UNIVERSITY OF NORTH BENGAL

Accredited by NAAC with grade "B++"

B.Sc. Zoology FOUR YEAR UNDERGRADUATE PROGRAM
(FYUGP)
w.e.f. 2023-2024

Course Curriculum for B.Sc. Zoology (Major & Minor)
Under
THE NEW CURRICULUM AND CREDIT FRAMEWORK, 2022

समानो मन्त्रः समितिः समानी

B.Sc. Zoology

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

FYUGP COURSE STRUCTURE OF ZOOLOGY MAJOR

Semester	Major Courses (Credit)	Skill Enhancement Courses (Credit)	Minor Courses (Credit)	Multidisciplinary Courses (Credit)	Ability Enhancement Compulsory Courses (Credit)	Value Added Courses (Credit)	Semester Credit
I	MAJ-1 Biology of Non-Chordates (4)	SEC-1 Sericulture and Apiculture (3)	MIN- (A)-1 (4) (Any one from the list provided by the college)	MDC-1 (3) (Any one from the list provided by the college)	AECC- MIL/ ALT. ENG.-1 (2)	VAC- Understanding India/Digital marketing (4)	20
II	MAJ-2 Biology of Chordates (4)	SEC-2 Aquaculture & Fisheries and Poultry Farming (3)	MIN- (B)-1 (4) (Any one from the list provided by the college)	MDC-2 (3) (Any one from the list provided by the college)	AECC- ENG.-1 (2)	VAC- Environmental Education (4)	20
III	MAJ-3 Genetics (4) MAJ-4 Biochemistry: Fundamentals (4) MAJ-5 Ecology (4)	SEC-3 Pest Management and Medical Diagnostics (3)	MIN- A-2 (4)		AECC- MIL/ALT. ENG.-2 (2)		21
IV	MAJ-6 Cell Biology (4) MAJ-7 Physiology (4) MAJ-8 Wildlife and Biodiversity (4)		MIN- B-2 (4)	MDC-3 (3) (Any one from the list provided by the college)	AECC- ENG.-2 (2)		21
V	MAJ-9 Molecular Biology (4) MAJ-10 Biochemistry: Metabolic processes (4) MAJ-11 Endocrinology and Reproductive Biology (4) MAJ-12 Adaptation, Evolution and Taxonomy (4)	Internship (2)	MIN- A-3 (4)				22
VI	MAJ-13 Immunology (4) MAJ-14 Parasitology and Medical Microbiology (4) MAJ-15 Developmental Biology (4) MAJ-16 Ethology and Chronobiology (4)		MIN- B-3 (4)				20
VII	MAJ-17 Comparative Anatomy and Functional Biology (4) MAJ-18 Biotechnology (4) MAJ-19 Biostatistics and Bioinstrumentation (4)		MIN- A-4 (4)				16
VIII	MAJ-20 Artificial Intelligence & Computational Biology (4) MAJ-21 Research Methodology (4)* MAJ-22 Field Work/Industry Visit (4)* MAJ-23 Group Discussion/ Seminar Presentation/ Grand Viva (4)* Research Project/Dissertation (12) **		MIN- B-4 (4)				20

* without research, ** with research

FYUGP COURSE STRUCTURE OF ZOOLOGY MINOR

Semester	Paper (Credit)
I and II	MIN 1: Animal Diversity (4)
III and IV	MIN 2: Cell Biology and Genetics (4)
V and VI	MIN 3: Molecular Biology and Physiology (4)
VII and VIII	MIN 4: Economic Zoology (4)

Semester I

MAJOR 1: Biology of Non-Chordates (Paper Code: UZOOMAJ1101)

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: 75 (Theory 40 + Practical 20 + Continuous evaluation 10 + Attendance 05)

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

Syllabus:

Theory	**Class Hour(s)**
Unit I: Introduction to Non-chordates	**01**
• Introduction to Five Kingdoms System. • General characters of Kingdom Animalia. • Basis of classification of Kingdom Animalia into different phyla.	
Unit II: Protista	**06**
• General characteristics and classification up to phyla. • Locomotion in *Amoeba, Euglena* and *Paramoecium* • Conjugation in *Paramoecium.* • Life cycle of *Plasmodium vivax.*	
Unit III: Porifera	**03**
• General characteristics and classification up to classes. • Canal system in sponges.	
Unit IV: Cnidaria and Ctenophora	**05**
• General characteristics and classification up to classes. • Polymorphism in Cnidaria. • Corals and coral reefs.	
Unit V: Platyhelminthes and Nematoda	**06**
• General characteristics and classification up to classes. • Reproductive system and life cycle of *Fasciola hepatica* and *Ascaris lumbricoides.* • Parasitic adaptations of helminths.	
Unit VI: Annelida	**05**
• General characteristics and classification up to classes. • Locomotion in *Nereis.* • Excretion in Annelida.	
Unit VII: Arthropoda and Onychophora	**07**
• General characteristics and classification up to classes. • Structure and affinities of Xiphosura. • Tracheal respiration in cockroach. • Vision in Insecta. • General characteristics and evolutionary significance of Onychophora.	

Unit VIII: Mollusca	**05**
• General characteristics and classification up to classes. • Respiration in *Pila.* • Nervous system in Gastropoda. • Torsion and detorsion in Gastropoda.	
Unit IX: Echinodermata	**05**
• General characteristics and classification up to classes. • Water-vascular System in Asteroidea. • Affinities with chordates.	
Unit X: Hemichordata	**02**
• 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**
• Museum study (i) Protozoa: *Euglena, Paramecium* (including binary fission and conjugation), *Amoeba, Plasmodium vivax* (trophozoite/signet ring stage). (ii) Porifera: *Sycon, Hyalonema, Spongilla.* (iii) Cnidaria: *Hydra, Obelia, Aurelia, Gorgonia*, *Pennatula, Fungia, Metridium.* (iv) Platyhelminthes: *Planeria, Fasciola hepatica, Taenia solium*. (v) Nematoda: *Ascaris lumbricoides* (male and female). (vi) Annelida: *Neries, Chaetopterus, Pheretima, Hirudinaria.* (vii) Arthropoda: *Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplanta, Apis.* (viii) Mollusca: *Chiton, Dentalium, Pila, Unio, Sepia, Octopus.* (ix) Echinodermata: *Asterias, Ophiura, Echinus, Cucumaria, Antedon.* • 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 = ½, Systematic position= ½, Characters = 1), 1 section /each 2 marks (Identification = ½, Characters= 1½) Total = 8 marks

2. Dissection & display, drawing and labelling (one system) (4 ½ + ½+ ½+ ½= 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.

SEC 1: Sericulture and Apiculture (Paper Code: UZOOSEC11001)

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

Credit: 3 (Theory 2+ Practical 1)

Class Hours: 60 (Theory 30 hrs. + Practical 30 hrs.)

Full Marks: 75 (Theory 40 + Practical 20 + Continuous evaluation 10 + Attendance 05)

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

Syllabus:

Theory	**Class Hour(s)**
A. Sericulture	
Unit I: Introduction	**01**
• Types of silkworms, distribution and races.	
Unit II: Biology of Silkworm	**02**
• Classification and lifecycle of *Bombyx mori.* • Structure of silk gland and secretion of silk. • Physical and chemical nature of silk fibre, uses of silk.	
Unit III: Rearing of Silkworms	**05**
• 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**
• 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**
• Prospects of Sericulture in India. • By-products of Sericulture and Seri-products for value addition.	
B. Apiculture (Theory)	
Unit I: Biology of Bees	**01**

• Classification and biology of honey bees.	
Unit II: Rearing of Bees	**06**
• 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**
• 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**
• Products of Apiculture Industry and its uses (Honey, Bees wax, Propolis, Pollen, Royal Jelly, Bee Venom).	
Unit V: Entrepreneurship in Apiculture	**02**
• Resource available, prospects and problems. • Bee keeping industry: Recent efforts and developments. • Modern methods in employing artificial beehives for crosspollination in horticultural gardens.	

Practical	**30 Hours**
• 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.	

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).

MINOR 1: Animal Diversity (Paper Code: UZOOMIN10001)

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: 75 (Theory 40 + Practical 20 + Continuous evaluation 10 + Attendance 05)

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

Syllabus:

Theory	**Class Hour(s)**
A. Non-Chordates	
Unit I: Protista	**04**
• General characters and classification up to phyla. • Locomotory organelles in Protozoa (structure only). • Life cycle of *Plasmodium vivax.*	
Unit II: Porifera	**02**
• General characters and classification up to classes. • Canal system in *Sycon.*	
Unit III: Cnidaria and Ctenophora	**03**
• General characters and classification up to classes of Phylum Cnidaria. • General characters of Phylum Ctenophora. • Polymorphism in *Obelia.*	
Unit IV: Platyhelminthes and Nematoda	**05**
• General characters and classification up to classes. • Life cycle of *Taenia solium.* • Life cycle of *Ascaris lumbricoides.*	
Unit V: Annelida	**03**
• General characters and classification up to classes. • Coelom and metamerism in Annelida.	
Unit VI: Arthropoda	**04**
• General characters and classification up to classes. • Metamorphosis in lepidopteran insects.	
Unit VII: Mollusca	**03**
• General characters and classification up to classes. • Pearl culture.	
Unit VIII: Echinodermata	**03**
• General characters and classification up to classes. • Water vascular system in *Asterias.*	
Unit IX: Hemichordata	**01**
• Salient features.	

B. Chordates	
Unit I: Protochordata	**01**
• Salient features of Urochordata and Cephalochordata.	
Unit II: Chordata	**01**
• Salient features.	
Unit III: Pisces	**03**
• General characters and classification up to classes. • Migration of fish.	
Unit IV: Amphibia	**03**
• General characters and classification up to extant orders. • Parental care in Amphibia.	
Unit V: Reptilia	**03**
• General characters and classification up to extant orders. • Differences between poisonous and non-poisonous snakes.	
Unit VI: Aves	**03**
• General characters and classification up to sub-classes. • Flight adaptation in birds.	
Unit VII: Mammals	**03**
• General characters and classification up to infra-classes. • Adaptive radiation in mammals.	

Note: *Outline classification of the Kingdom Protista up to Phyla to be followed from Levine et al. (1980) and that of other non-chordate 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. Classification of Pisces to be followed from Romer (1959)/ Berg (1940), for Amphibia to be followed from Duellman & Trueb (1986)/ Young (1981), for Reptilia, Aves & Mammals to be followed from Young (1981).*

Practical	**30 Hours**
❖ Spot identification: • Non-Chordates: *Euglena, Paramoecium, Sycon, Physalia, Metridium, Taenia, Ascaris, Nereis*, leech, *Peripatus, Limulus*, hermit crab, *Daphnia*, millipede, centipede, cockroach, *Chiton, Octopus,* starfish and *Balanoglossus.* • Chordates: *Ascidia, Herdmania, Branchiostoma, Scoliodon, Labeo, Hippocampus, Tylototriton, Draco, Naja, Viper*, any three common birds (crow, duck, owl), squirrel and bat. ❖ Temporary mounts of: • *Cyclops, Daphnia, Mysis.* • Unstained mounts of cycloid and ctenoid scales. ❖ Submission of a report on the prevalence of insect or avian fauna in the college campus/your locality.	

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. Spot dentification: 4 specimens (2 non chordates and 2 chordates)/each 2 marks (Identification = ½, Systematic position= ½, Characters = 1) Total = 8 marks

2. Mounting: Any one (2 marks)

3. Submission of project: 6 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.P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2009). The Invertebrates: A Synthesis. III Edition, John Wiley & Sons.
2. Berg, L.S. (1940). Classification of fishes both recent and fossil. Trudy Zoologischeskogo Instituta. 5:85-517.
3. Brusca, R.C. and Brusca, G.J. (2003). Invertebrate. II Edition, Sinauer Associates Inc., Sunderland.
4. Duellman, W.E. and Trueb, L. (1986). Biology of Amphibians. Mc. Graw Hill Books Company.
5. Kardong, K.V. (2002). Vertebrates: Comparative Anatomy, Function, Evolution. III Edition, McGraw-Hill.
6. 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.
7. Parker, T.J. and Haswell, W.A. (1972). A text book of Zoology, Vol–I & II. VII edition, Marshall and Williams (eds.), Mcmillan Press ltd.
8. Pechenik, J.A. (2015). Biology of the Invertebrates. VII Edition, McGraw-Hill Education.
9. Romer, A.S. (1959). The Vertebrate Story. University of Chicago Press.
10. Ruppert, E.E., Fox, R.S., Barnes, R.D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. VII Edition, Cengage Learning, India.
11. Young, J. Z. (1981). The Life of Vertebrates. III Edition, ELBS, Oxford.
12. Young, J.Z. (2004). The Life of Vertebrates. III Edition (Indian Edition), Oxford University press.

Semester II

MAJOR 2: Biology of Chordates (Paper Code: UZOOMAJ12002)

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: 75 (Theory 40 + Practical 20 + Continuous evaluation 10 + Attendance 05)

Duration of end semester examination: (Theory 2 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**
• General characteristics and classification of Sub-Phylum Urochordata and Cephalochordata up to classes. • Retrogressive metamorphosis in *Ascidia.* • General organization of *Branchiostoma.*	
Unit III: Origin of Chordata	**02**
• Dipleurula concept and the Echinoderm theory of origin of chordates.	
Unit IV: Agnatha	**02**
• General characteristics and classification of Cyclostomata up to orders. • Metamorphosis in *Petromyzon*. • Zoological importance of ammocoete larva.	
Unit V: Pisces	**10**
• General characteristics and classification of Chondrichthyes and Osteichthyes up to sub-classes. • Swim bladder in fishes. • Accessory respiratory organs in fishes. • Migration of fishes. • Parental care in fishes. • Dipnoi: Distribution, morphology & affinities.	
Unit VI: Amphibia	**04**
• General characteristics and classification up to extant orders. • Parental care in Amphibia. • Metamorphosis in *Bufo*. • Neoteny and paedogenesis.	
Unit VII: Reptilia	**06**
• 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**
• General characteristics and classification up to sub-classes. • Exoskeleton (in relation to feathers). • Double respiration in birds. • Principles and aerodynamics of flight. • Migration of birds.	
Unit IX: Mammals	**06**
• General characters and classification up to extant orders. • Exoskeletal derivatives of mammals. • Echolocation in Microchiroptera and Cetacea.	
Unit X: Zoogeography	**03**
• Zoogeographical realms. • Plate tectonic and Continental drift theory. • Distribution of birds and mammals in different realms.	

***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**
• Museum Study of (i) Protochordata: *Herdmania, Ascidia*, *Branchiostoma.* (ii) Agnatha: *Petromyzon*, *Myxine*, Ammocoete larva. (iii) Pisces: *Scoliodon, Sphyrna*, *Torpedo*, *Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon, Diodon, Anabas,* Flat fish. (iv) Amphibia: *Necturus*, Axolotl, *Tylototriton, Bufo, Hyla*. (v) Reptilia: *Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Draco, Bungarus, Vipera, Naja, Hydrophis, Crocodylus.* (vi) Aves: Oriental pied hornbill, Red breasted flycatcher, Great tit, Pelican. (vii) Mammalia: Bat (insectivorous and frugivorous), *Funambulus,* Red panda. • 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 = ½, Systematic position= ½, 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 Zoologischeskogo Instituta. 5:85-517.
2. Darlington, P.J. The Geographical Distribution of Animals. R.E. Krieger Pub Co.
3. Duellman, W.E. and Trueb, L. (1986). Biology of Amphibians. Mc. Graw Hill Books Company.
4. Hall, B.K. and Hallgrimsson, B. (2008). Strickberger's Evolution. IV Edition, Jones and Bartlett Publishers Inc.
5. Jordan, E.L. and Verma, P.S. (2003). Chordate Zoology. S. Chand & Company Ltd., New Delhi.
6. Kardong, K.V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
7. Kent, G.C. and Carr, R.K. (2001). Comparative anatomy of the Vertebrates. IX Edition, McGraw Hill.
8. Nelson, J.S. (2006). Fishes of the World. IV Edition, Wiley.
9. Parker, T.J. and Haswell, W. (1972). Text Book of Zoology, Volume II. VII Edition, Marshall and Willam (eds.), Macmillan Press, London.
10. Pough, H. Vertebrate life. VIII Edition, Pearson International.
11. Romer, A.S. (1959). The Vertebrate Story. University of Chicago Press.
12. Romer, A.S. and Parsons, T.S. (1986). The vertebrate body. VI Edition, Saunders College Publishing.
13. Young, J. Z. (1981). The Life of Vertebrates. III Edition, ELBS, Oxford.
14. Young, J.Z. (2004). The Life of Vertebrates. III Edition (Indian Edition), Oxford University press.

SEC: Aquaculture & Fisheries and Poultry Farming (Paper Code: UZOOSEC12002)

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

Credit: 3 (Theory 2+ Practical 1)

Class Hours: 60 (Theory 30 hrs. + Practical 30 hrs.)

Full Marks: 75 (Theory 40 + Practical 20 + Continuous evaluation 10 + Attendance 05)

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

Syllabus:

Theory	**Class Hour(s)**
A. Aquaculture and Fisheries	
Unit I: Introduction to aquaculture and fisheries	**01**
• Definition, scope and importance of aquaculture and fisheries.	
Unit II: Fish culture and Management	**05**
• 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**
• Preservation and processing of fish. • Fish by-products and their economic importance.	
Unit IV: Prawn Farming and Pearl Culture	**04**
• 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**
• 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.	
B. Poultry Farming	
Unit I: Introduction to Poultry Farming	**04**
• General introduction to poultry farming, • Characteristics of common fowl breeds: Indigenous (Aseel, Kadaknath, Ghagus, Harringhata Black) and exotic (Leghorn, Cornish, Rhode Island Red, Cochin). • Systems of poultry farming.	
Unit II: Farm Management	**04**
• Nutrient requirements for different stages of layers and broilers. • Methods of feeding. • Management of chicks, growers, layers and broilers.	

Unit III: Poultry diseases	03
• Causative agents, symptoms and remedies of poultry diseases: Viral (Avian influenza), Bacterial (Pullorum disease), Protozoan (Coccidiosis) and Fungal (Aspergillosis). • Vaccination program.	
Unit IV: Harvesting of Eggs	**03**
• Selection, care and handling of hatching eggs. • Egg testing. • Methods of hatching. • Brooding and rearing. • Sexing of chicks.	
Unit V: Entrepreneurship in Poultry Farming	**01**
• Present and future scenario of poultry industry in India.	

Practical	**30 Hours**
Spot Identification: ○ *Labeo rohita, Labeo calbasu, Catla catla, Cyprinus carpio, Hypophthalmichthys molitrix, Ctenopharyngodon idella, Cirrhinus mrigala, Clarias batrachus, Heteropneustes fossilis, Ophiocephalus punctatus, Ophiocephalus marulius, Anabas testudineus.* ○ Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish, Butterfly fish. ○ *Penaeus monodon, Metapenaeus affinis, Palaemon fluminicola, Macrobrachium rosenbergii, Pinctada* sp., *Mytilus* sp. • Identification of chicken breeds (as per theory syllabus). • Identification of diseased fish and chicken (as per theory syllabus). • Project report on a visit to a fish/prawn/pearl culture farm or aquarium fish farm or poultry farm.	

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

Evaluation Structure for end semester practical examination:

1. Identification: 5 specimens (any one species of fish, any species of prawn/bivalve, any one breed of chicken, any one diseased fish, any one diseased chicken) /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. Banerjee, T.K. (2016). Applied Zoology. New Central Book Agency (P) Ltd., Kolkata.
2. Chaudhuri, S. (2017). Economic Zoology. New Central Book Agency (P) Ltd., Kolkata.
3. Das, M.K. and Das, R.K. Fish and Prawn diseases in India – Diagnosis and Control. Inland Fisheries Society of India, Barrackpore, West Bengal.
4. Ghosh, N. (2015). Poultry Science and Practice. CBS Publishers & Distributors.
5. Govindan, T.K. Fish Processing Technology. Oxford & IBH Publishing Co. Pvt. Ltd., Kolkata.
6. Gupta, S.K. and Gupta, P.C. General and Applied Ichthyology (Fish & Fisheries). S. Chand & Co. Ltd., New Delhi.
7. Hiware, C.J., Pawar, R.T., Gaikward, J.M. and Sonawane, S.R. Classification and Identification of Freshwater fishes, Daya Publishing House, New Delhi.
8. Hurd, L.M. (2003). Modern Poultry Farming. I Edition, International Book Distributing Company, Lucknow.
9. Jhingran, V.G. Fish & Fisheries of India. Hindustan Publishing Corporation, Delhi.
10. Jull, M.A. (2007). Successful Poultry Management. II Edition, Biotech Books, New Delhi.
11. Khanna, S.S. and Singh, H.R. A textbook of fish biology and fisheries. III Edition, Narendra Publishing House, Delhi.
12. Pillay, T.V.R. Aquaculture; Principles & Practices. Fishing News Books, Oxford.
13. Prasad, J. (2015). Poultry Production and Management. Kalyani Publishers.
14. Rath, R.K. Freshwater Aquaculture. Scientific Publishers, Jodhpur.
15. Santhanam, R., Sukumaran N. and Natarajan, P. A Manual on Freshwater Aquaculture. Oxford IBH Publishing Co. Ltd., Kolkata.
16. Sreenivasaiah, P.V. (2015). Textbook of Poultry Science. I Edition, Write & Print Publications, New Delhi.

MINOR 1: Animal Diversity (Paper Code: UZOOMIN10001)

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: 75 (Theory 40 + Practical 20 + Continuous evaluation 10 + Attendance 05)

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

Syllabus:

Theory	**Class Hour(s)**
A. Non-Chordates	
Unit I: Protista	**04**
• General characters and classification up to phyla. • Locomotory organelles in Protozoa (structure only). • Life cycle of *Plasmodium vivax.*	
Unit II: Porifera	**02**
• General characters and classification up to classes. • Canal system in *Sycon.*	
Unit III: Cnidaria and Ctenophora	**03**
• General characters and classification up to classes of Phylum Cnidaria. • General characters of Phylum Ctenophora. • Polymorphism in *Obelia.*	
Unit IV: Platyhelminthes and Nematoda	**05**
• General characters and classification up to classes. • Life cycle of *Taenia solium.* • Life cycle of *Ascaris lumbricoides.*	
Unit V: Annelida	**03**
• General characters and classification up to classes. • Coelom and metamerism in Annelida.	
Unit VI: Arthropoda	**04**
• General characters and classification up to classes. • Metamorphosis in lepidopteran insects.	
Unit VII: Mollusca	**03**
• General characters and classification up to classes. • Pearl culture.	
Unit VIII: Echinodermata	**03**
• General characters and classification up to classes. • Water vascular system in *Asterias.*	
Unit IX: Hemichordata	**01**
• Salient features.	

B. Chordates	
Unit I: Protochordata	**01**
• Salient features of Urochordata and Cephalochordata.	
Unit II: Chordata	**01**
• Salient features.	
Unit III: Pisces	**03**
• General characters and classification up to classes. • Migration of fish.	
Unit IV: Amphibia	**03**
• General characters and classification up to extant orders. • Parental care in Amphibia.	
Unit V: Reptilia	**03**
• General characters and classification up to extant orders. • Differences between poisonous and non-poisonous snakes.	
Unit VI: Aves	**03**
• General characters and classification up to sub-classes. • Flight adaptation in birds.	
Unit VII: Mammals	**03**
• General characters and classification up to infra-classes. • Adaptive radiation in mammals.	

Note: *Outline classification of the Kingdom Protista up to Phyla to be followed from Levine et al. (1980) and that of other non-chordate 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. Classification of Pisces to be followed from Romer (1959)/ Berg (1940), for Amphibia to be followed from Duellman & Trueb (1986)/ Young (1981), for Reptilia, Aves & Mammals to be followed from Young (1981).*

Practical	**30 Hours**
❖ Spot identification: • Non Chordates: *Euglena, Paramoecium, Sycon, Physalia, Metridium, Taenia, Ascaris, Nereis*, leech, *Peripatus, Limulus*, hermit crab, *Daphnia*, millipede, centipede, cockroach, *Chiton, Octopus,* starfish and *Balanoglossus.* • Chordates: *Ascidia, Herdmania, Branchiostoma, Scoliodon, Labeo, Hippocampus, Tylototriton, Draco, Naja, Viper*, any three common birds (crow, duck, owl), squirrel and bat. ❖ Temporary mounts of: • *Cyclops, Daphnia, Mysis.* • Unstained mounts of cycloid and ctenoid scales. ❖ Submission of a report on the prevalence of insect or avian fauna in the college campus/your locality.	

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. Spot dentification: 4 specimens (2 non chordates and 2 chordates)/each 2 marks (Identification = ½, Systematic position= ½, Characters = 1) Total = 8 marks

2. Mounting: Any one (2 marks)

3. Submission of project: 6 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.P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2009). The Invertebrates: A Synthesis. III Edition, John Wiley & Sons.
2. Berg, L.S. (1940). Classification of fishes both recent and fossil. Trudy Zoologischeskogo Instituta. 5:85-517.
3. Brusca, R.C. and Brusca, G.J. (2003). Invertebrate. II Edition, Sinauer Associates Inc., Sunderland.
4. Duellman, W.E. and Trueb, L. (1986). Biology of Amphibians. Mc. Graw Hill Books Company.
5. Kardong, K.V. (2002). Vertebrates: Comparative Anatomy, Function, Evolution. III Edition, McGraw-Hill.
6. 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.
7. Parker, T.J. and Haswell, W.A. (1972). A text book of Zoology, Vol–I & II. VII edition, Marshall and Williams (eds.), Mcmillan Press ltd.
8. Pechenik, J.A. (2015). Biology of the Invertebrates. VII Edition, McGraw-Hill Education.
9. Romer, A.S. (1959). The Vertebrate Story. University of Chicago Press.
10. Ruppert, E.E., Fox, R.S., Barnes, R.D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. VII Edition, Cengage Learning, India.
11. Young, J. Z. (1981). The Life of Vertebrates. III Edition, ELBS, Oxford.
12. Young, J.Z. (2004). The Life of Vertebrates. III Edition (Indian Edition), Oxford University press.

MDC: Conservation Biology (Paper Code: UPOBMDC12026)

Paper Type: Theory [TH]

Credit: 3 (Theory)

Class Hours: 45 (Theory)

Full Marks: 75 (Theory 60 + Continuous evaluation 10 + Attendance 05)

Duration of end semester examination: (Theory 2 ½ hrs.)

Syllabus:

Theory	**Class Hour(s)**
Unit I: History of Conservation Biology	**02**
• Ancient concepts and efforts. • Origin of 'Conservation Biology' as a new arena in the modern world.	
Unit II: Living kingdom of the world	**02**
• Five Kingdoms classification (Whitaker, 1969), Three Domains concept (Carl Woese et al., 1990) (Basic concepts).	
Unit III: Classification of living organisms	**02**
• Taxonomy and classification (definition) • Concepts of Biological species, Morphospecies.	
Unit IV: Elementary concepts associated with Conservation Biology	**05**
• Biome, Biosphere, Ecosystem, Biodiversity, Ecological diversity, Genetic diversity (Definition and basic concept). • Biodiversity hotspots, Megadiverse countries. (Definition and basic concept).	
Unit V: Measurements for conservation	**03**
• Elementary idea of Data and sampling. • Population abundance and density.	
Unit VI: Global patterns of diversity	**02**
• Biogeographical realms (Terrestrial only).	
Unit VII: Values of biodiversity	**02**
• Values of biodiversity. • Significance of conservation biology.	
Unit VIII: Loss of Biodiversity	**05**
• Extinction (definition, reasons; concept of mass extinction, pseudoextinction. coextinction and Lazarus taxa). • Habitat fragmentation & degradation, overexploitation, invasive alien species, climate change. • Biodiversity loss in Indian context.	

Unit VIII: Legal foundations of conservation	**04**
• Laws related to biodiversity conservation (Wildlife protection act 1972; Forest right act, 2006). • National and International organizations/ bodies/ programs (WWF, IUCN, CBD, CITES, MoEF,).	
Unit IX: Idea of IUCN Red List	**02**
• Elementary idea of IUCN Red List (Conservation status of species by IUCN Red List categories).	
Unit X: Conservation Strategies	**14**
• Concepts of Reserve Forest, Biosphere reserve, Wildlife sanctuary, National Park, Sacred grove, Gene Bank, PBR. • Keystone species, Flagship species, Endemic species, Umbrella species. • Endemic and endangered species of India. • Concepts of *ex situ* and *in situ* conservation. • Major animal conservation projects in India (Project Tiger, Project Elephant, Project Rhino and Project Cheetah).	
Unit X: Technology in Conservation Biology	
• Modern technology in Conservation Biology (Camera trapping, Acoustic monitoring, Remote sensing with LIDAR).	**02**

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.

Question pattern for end semester theory examination

For 60 marks

Sl. No.	**Questions to be answered**	**Out of**	**Marks of each question**	**Total marks**
1	10	15	1	1 x 10 =10
2	6	9	5	5 x 6 = 30
3	2	4	10	10 x 2 =20

For 40 marks

Sl. No.	**Questions to be answered**	**Out of**	**Marks of each question**	**Total marks**
1	5	8	1	1 x 5 =5
2	3	5	5	5 x 3= 15
3	2	4	10	10 x 2=20