

# UNIVERSITY OF NORTH BENGAL

Accredited by NAAC with grade "B++"

B.Sc. Zoology FOUR YEAR UNDERGRADUATE PROGRAM  
(FYUGP)  
w.e.f. 2024-2025

Course Curriculum for B.Sc. Zoology (Major for Single Major  
Single Minor Course)

Under  
THE NEW CURRICULUM AND CREDIT FRAMEWORK, 2024



समानो मन्त्रः समितिः समानी

## B.Sc. Zoology Major

UNIVERSITY OF NORTH BENGAL  
RAJA RAMMOHANPUR, DARJEELING  
WEST BENGAL  
PIN-734013

## FYUGP COURSE STRUCTURE OF ZOOLOGY (SINGLE MAJOR WITH SINGLE MINOR)

Semester	Major Courses (Credit)	Skill Enhancement Courses (Credit)	Minor Courses (Credit)	Inter-disciplinary Courses (Credit)	Ability Enhancement Compulsory Courses (Credit)	Value Added Courses (Credit)	Semester-wise Credit
<b>I</b>	MAJ-1 Biology of Non-Chordates (4)	SEC-1(3) (Anyone from the list provided by the college)	MIN-1 (4)			VAC- Environmental Education (4)	19
	MAJ-2 Ecology (4)						
<b>II</b>	MAJ-3 Biology of Chordates (4)	SEC-2 (3) (Anyone from the list provided by the college)	MIN-2 (4)	IDC-1 (3) (Anyone from the list provided by the college)	AECC-Comp. ENG.-(4)		22
	MAJ-4 Applied Zoology (4)						
<b>III</b>	MAJ-5 Cell Biology (4)	SEC-3 (3) (Anyone from the list provided by the college)	MIN-3 (4)	IDC-2 (3) (Anyone from the list provided by the college)	AECC- MIL/ALT.ENG.-(4)		22
	MAJ-6 Biochemistry: Fundamentals (4)						
<b>IV</b>	MAJ-7 Genetics (4)	Internship(2)*	MIN-4 (4)	IDC-3 (3) (Anyone from the list provided by the college)		VAC- Understanding India (4)	19+2
	MAJ-8 Ethology and Chronobiology (4)						
<b>V</b>	MAJ-9 Biochemistry: Metabolic processes (4)		MIN-5 (4)				20
	MAJ-10 Molecular Biology (4)						
	MAJ-11 Immunology (4)						
	MAJ-12 Parasitology and Medical Microbiology (4)						
<b>VI</b>	MAJ-13 Physiology (4)		MIN-6 (4)				20
	MAJ-14 Endocrinology and Reproductive Biology (4)						
	MAJ-15 Gamete biology and embryology (4)						
	MAJ-16 Adaptation, Evolution and Taxonomy (4)						
<b>VII</b>	MAJ-17 Research Methodology (4)		MIN-7 (4)				16
	MAJ-18 Wildlife conservation and Biodiversity (4)**						
	MAJ-19 Comparative Anatomy and Functional Biology (4)						
<b>III</b>	MAJ-20 Biostatistics and Bioinstrumentation (4)		MIN-8 (4)				20
	MAJ-21 Biotechnology (4)						
	MAJ-22 Field Work/Industry Visit (4)**						
	MAJ-23 Group Discussion, Seminar Presentation, Grand Viva (4) **						

\* Should be completed at the end of 2<sup>nd</sup>/4<sup>th</sup> semester during summer recess

\*\*For candidates 'without research' [For the candidates 'with research' these 3 courses will be replaced by Research Project/Dissertation (12)]

## Semester I

**MAJOR 1: BIOLOGY OF NON-CHORDATES (Paper Code: ZOOLMAJ101)**

**Paper Type: Theory + Practical Lab Based [TH+PLB]**

**Credit: 4 (Theory 3+ Practical 1)**

**Class Hours: 75 (Theory 45 hrs. + Practical 30 hrs.)**

**Full Marks: 80 (Theory 60 + Practical 20)**

**Duration of end semester examination: (Theory 2.5 hrs. + Practical 2 hrs.)**

### Syllabus:

<b>Theory</b>	<b>Class Hour(s)</b>
<b>Unit I: Introduction to Non-chordates</b>	<b>01</b>
<ul style="list-style-type: none"><li>• Introduction to Five Kingdoms System.</li><li>• Basis of classification of Kingdom Animalia into different phyla.</li></ul>	
<b>Unit II: Protista</b>	<b>06</b>
<ul style="list-style-type: none"><li>• General characteristics and classification up to phyla.</li><li>• Locomotory organelles in <i>Amoeba</i>, <i>Euglena</i> and <i>Paramoecium</i></li><li>• Conjugation in <i>Paramoecium</i>.</li></ul>	
<b>Unit III: Porifera</b>	<b>03</b>
<ul style="list-style-type: none"><li>• General characteristics and classification up to classes.</li><li>• Canal system in sponges.</li></ul>	
<b>Unit IV: Cnidaria and Ctenophora</b>	<b>06</b>
<ul style="list-style-type: none"><li>• General characteristics and classification up to classes.</li><li>• Polymorphism in Cnidaria.</li><li>• Types of coral reefs.</li></ul>	
<b>Unit V: Platyhelminthes and Nematoda</b>	<b>08</b>
<ul style="list-style-type: none"><li>• General characteristics and classification up to classes.</li><li>• Life cycle of <i>Fasciola hepatica</i> and <i>Ascaris lumbricoides</i>.</li><li>• Parasitic adaptations of helminths.</li></ul>	
<b>Unit VI: Annelida</b>	<b>04</b>
<ul style="list-style-type: none"><li>• General characteristics and classification up to classes.</li><li>• Parapodia in <i>Nereis</i>.</li></ul>	
<b>Unit VII: Arthropoda and Onychophora</b>	<b>05</b>
<ul style="list-style-type: none"><li>• General characteristics and classification up to classes.</li><li>• Vision in Insecta.</li><li>• General characteristics and evolutionary significance of Onychophora.</li></ul>	
<b>Unit VIII: Mollusca</b>	<b>05</b>
<ul style="list-style-type: none"><li>• General characteristics and classification up to classes.</li><li>• Nervous system in Gastropoda.</li><li>• Torsion and detorsion in Gastropoda.</li></ul>	
<b>Unit IX: Echinodermata</b>	<b>05</b>
<ul style="list-style-type: none"><li>• General characteristics and classification up to classes.</li><li>• Water-vascular System in Asterozoa.</li><li>• Affinities with chordates.</li></ul>	
<b>Unit X: Hemichordata</b>	<b>02</b>
<ul style="list-style-type: none"><li>• General characteristics.</li><li>• Affinities with non-chordates and chordates.</li></ul>	

**Note:** Outline classification of the kingdom Protista up to phyla to be followed from Levine et al.

(1980) and that of other phyla up to classes to be followed from "Ruppert, Fox and Barnes (2003): *Invertebrate Zoology: A Functional Evolutionary Approach*". VII Edition or from Brusca, R.C and Brusca, G. J (2003): *Invertebrate (2nd ed.) Sinauer Associates Inc., Publishers Sunderland.*

Practical	30 Hours
<ul style="list-style-type: none"> <li>• Museum study               <ul style="list-style-type: none"> <li>(i) Protozoa: <i>Euglena</i>, <i>Paramecium</i> (including binary fission and conjugation), <i>Amoeba</i>, <i>Plasmodium vivax</i> (trophozoite/signet ring stage).</li> <li>(ii) Porifera: <i>Sycon</i>, <i>Hyalonema</i>, <i>Spongilla</i>.</li> <li>(iii) Cnidaria: <i>Hydra</i>, <i>Obelia</i>, <i>Aurelia</i>, <i>Gorgonia</i>, <i>Pennatula</i>, <i>Fungia</i>, <i>Metridium</i>.</li> <li>(iv) Platyhelminthes: <i>Planeria</i>, <i>Fasciola hepatica</i>, <i>Taenia solium</i>.</li> <li>(v) Nematoda: <i>Ascaris lumbricoides</i> (male and female).</li> <li>(vi) Annelida: <i>Nereis</i>, <i>Chaetopterus</i>, <i>Pheretima</i>, <i>Hirudinaria</i>.</li> <li>(vii) Arthropoda: <i>Limulus</i>, <i>Palamnaeus</i>, <i>Palaemon</i>, <i>Daphnia</i>, <i>Balanus</i>, <i>Cancer</i>, <i>Eupagurus</i>, <i>Scolopendra</i>, <i>Julus</i>, <i>Bombyx</i>, <i>Periplanta</i>, <i>Apis</i>.</li> <li>(viii) Mollusca: <i>Chiton</i>, <i>Dentalium</i>, <i>Pila</i>, <i>Unio</i>, <i>Sepia</i>, <i>Octopus</i>.</li> <li>(ix) Echinodermata: <i>Asterias</i>, <i>Ophiura</i>, <i>Echinus</i>, <i>Cucumaria</i>, <i>Antedon</i>.</li> </ul> </li> <li>• Study of the sections: T.S. and L.S. of sponge; T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm.</li> <li>• Mounting: Nerve ring and spermatheca of earthworm, salivary glands and mouthparts of cockroach.</li> <li>• Dissection: Alimentary system and nervous system of earthworm, digestive system and nervous system of cockroach .</li> </ul>	

**Note:** In case of unavailability of preserved specimens/slides, departments can use photographs for the study of museum specimens and permanent slides

### Evaluation Structure for end semester practical examination:

1. Identification with reason: 3 specimens/each 2 marks (Identification =  $\frac{1}{2}$ , Systematic Position (as per theory syllabus)=  $\frac{1}{2}$ , Characters = 1), 1 section /each 2 marks (Identification =  $\frac{1}{2}$ , Characters=  $1\frac{1}{2}$ )  
Total = 8 marks
2. Dissection & display, drawing and labelling (one system) ( $4\frac{1}{2} + \frac{1}{2} + \frac{1}{2} + \frac{1}{2} = 6$  marks)
3. Mounting: Any one (2 marks)
4. Laboratory Note Book: 2 marks (Based on the neatness, inclusiveness, overall presentation and regularity)
5. Viva-Voce: 2 marks (Testing of Knowledge in the said Course)

### Suggested Readings

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2009). The Invertebrates: A Synthesis. III Edition, Jhon Willey & Sons.
2. Barrington, E.J.W. (2012). Invertebrate Structure and Functions. II Edition, EWP Publishers.
3. Brusca, R.C. and Brusca, G.J. (2003). Invertebrate. II Edition, Sinauer Associates Inc., Sunderland.
4. Levine, N. D., J. O. Corliss, F. E.G. Cox, G. Deroux, J. Grain, B. M. Honigberg, G. F. Leedale, et al. 1980. "A Newly Revised Classification of the Protozoa." *The Journal of Protozoology*. 27 (1): 37-58.
5. Parker, T.J. and Haswell, W.A. (1972). A text book of Zoology, Vol-I. VII Edition, Marshall and Williams (eds.), Mc Millan Press ltd.
6. Pechenik, J.A. (2015). Biology of the Invertebrates. VII Edition, McGraw-Hill Education.
7. Ruppert, E.E., Fox, R.S. and Barnes, R.D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. VII Edition, Cengage Learning, India.

**MAJOR 2: Ecology (Paper Code: ZOOLMAJ102)**

**Credit: 4 (Theory 3+ Practical 1)**

**Class Hours: 75 hrs. (Theory 45 hrs.+ Practical 30 hrs.)**

**Full Marks: 80 (Theory 60 + Practical 20)**

**Duration of end semester examination: (Theory 2.5 hrs. + Practical 2 hrs.)**

**Syllabus:**

<b>Theory</b>	<b>Class Hour(s)</b>
<b>Unit 1: Introduction to Ecology</b>	<b>04</b>
<ul style="list-style-type: none"><li>• Autecology and synecology.</li><li>• Levels of organization.</li><li>• Laws of limiting factors, Study of Physical factors (light, precipitation, temperature).</li></ul>	
<b>Unit II: Population</b>	<b>15</b>
<ul style="list-style-type: none"><li>• Unique and group attributes of population: Demographic factors, life tables, fecundity tables (definitions), survivorship curves, dispersal, and dispersion.</li><li>• Exponential and logistic growth, r and k strategies, Population regulation - density-dependent and independent factors.</li><li>• Population Interactions: commensalism, ammensalism, mutualism, predation, competition, and parasitism.</li><li>• Gause's Principle, Lotka-Volterra equation for competition.</li></ul>	
<b>Unit III: Community</b>	<b>09</b>
<ul style="list-style-type: none"><li>• Community characteristics: species diversity, abundance, dominance, richness.</li><li>• Vertical stratification, Ecotone, and edge effect.</li><li>• Ecological succession (in reference to hydrosere).</li></ul>	
<b>Unit IV: Ecosystem</b>	<b>12</b>
<ul style="list-style-type: none"><li>• Ecosystem structure and function: Types of Ecosystem (Pond, Grassland &amp; Forest Ecosystem)</li><li>• Food chain: Grazing and detritus food chains, Linear and Y-shaped food chains, Foodweb.</li><li>• Energy flow through the ecosystem, Ecological pyramids</li><li>• Nutrient and biogeochemical cycle with an example of Nitrogen cycle</li></ul>	
<b>Unit V: Biomes and Faunal Distribution</b>	<b>05</b>
<ul style="list-style-type: none"><li>• Factors that Make a Biome and Biomes classification</li><li>• Types and characteristics of biomes (Tropical Rainforest, Temperate Forest, Taiga, Tundra, Savannah, Desert, Freshwater, Marine)</li><li>• Significance of Biomes</li><li>• Basic concept of Zoogeographical realms (physical boundaries and faunal characteristics of each realm)</li><li>• Wallace Line and Weber Line</li></ul>	

**Practical****30 Hours**

- ❖ Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community.
- ❖ Study of an aquatic ecosystem:
  - Determination of pH
  - Determination of turbidity
  - Population density of zooplankton (by Sedgewick Rafter scale)
  - Estimation of Dissolved Oxygen content (Winkler's method).
  - Estimation of Total Alkalinity.
  - Estimation of Free CO<sub>2</sub>.
  - Estimation of total Hardness

### Evaluation Structure for end semester practical examination:

1. Calculation of the Shannon-Wiener Diversity Index from the provided data **(6 Marks)**: Principle (1Mark), Calculation (4 Marks), Inference (1 Mark).

**OR**

Calculation of population density of zooplankton **(6 Marks)**: Principle (1 Mark), Calculation (4 Marks), Inference (1 Mark).

2. Estimation of Dissolved Oxygen/Free CO<sub>2</sub>/Alkalinity **(10 Marks)**: Principle (2 Marks), Workout (4 Marks), Calculation (3 Marks), Comment (1 Mark).
3. Laboratory Note Book **(2 marks)**: (Based on the neatness, inclusiveness, overall presentation and regularity).
4. Viva-voce **(2 marks)**: (Testing of knowledge in the said Course)

### Suggested Reference Books

1. Stilling, P. (2001): Ecology: Theories & Application. 4th Edition
2. Odum, E.P. (2008): Fundamentals of Ecology. Indian Edition. Brooks/Cole
3. Smith, T. M., and Smith R. L. (2016): Elements of Ecology. 8th Ed. Pearson Education.
4. Begon, M., Harper J. L. and Townsend, C. R. (2006): Ecology: Individuals, Populations & communities. 4<sup>th</sup> Ed. Blackwell Publishing Ltd.
5. Ricklefs, R. E. and Miller, G. L. (2000): Ecology. 4th Ed. W. H. Freeman & Company.
6. Sinclair, A. R. E., Fryxell, J. M. and Caughley, G. (2006): Wildlife Ecology, Conservation, and Management. 2<sup>nd</sup> Edition. Blackwell Publishing Ltd
7. Krebs, C. J. (2016): Ecology: The Experimental Analysis of Distribution and Abundance. 6<sup>th</sup> Ed. Pearson India Education Ltd.
8. Sutherland, W. J. (2000): The Conservation Handbook: Research, Management & Policy. Blackwell Publishing Ltd.
9. Sodhi, N.S. and Ehlich, P. R. (2010): Conservation Biology for All. Oxford University Press.
10. Cunningham, W. P. and Cunningham, M. A. (2008): Environmental Science- A Global Concern. McGraw-Hill.
11. Darlington, Philip J Jr. (1966) Zoogeography: The geographical distribution of animals. John Wiley



## Semester II

MAJOR 3: Biology of Chordates (Paper Code: Z00LMAJ203)

Paper Type: Theory + Practical Lab Based [TH+PLB]

Credit: 4 (Theory 3+ Practical 1)

Class Hours: 75 (Theory 45 hrs. + Practical 30 hrs.)

Full Marks: 80 (Theory 60 + Practical 20)

Duration of end semester examination: (Theory 2.5 hrs. + Practical 2 hrs.)

### Syllabus:

Theory	Class Hour(s)
<b>Unit I: Introduction to chordates</b>	<b>01</b>
General characteristics and outline classification of Phylum Chordata up to classes.	
<b>Unit II: Protochordata</b>	<b>04</b>
<ul style="list-style-type: none"><li>• General characteristics and classification of Sub-Phylum Urochordata and Cephalochordata up to classes.</li><li>• Retrogressive metamorphosis in <i>Ascidia</i>.</li><li>• General organization of <i>Branchiostoma</i>.</li></ul>	
<b>Unit III: Origin of Chordata</b>	<b>02</b>
<ul style="list-style-type: none"><li>• Dipleurula concept and the Echinoderm theory of origin of chordates.</li></ul>	
<b>Unit IV: Agnatha</b>	<b>02</b>
<ul style="list-style-type: none"><li>• General characteristics and classification of Cyclostomata up to orders.</li><li>• Metamorphosis in <i>Petromyzon</i>.</li><li>• Zoological importance of ammocoete larva.</li></ul>	
<b>Unit V: Pisces</b>	<b>10</b>
<ul style="list-style-type: none"><li>• General characteristics and classification of Chondrichthyes and Osteichthyes up to sub-classes.</li><li>• Swim bladder in fishes.</li><li>• Migration of fishes.</li><li>• Parental care in fishes.</li><li>• Dipnoi: Distribution, morphology &amp; affinities.</li></ul>	
<b>Unit VI: Amphibia</b>	<b>04</b>
<ul style="list-style-type: none"><li>• General characteristics and classification up to extant orders.</li><li>• Parental care in Amphibia.</li><li>• Neoteny and paedogenesis.</li></ul>	
<b>Unit VII: Reptilia</b>	<b>06</b>
<ul style="list-style-type: none"><li>• General characteristics and classification up to extant orders.</li><li>• Poison apparatus and biting mechanism of snakes.</li><li>• Types of snake venom &amp; their mode of actions.</li></ul>	

<b>Unit VIII: Aves</b>	<b>07</b>
<ul style="list-style-type: none"> <li>• General characteristics and classification up to sub-classes.</li> <li>• Exoskeleton (in relation to feathers).</li> <li>• Double respiration in birds.</li> <li>• Migration of birds.</li> </ul>	
<b>Unit IX: Mammals</b>	<b>09</b>
<ul style="list-style-type: none"> <li>• General characters and classification up to extant orders.</li> <li>• Exoskeletal derivatives of mammals.</li> <li>• Echolocation in Microchiroptera and Cetacea.</li> </ul>	

**Note:** Classification of Protochordata, Agnatha, Reptilia, Aves & Mammals to be followed from Young (1981), for Pisces to be followed from Romer (1959)/Berg (1940), for Amphibia to be followed from Duellman & Trueb (1986)/ Young (1981).

<b>Practical</b>	<b>30 Hours</b>
<ul style="list-style-type: none"> <li>• Museum Study of <ul style="list-style-type: none"> <li>(i) Protochordata: <i>Herdmania</i>, <i>Ascidia</i>, <i>Branchiostoma</i>.</li> <li>(ii) Agnatha: <i>Petromyzon</i>, <i>Myxine</i>, Ammocoete larva.</li> <li>(iii) Pisces: <i>Scoliodon</i>, <i>Sphyrna</i>, <i>Torpedo</i>, <i>Heteropneustes</i>, <i>Labeo</i>, <i>Exocoetus</i>, <i>Echeneis</i>, <i>Anguilla</i>, <i>Hippocampus</i>, <i>Tetrodon</i>, <i>Diodon</i>, <i>Anabas</i>, Flat fish.</li> <li>(iv) Amphibia: <i>Necturus</i>, <i>Axolotl</i>, <i>Tylotriton</i>, <i>Bufo</i>, <i>Hyla</i>.</li> <li>(v) Reptilia: <i>Chelone</i>, <i>Trionyx</i>, <i>Hemidactylus</i>, <i>Varanus</i>, <i>Uromastix</i>, <i>Chamaeleon</i>, <i>Draco</i>, <i>Bungarus</i>, <i>Vipera</i>, <i>Naja</i>, <i>Hydrophis</i>, <i>Crocodylus</i>.</li> <li>(vi) Aves: Oriental pied hornbill, Red breasted flycatcher, Great tit, Pelican.</li> <li>(vii) Mammalia: Bat (insectivorous and frugivorous), <i>Funambulus</i>, Red panda.</li> </ul> </li> <li>• Key for identification of poisonous and non-poisonous snakes.</li> <li>• Mounting: Fish scales &amp; pecten from fowl head.</li> <li>• Isolation of pituitary from fish head.</li> </ul>	

**Note:** In case of unavailability of preserved specimens/slides, departments can use photographs for the study of museum specimens and permanent slides.

### **Evaluation Structure for end semester practical examination:**

1. Identification with reason: 4 specimen/each 2 marks (Identification =  $\frac{1}{2}$ , Systematic position (as per theory syllabus)=  $\frac{1}{2}$ , Characters = 1) Total = 8 marks
2. Key preparation: 2 marks
3. Isolation of pituitary gland from fish head: 4 marks
4. Mounting: Any one (2 marks)
5. Laboratory Note Book: 2 marks (Based on the neatness, inclusiveness, overall presentation and regularity)
6. Viva-Voce: 2 marks (Testing of Knowledge in the said Course)

### **Suggested Readings**

1. Berg, L.S. (1940). Classification of fishes both recent and fossil. Trudy Zoologicheskogo Instituta. 5:85-517.
2. Duellman, W.E. and Trueb, L. (1986). Biology of Amphibians. Mc. Graw Hill Books Company.
3. Hall, B.K. and Hallgrímsson, B. (2008). Strickberger's Evolution. IV Edition, Jones and Bartlett Publishers Inc.
4. Jordan, E.L. and Verma, P.S. (2003). Chordate Zoology. S. Chand & Company Ltd., New Delhi.
5. Kardong, K.V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
6. Kent, G.C. and Carr, R.K. (2001). Comparative anatomy of the Vertebrates. IX Edition, McGraw Hill.
7. Nelson, J.S. (2006). Fishes of the World. IV Edition, Wiley.
8. Parker, T.J. and Haswell, W. (1972). Text Book of Zoology, Volume II. VII Edition, Marshall and Willam (eds.), Macmillan Press, London.
9. Pough, H. Vertebrate life. VIII Edition, Pearson International.
10. Romer, A.S. (1959). The Vertebrate Story. University of Chicago Press.
11. Romer, A.S. and Parsons, T.S. (1986). The vertebrate body. VI Edition, Saunders College Publishing.
12. Young, J. Z. (1981). The Life of Vertebrates. III Edition, ELBS, Oxford.
13. Young, J.Z. (2004). The Life of Vertebrates. III Edition (Indian Edition), Oxford University press.

**MAJOR 4: Applied Zoology [Sericulture, Apiculture and Fisheries]  
(Paper Code: ZOOMAJ204)**

**Paper Type: Theory + Practical Lab Based [TH+PLB]**

**Credit: 4 (Theory 3+ Practical 1)**

**Class Hours: 75 (Theory 45 hrs. + Practical 30 hrs.)**

**Full Marks: 80 (Theory 60 + Practical 20)**

**Duration of end semester examination: (Theory 2.5 hrs. + Practical 2 hrs.)**

**Syllabus:**

<b>Theory</b>	<b>Class Hour(s)</b>
<b>A. Sericulture</b>	
<b>Unit I: Introduction</b>	<b>01</b>
<ul style="list-style-type: none"> <li>Types of silkworms, distribution and races.</li> </ul>	
<b>Unit II: Biology of Silkworm</b>	<b>02</b>
<ul style="list-style-type: none"> <li>Classification and lifecycle of <i>Bombyx mori</i>.</li> <li>Structure of silk gland and secretion of silk.</li> <li>Physical and chemical nature of silk fibre, uses of silk.</li> </ul>	
<b>Unit III: Rearing of Silkworms</b>	<b>05</b>
<ul style="list-style-type: none"> <li>Selection of mulberry variety and establishment of mulberry garden (Moriculture).</li> <li>Rearing house and rearing appliances.</li> <li>Disinfectants: Formalin, bleaching powder, RKO.</li> <li>Silkworm rearing technology: Early age and late age rearing.</li> <li>Types of mountages.</li> <li>Spinning, harvesting and storage of cocoons.</li> </ul>	
<b>Unit IV: Pests and Diseases</b>	<b>05</b>
<ul style="list-style-type: none"> <li>Pests of silkworm: Uzi fly, dermestid beetles and vertebrates.</li> <li>Control and preventive measures for pest infestation.</li> <li>Causative agents, symptoms and remedies of silkworm diseases: Viral (Grasserie), bacterial (Flacherie), protozoan (Pebrine) and fungal (Muscardine).</li> </ul>	
<b>Unit V: Entrepreneurship in Sericulture</b>	<b>02</b>
<ul style="list-style-type: none"> <li>Prospects of Sericulture in India.</li> <li>By-products of Sericulture and Seri-products for value addition.</li> </ul>	
<b>B. Apiculture (Theory)</b>	
<b>Unit I: Biology of Bees</b>	<b>01</b>
<ul style="list-style-type: none"> <li>Classification and biology of honey bees.</li> </ul>	
<b>Unit II: Rearing of Bees</b>	<b>06</b>

<ul style="list-style-type: none"> <li>• Artificial bee rearing (Apiary), beehives: Newton and Langstroth, bee pasturage.</li> <li>• Selection of bee species for Apiculture.</li> <li>• Bee keeping equipment.</li> <li>• Methods of extraction of honey (indigenous and modern).</li> </ul>	
<b>Unit III: Enemies and Diseases</b>	<b>04</b>
<ul style="list-style-type: none"> <li>• Enemies: Wasp and small hive beetle.</li> <li>• Causative agents, symptoms and remedies of bee diseases: Viral (Sac-brood disease), bacterial (American foul brood), protozoan (Nosema), Fungal (Chalk brood).</li> </ul>	
<b>Unit IV: Bee Economy</b>	<b>02</b>
<ul style="list-style-type: none"> <li>• Products of Apiculture Industry and its uses (Honey, Bees wax, Propolis, Pollen, Royal Jelly, Bee Venom).</li> </ul>	
<b>Unit V: Entrepreneurship in Apiculture</b>	<b>02</b>
<ul style="list-style-type: none"> <li>• Resource available, prospects and problems.</li> <li>• Bee keeping industry: Recent efforts and developments.</li> <li>• Modern methods in employing artificial beehives for crosspollination in horticultural gardens.</li> </ul>	
<b>C. Aquaculture and Fisheries</b>	
<b>Unit I: Introduction to aquaculture and fisheries</b>	<b>01</b>
<ul style="list-style-type: none"> <li>• Definition, scope and importance of aquaculture and fisheries.</li> </ul>	
<b>Unit II: Fish culture and Management</b>	<b>05</b>
<ul style="list-style-type: none"> <li>• Management and types of fish culture, induced breeding; breeding pond, hatching pit, nursery pond, rearing pond and stocking pond; fish harvesting.</li> <li>• Polyculture or Composite fish culture, integrated fish farming, pen and cage culture, and raceway culture.</li> <li>• Causative agents, symptoms and remedies of fish diseases: Fungal (gill rot), bacterial (tail and fin rot, Dropsy), protozoan (ichthyophthiriasis) and parasitic (diptostomiasis and argulosis).</li> </ul>	
<b>Unit III: Fish Technology</b>	<b>02</b>
<ul style="list-style-type: none"> <li>• Preservation and processing of fish.</li> <li>• Fish by-products and their economic importance.</li> </ul>	
<b>Unit IV: Prawn Farming and Pearl Culture</b>	<b>04</b>
<ul style="list-style-type: none"> <li>• Species of commercial prawn; types of prawn farming; methods of prawn farming</li> <li>• Pearl producing molluscs, pearl formation, methods of pearl culture.</li> </ul>	
<b>Unit V: Aquarium fish management</b>	<b>03</b>
<ul style="list-style-type: none"> <li>• Common characters and sexual dimorphism of fresh water and marine aquarium fish: Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish, Butterfly fish.</li> <li>• Live fish transportation: Fish handling, packing and forwarding techniques.</li> <li>• Aquarium maintenance.</li> <li>• Entrepreneurship in aquarium fish farming.</li> </ul>	

Practical	30 Hours
<ul style="list-style-type: none"> <li>• Identification of different stages of life cycle of silk-moth.</li> <li>• Identification of worker, drone and queen of honeybee.</li> <li>• Identification of the pests of silkworm (as per theory syllabus).</li> <li>• Identification of the diseased silkworm (as per theory syllabus).</li> <li>• Identification of the diseased honey bee (as per theory syllabus).</li> <li>• Project report on a visit to a sericulture/apiculture farm.</li> <li>• Spot Identification:  <i>Labeo rohita, Labeo calbasu, Catla catla, Cyprinus carpio, Hypophthalmichthys molitrix, Ctenopharyngodon idella, Cirrhinus mrigala, Clarias batrachus, Heteropneustes fossilis, Ophiocephalus punctatus, Ophiocephalus marulius, Anabas testudineus.</i>  Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish, Butterfly fish.  <i>Penaeus monodon, Metapenaeus affinis, Palaemon fluminicola, Macrobrachium rosenbergii, Pinctada sp., Mytilus sp.</i> </li> </ul>	

**Note:** In case of unavailability of specimens, departments can use photographs for the study.

#### **Evaluation Structure for end semester practical examination:**

1. Identification: 5 specimens (any one stage of life cycle of silk-moth, any one caste of honeybee, any one pest of silkworm, any one diseased silkworm, any one diseased honeybee) /each 2 marks (Identification = ½, Characters= 1½). Total = 10 marks
2. Submission of project report. 6 marks
3. Laboratory Note Book: 2 marks (Based on the neatness, inclusiveness, overall presentation and regularity)
4. Viva-Voce: 2 marks (Testing of Knowledge in the said Course)

### **Suggested Readings**

1. Appropriate Sericultural Techniques. M. S. Jolly (ed.), CSR&TI, Mysore.
2. Banerjee, T.K. (2016). Applied Zoology. New Central Book Agency (P) Ltd., Kolkata.
3. Bisht, D.S. Apiculture, ICAR Publication.
4. Chaudhuri, S. (2017). Economic Zoology. New Central Book Agency (P) Ltd., Kolkata.
5. Singh, S. Bee keeping in India. Indian council of Agricultural Research, New Delhi.
6. Tripathi, A.K., Pandey, B.N., Jaiswal, K. and Trivedi, S.P. (2009). Mulberry Sericulture: Problems and Prospects. Aph Publishing Corporation.
7. Ullal, S.R. and Narasimhanna, M.N. Handbook of Practical Sericulture, CSB, Bangalore.
8. Ganga, G. and Sulochana Chetty, J. (2014). Introduction To Sericulture. Oxford & Ibh Publishing Co. Pvt. Ltd.
9. Jaiswal, K., Trivedi, S.P., Pandey, B.N. and Pandey, P.N. (2009). Indian Sericulture: Past, Present and Future. Alfa Publication.
10. Sengupta, K. (1989). A Guide for Bivoltine Sericulture. CSR&TI, Mysore.
11. Narasimhanna, M.N. (1988). Manual of Silkworm Egg Production. CSB, Bangalore.
12. Wupang-Chun and Chen Da-Chung. (1988). Silkworm Rearing. FAO, Rome.
13. Krishnaswamy, S. (1986). Improved Method of Rearing Young age silkworm. CSB, Bangalore.
14. Prost, P.J. (1962). Apiculture. Oxford and IBH, New Delhi.
15. Hand book of Silkworm Rearing: Agriculture and Technical Manual-1. Fuzi Pub. Co. Ltd., Tokyo, Japan. (1972).

### **Question Pattern for MAJ, DSC, MIN & AEC (Theoretical)**

<b>Sl. No.</b>	<b>Questions to be answered</b>	<b>Out of</b>	<b>Marks of each question</b>	<b>Total Marks</b>
<b>1</b>	<b>4</b>	<b>6</b>	<b>3</b>	<b>4 × 3 = 12</b>
<b>2</b>	<b>4</b>	<b>6</b>	<b>6</b>	<b>4 × 6 = 24</b>
<b>3</b>	<b>2</b>	<b>4</b>	<b>12</b>	<b>2 × 12 = 24</b>

