivation of Michaelis-Menten equation, Lineweaver-Burk plot; Factors affecting rate of enzyme-catalyzed reactions; Enzyme inhibition; Allosteric enzymes and their kinetics.

**Module 6: Oxidative Phosphorylation**

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

**COURSE OUTCOME:** Students will acquire in-depth knowledge of metabolic pathways, biomolecular structures, and enzyme kinetics, alongside practical skills in biochemical techniques. They will be prepared to analyze and apply biochemical principles to zoological contexts, enhancing their ability to contribute to research and practical applications in the field of zoology.

**References and Suggested Texts**

- 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.

**ZOO-MJ-P-402: 2 Class Hours/week**

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Quantitative estimation of proteins by Lowry Method.
3. Demonstration/Virtual lab/Dry lab of paper chromatography of amino acids.
4. Demonstration/Virtual lab/Dry lab of proteins separation by SDS-PAGE.
5. Wet lab: to study the enzymatic activity of Trypsin or Lipase.
6. Wet lab: To perform the Acid or Alkaline phosphatase assay from serum/ tissue/soil.

Either 3 or 4; either 5 or 6.

Lab note book, with methods where applicable

**ZOO-MI-T-401: 9 Modules, 4 Class Hours/week**

Semester	Course Name	Course Detail	Credits	Total Award
IV	ZOO-MI-T-401	Comparative anatomy and Developmental Biology	3	25+15+10 = 50
	ZOO-MI-P-401	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.

**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 in detail; Oogenesis in detail; egg types; cleavage and gastrulation in chick; Fertilization in detail.

**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

**ZOO-MI-P-401: 2 Class Hours/week**

6. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
7. Study of disarticulated skeleton of Toad/Pigeon/Guineapig.
8. Demonstration of Carapace and plastron of turtle OR Identification of mammalian skulls: One herbivorous (Guineapig) and one carnivorous (Dog) animal.
9. Dissection of Tilapia/carp: Circulatory system/urinogenital system; brain/pituitary.
10. 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.