

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



সমানো মন্ব: সমিতি: সমানী

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
I	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)						
II	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)						
III	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)						
IV	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)						
V	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)						
VI	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)						
VII	MAJ-17 Research Methodology (4)		MIN-7 (4)				16
	MAJ-18 Wildlife conservation and Biodiversity (4)**						
	MAJ-19 Comparative Anatomy and Functional Biology (4)						
III	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 2nd/4th 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:

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

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

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:

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

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 CO₂.
 - 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 CO₂/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. 4th 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. 2nd Edition. Blackwell Publishing Ltd
7. Krebs, C. J. (2016): Ecology: The Experimental Analysis of Distribution and Abundance. 6th 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: ZOO LMAJ203)

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

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

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).

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

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: ZOOLMAJ204)**

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

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

Practical	30 Hours
<ul style="list-style-type: none"> • Identification of different stages of life cycle of silk-moth. • Identification of worker, drone and queen of honeybee. • Identification of the pests of silkworm (as per theory syllabus). • Identification of the diseased silkworm (as per theory syllabus). • Identification of the diseased honey bee (as per theory syllabus). • Project report on a visit to a sericulture/apiculture farm. • 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> 	

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)

Sl. No.	Questions to be answered	Out of	Marks of each question	Total Marks
1	4	6	3	$4 \times 3 = 12$
2	4	6	6	$4 \times 6 = 24$
3	2	4	12	$2 \times 12 = 24$

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 Minor (For both
single Major single Minor & Multidisciplinary course)

Under
THE NEW CURRICULUM AND CREDIT FRAMEWORK, 2024



সমানো মন্ব: সমিতি: সমানী

B.Sc. Zoology Minor

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
I	MAJ-1 (4)	SEC-1(3) (Anyone from the list provided by the college)	MIN-1 Non-Chordates (4)			VAC- Environmental Education (4)	19
	MAJ-2 (4)						
II	MAJ-3 (4)	SEC-2 (3) (Anyone from the list provided by the college)	MIN-2 Chordates (4)	IDC-1 (3) (Anyone from the list provided by the college)	AECC-Comp- ENG-(4)		22
	MAJ-4 (4)						
III	MAJ-5 (4)	SEC-3 (3) (Anyone from the list provided by the college)	MIN-3 Cell Biology (4)	IDC-2 (3) (Anyone from the list provided by the college)	AECC- MIL/ALT ENG-(4)		22
	MAJ-6 (4)						
IV	MAJ-7 (4)	Internship(2)*	MIN-4 Genetics (4)	IDC-3 (3) (Anyone from the list provided by the college)		VAC- Understanding India (4)	19+2
	MAJ-8 (4)						
V	MAJ-9 (4)		MIN-5 Biochemistry (4)				20
	MAJ-10 (4)						
	MAJ-11 (4)						
	MAJ-12 (4)						
VI	MAJ-13 (4)		MIN-6 Physiology (4)				20
	MAJ-14 (4)						
	MAJ-15 (4)						
	MAJ-16 (4)						
VII	MAJ-17 (4)		MIN-7 Applied Zoology- 1 (4)				16
	MAJ-18 (4)						
	MAJ-19 (4)						
III	MAJ-20 (4)		MIN-8 Applied Zoology- 2 (4)				20
	MAJ-21 (4)						
	MAJ-22 (4)						
	MAJ-23 G (4)						

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

FYUGP COURSE STRUCTURE OF ZOOLOGY (MULTIDISCIPLINARY)

Semester	Major Courses -1 (Credit)	Major Courses -2 (Credit)	Optional Major Courses (Credit)	Skill Enhancement Courses (Credit)	Minor Courses (Credit)	Inter- disciplinary Courses (Credit)	Ability Enhancement Compulsory Courses (Credit)	Value Added Courses (Credit)
I	DSC-1 (4)	DSC-1 (4)		SEC-1(3) (Anyone from the list provided by the college)	MIN-1 Non-Chordates (4)			VAC- Understanding India (4)
II	DSC-2 (4)	DSC-2 (4)		SEC-2 (3) (Anyone from the list provided by the college)	MIN-2 Chordates (4)	IDC-1 (3) (Anyone from the list provided by the college)	AECC- MIL/ALT.ENG.-(4)	
III	DSC-3 (4)	DSC-3 (4)		SEC-2 (3) (Anyone from the list provided by the college)	MIN-3 Cell Biology (4)	IDC-2 (3) (Anyone from the list provided by the college)	AECC-Comp. ENG.- (4)	
IV	DSC-4 (4)	DSC-4 (4)		Internship (2)*	MIN-4 Genetics (4)	IDC-3 (3) (Anyone from the list provided by the college)		VAC- Environmental Education (4)
V	DSC-5 (4)	DSC-5 (4)			MIN-5 Biochemistry (4)			
	DSC-6 (4)	DSC-6 (4)						
VI	DSC-7 (4)	DSC-7 (4)			MIN-6 Physiology (4)			
	DSC-8 (4)	DSC-8 (4)						
VII	DSC-9 (4)**	DSC-9 (4)**	DSC-12 Research Methodology *** DSC-13 Comparative Anatomy & Functional Biology (4) #		MIN-7 Applied Zoology-1 (4)			
VIII	DSC-10 (4) ** DSC-11 (4) **	DSC-10 (4) ** DSC-11 (4) **	DSC-14 Gamete biology and embryology (4) # DSC-15 Ecology (4) #		MIN-8 Applied Zoology-2 (4)			

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

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

*** To be chosen from either of the Major papers

For the candidates who will opt Zoology as single major during last two semester

Semester I

Minor 1: NON-CHORDATES

(Paper Code: ZOOLMIN101)

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)
Unit I: Introduction to Non-chordates	01
<ul style="list-style-type: none">Basis of classification of Kingdom Animalia into different phyla.	
Unit II: Protista	06
<ul style="list-style-type: none">General characteristics and classification up to phyla.Locomotory organelles in <i>Amoeba</i>, <i>Euglena</i> and <i>Paramecium</i>Life cycle of <i>Plasmodium vivax</i>	
Unit III: Porifera	04
<ul style="list-style-type: none">General characteristics and classification up to classes.Canal system in sponges.	
Unit IV: Cnidaria and Ctenophora	07
<ul style="list-style-type: none">General characteristics and classification up to classes.Polymorphism in Cnidaria.Types of coral reefs.	
Unit V: Platyhelminthes and Nematoda	08
<ul style="list-style-type: none">General characteristics and classification up to classes.Life cycle of <i>Taenia solium</i> and <i>Ascaris lumbricoides</i> along with their parasitic adaptation.	
Unit VI: Annelida	03
<ul style="list-style-type: none">General characteristics and classification up to classes.Metamerism in Annelida	
Unit VII: Arthropoda	06
<ul style="list-style-type: none">General characteristics and classification up to classes.Vision in Insecta.Metamorphosis in Lepidoptera	
Unit VIII: Mollusca	04
<ul style="list-style-type: none">General characteristics and classification up to classes.Respiration in <i>Pila</i> Pearl Culture	
Unit IX: Echinodermata	04
<ul style="list-style-type: none">General characteristics and classification up to classes.Water-vascular System in Asteroidea.	
Unit X: Hemichordata	02
<ul style="list-style-type: none">General characteristics.	

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"> • Museum study (Spot identification) <ul style="list-style-type: none"> (i) Protozoa: <i>Euglena</i>, <i>Paramecium</i>, <i>Amoeba</i>, . (ii) Porifera: <i>Sycon</i>, <i>Hyalonema</i>, (iii) Cnidaria: <i>Aurelia</i>, <i>Gorgonia</i>, , <i>Metridium</i>. (iv) Platyhelminthes: <i>Fasciola hepatica</i>, <i>Taenia solium</i>. (v) Nematoda: <i>Ascaris lumbricoides</i> (male and female). (vi) Annelida: <i>Nereis</i>, <i>Pheretima</i>, <i>Hirudinaria</i>. (vii) Arthropoda: <i>Limulus</i>, <i>Peripatus</i>, <i>Palaemon</i>, <i>Daphnia</i>, , <i>Cancer</i>, <i>Eupagurus</i>, <i>Scolopendra</i>, <i>Julus</i>, <i>Bombyx</i>, <i>Periplanta</i>, <i>Apis</i>. (viii) Mollusca: <i>Chiton</i>, , <i>Pila</i>, <i>Unio</i>, <i>Octopus</i>. (ix) Echinodermata: <i>Asterias</i>, <i>Echinus</i>, <i>Antedon</i>. • Mounting: <i>Cyclops</i>, <i>Daphnia</i>, <i>Mysis</i> 	

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: 4 specimen/each 3 marks (Identification = 1, Systematic position (as per theory syllabus)= 1, Characters = 1), Total = 12 marks
2. Mounting and Identification Any one: 4 marks (Staining:1, Mounting:1, Spot Identification: 1, Characters = 1)
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)

Semester II

Minor 2: CHORDATES

(Paper Code: ZOOMIN202)

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:

Chordates —Theory (3 credits)	45 Hours/60 marks	Class
Unit 1: Chordata		1
Salient features		
Unit 2: Protochordata		5
Salient features and phylogeny of protochordates; Structure of pharynx and ciliary mode of feeding in <i>Branchiostoma</i>		
Unit 3: Agnatha		2
General features of Agnatha and classification of cyclostomes up to classes		
Unit 4: Pisces		10
General characters and classification up to Classes; Scales in fishes; Migration of fishes; Parental Care in fishes; Swimbladder in fishes		
Unit 5: Amphibia		5
General characters and classification up to extant Order; Parental care in amphibians		
Unit 6: Reptilia		6
General Characters and classification up to extant Order; Differences between poisonous and non-poisonous snakes; Poison apparatus and biting mechanism in snakes		
Unit 7: Aves		8
General characters and classification up to Sub-class; Flight adaptations; Aerodynamics of flight; exoskeleton in birds		
Unit 8: Mammalia		8
General Characters and classification up to Infra-Class; Adaptive Radiation in mammals; Integumentary glands in mammals and their derivatives		

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

List of Practical (1 credit)**30 hours/20 marks**

1. Spot identification (specimen/ photograph):

Ascidia, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Torpedo, Scoliodon, stingray, *Pristis*, *Labeo*, *Catla*, *Hippocampus*, *Exocoetus*, *Ichthyophis/Ureotyphlus*, *Tylotriton*, *Bufo*, *Hemidactylus*, *Chamaeleon*, *Draco*, *Vipera*, *Naja*, *Crocodylus*, any three common birds-(Crow, duck, Owl), Squirrel and Bat.

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

3. Study of disarticulated skeleton of toad and pigeon.

Evaluation Structure for end semester practical examination:

1. Identification: 3 specimen/each 2 marks (Identification = $\frac{1}{2}$, Characters = $1\frac{1}{2}$), Total = 06 marks
2. Bones identification: 4 specimens/each 2 marks (one each from skull, limb bones, girdles and vertebra) (Identification = $\frac{1}{2}$, Characters = $1\frac{1}{2}$), Total = 08 marks
3. Mounting and Identification Any one: 2 marks (Staining: $\frac{1}{2}$, Mounting: $\frac{1}{2}$, Spot Identification: 1)
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. 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.

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

Sl. No.	Questions to be answered	Out of	Marks of each question	Total Marks
1	4	6	3	$4 \times 3 = 12$
2	4	6	6	$4 \times 6 = 24$
3	2	4	12	$2 \times 12 = 24$

UNIVERSITY OF NORTH BENGAL

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

Course Curriculum for Inter-disciplinary Courses (IDC) for
both Single Major Single Minor Course & Multidisciplinary course

Under
THE NEW CURRICULUM AND CREDIT FRAMEWORK, 2024



সমানো মন্ত: সমিতি: সমানী

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

Semester-II

IDC: Conservation Biology (Paper Code: LSC1IDC202)

Paper Type: IDC

Credit: 3 [Theory +Tutorial]

Class Hours: 45 (Theory)

Full Marks: 60 (Theory 40 + Tutorial 20)

Syllabus:

Theory	Class Hour(s)
Unit I: History of Conservation Biology	02
<ul style="list-style-type: none">• Origin of 'Conservation Biology' as a new arena in the modern world.	
Unit II: Classification of living organisms	06
<ul style="list-style-type: none">• Five Kingdom classification (Whitaker, 1969) (Basic concept).• Basic concept of Biological species.	
Unit III: Elementary concepts associated with Conservation Biology	08
<ul style="list-style-type: none">• Biome, Biosphere, Ecosystem, Biodiversity, (Definition and basic concept).• Biodiversity hotspots, Megadiverse countries. (Definition and basic concept).	
Unit IV: Values of biodiversity	04
<ul style="list-style-type: none">• Values of biodiversity.• Significance of conservation biology.	
Unit V: Loss of Biodiversity	04
<ul style="list-style-type: none">• Extinction: (definition, reasons: habitat fragmentation & degradation, overexploitation, climate change).• Biodiversity loss in Indian context	
Unit VI: Legal foundations of conservation	06
<ul style="list-style-type: none">• The titles of the laws and the dates of their implementation• National and International organizations/ bodies/ programs (WWF, IUCN, CBD, CITES, MoEF,).	
Unit VII: Idea of IUCN Red List	07
<ul style="list-style-type: none">• Elementary idea of IUCN Red List• Conservation status of species (Asian Elephant, One-horned Rhinoceros, Royal Bengal Tiger) by IUCN Red List categories.	
Unit VIII: Conservation Strategies	08
<ul style="list-style-type: none">• Concepts of Reserve Forest, Biosphere reserve, Wildlife sanctuary, National Park• Keystone species, Endemic species (Definition and example).	

- Concepts of *ex situ* and *in situ* conservation.
- Animal conservation projects in India (Names and years of implementation).

Suggested Readings

1. Groom. (2005). Principles of Conservation Biology. III Edition, Sinauer.
2. Joshi and Joshi. (2020). Textbook of Conservation Biology, Evincepub Publishing.
3. Prasad, G. (2012). Handbook of Conservation Biology. Discovery Publishing.
4. Primack. (2014). Essentials of Conservation Biology. VI Edition, Sinauer.
5. Sodhi and Ehrlich. (2010). Conservation Biology for All. Oxford.

NB: MCQ Question pattern for end semester theory examination (Duration: 2 hrs.)