

The University of Burdwan



Syllabus for 3-Year Degree/4-Year Honours in Zoology

**Under Curriculum and Credit Framework
for Undergraduate Programmes (CCFUP)
ASPERNEP, 2020**

With effect from 2023-2024

SEMESTER WISE & COURSE WISE CREDIT & MARKS DISTRIBUTION STRUCTURE UNDER CCFUP as per NEP, 2020

Semester	Course Type	Course Title with Code	Credit	Lect.	Tuto.	Pract./ Viva	Full Marks	Distribution of Marks		
								Theory	Pract. / Viva-voce	Internal Assessment
I	Major/DS Course (Core)	ZOOL1011: Non-Chordates	4	3		1	75	40	20	15
	Minor Course	ZOOL1021: Non-Chordates	4	3		1	75	40	20	15
	Multi/Inter disciplinary	ZOOL1031: Introduction to Animalia	3	2	1	0	50	40	00	10*
	Ability Enhancement Course (AEC) [L ₁ -1 MIL]	Arabic/ Bengali/ Hindi/ Sanskrit/ Santali/ Urdu or EquvInt. Course from SWAYAM/ Any other UGC-recognized platform	2	2	0	0	50	40	0	10
	Skill Enhancement Course (SEC)	ZOOL1051: Apiculture/ Vermiculture	3	2	1	0	50	40	0	10**
	Common Value Added (CVA) Course	VAC1061: Environmental Science/ Education	4	3	0	1	100	60	20	20
	Total		20				400			

* Internal Assessment of 10 marks in case of Multi/Inter Disciplinary will be based on Practical Portion of the course concerned.

** Internal Assessment of 10 marks in case of SEC will be based on Practical Portion of the course concerned.

Semester	Course Type	Course Title with Code	Credit	Lect.	Tuto.	Pract./ Viva	Full Marks	Distribution of Marks		
								Theory	Pract. / Viva-voce	Internal Assessment
II	Major/DS Course (Core)	ZOOL2011: Chordates	4	3		1	75	40	20	15
	Minor Course	ZOOL2021: Chordates	4	3		1	75	40	20	15
	Multi/Inter disciplinary	ZOOL2031: Applied Zoology I	3	2	1	0	50	40	00	10*
	Ability Enhancement Course (AEC) [L ₁ -1 MIL]	Communicative English or EquvInt. Course from SWAYAM/ Any other UGC-recognized platform	2	2	0	0	50	40	00	10
	Skill Enhancement Course (SEC)	ZOOL2051: Sericulture/ Aquarium Fish keeping	3	2	1	0	50	40	00	10**
	Common Value Added (CVA) Course	VAC2061: Understanding India/ Digital & Technological Solutions/Health & wellness, Yoga Education, sports & Fitness	4	3	0	1	100	80/60	00/20	20
	Total		20				400			

* Internal Assessment of 10 marks in case of Multi/Inter Disciplinary will be based on Practical Portion of the course concerned.

** Internal Assessment of 10 marks in case of SEC will be based on Practical Portion of the course concerned.

ZOOL1011: NON-CHORDATES

OBJECTIVES OF THE STUDY: The main objective of this syllabus is to acquaint the students about the diversity of animals (invertebrates) of this universe especially their taxonomic position of animal kingdom as well as their physiology and organ system.

SLNO.	TOPICS(Credits:3)	TOTALNO. LECTURES (45)
1	Unit1:Basics of Animal Classification Definition: Classification, Systematics, and Taxonomy, Code of Zoological Nomenclature.	2
2	Unit2: Protista and Metazoa Protozoa: General Characteristics and Schematic Classification up to phylum (Levine et al. 1980) Locomotion in <i>Amoeba</i> , Conjugation in <i>Paramecium</i>	5
3	Unit3: Porifera General characteristics and schematic classification upto order (Hyman,1951) Canal System and Spicules Of Sponges	5
4	Unit4:Cnidaria General characteristics and schematic classification upto class (Ruppert and Barnes.1994); Metagenesis of <i>Obelia</i> , Coral Reef Types And Formation	4
5	Unit5:Ctenophora General Characteristics only	1
6	Unit6:Platyhelminthes General characteristics and schematic classification upto class (Ruppert and Barnes 1994)	2
7	Unit7:Nematoda General characteristics and schematic classification upto class (Ruppert and Barnes, 1994)	2
8	Unit8:Annelida General characteristics and schematic classification upto class (Ruppert and Barnes1994), Metamerism, Nephridia: Structure And Function	4
9	Unit9:Arthropoda General characteristics and schematic classification upto class (Ruppert & Barnes, 1994), Vision In Insects, Metamorphosis in Lepidopteran insect	6
10	Unit10:Onychophora Evolutionary Significance	2

11	Unit11:Mollusca General characteristics and schematic classification upto class (Ruppert and Barnes1994), Modification Of foot, Nervous system and torsion in Gastropods	5
12	Unit12:Echinodermata General characteristics and schematic classification up to class (Ruppert and Barnes1994), Water Vascular System of <i>Asteroidea</i> , Structure Of Tube Feet, Larval forms in Echinodermata	4
13	Unit13:Hemichordata General characteristics phylum Hemichordata, Relationship of non-chordates and chordates.	3

Suggested Readings:

1. Anderson,D.T.(Ed.)(2001).InvertebrateZoology.2ndEd.OxfordUniversity Press.
2. Barnes,R.D.&Ruppert,E.E.,(1994).InvertebrateZoology.6thEd.BrooksCole.
3. Barrington,E.J.W.(1981). Invertebrate Structure and function.2ndEd.ELBS&Nelson.Blackwelder,R.E.,(1967).Taxonomy-ATextandreference book. JohnWiley&Sons.
4. Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4th Ed. Sinauer Associates...Dhami.SandJ.K.Dhami–InvertebrateZoology–S.ChandAndCo.
5. Hickman,C.P.Jr.,F.M.HickumanandL.S.Roberts,1984.IntegratedPrinciples of Zoology, 7th Edition, Times Merror/Mosby College Publication. St. Louis. 1065pp.
6. Hyman,L.H.(1951).TheInvertebrates(Vol-I).Mc.GrawHillBookCompany.
7. Jordan,E.L.&Verma,P.S.(2006).InvertebrateZoology.S.Chand&CompanyLtd.NewDelhi.
8. Kapoor,V.C.(2008).Theoryandpracticeofanimaltaxonomy.6thEd.Oxford&IBH PubKotpal,R.L.,1988 –1992.(All Series)Protozoa,Porifera,Coelentereta,Annelida, Arthropoda,Mollusca, Echinodermata,–RastogiPublications, Meerut – 250002.
9. Mayr,E.(1969).PrinciplesofSystematicZoology.TataMcGraw-Hill.
10. Mayr,E.&Ashlock,P.D.(1991).PrinciplesofSystematicZoology.2ndEd.,McGraw-Hill.
11. Meglitsch,P.A. &Schram,F.R.(1991).Invertebrate Zoology.OxfordUniversityPress.
12. Chaki,Kundu,SarkarIntroductiontoGeneralZoology.Vol1.NewCentralBookAgency (P)LTD.
13. Parker,T.J.&Haswell,W.(1972).TextBookofZoology,VolumeI.MacmillanPress,London.
14. Pechenik,J.A.(1998).BiologyoftheInvertebrates,4thEd.McGraw Hill..RuppertE.E.,Fox,R.&BarnesR.D.(2003).InvertebrateZoology: aFunctionalEvolutionaryApproach.7th Ed. Brooks Cole.
15. Sinha,K.S.,Adhikari,S.,&Ganguly,B.B.Biologyof Animals.Vol.I.NewCentralBookAgency.Kolkata.

Classification to be followed from Barnes and Ruppert 1994,6thEdition

NON-CHORDATES PRACTICAL(Credit:1)

1. Spot Identification of *Amoeba*, *Euglena*, *Paramoecium*. Fullmarks:20
2. Spot Identification of *Sycon*, Neptune's Cup, *Obelia*, *Pennatula*, *Fungia*,
3. Spot Identification and Significance of adult *Taenia solium* and *Ascaris lumbricoides*.
4. Spot identification of the following specimens.

Annelids- *Nereis*, *Pheretima*, *Hirudinaria*

Arthropods- *Bombyx*, *Periplaneta*, *Apis*, *Anopheles*, *Culex*.

Molluscs- *Pila*, *Lamellidens*, *Sepia*, *Octopus*,

Echinoderms- *Pentaceros/Asterias*, *Ophiura*, *Echinus*,
Antedon

Hemichordata-*Balanoglossus*

5. Dissection–Digestive system and nervous system of *Periplaneta* sp.

6. Mounting Of the following specimens—

Mouthparts of cockroach, Whole Mount: Mosquito.

- | | |
|--|---------|
| 1. Dissection (From item No.5) anyone | (7x1=7) |
| 2. Spot Identification (any three from item no.1,2,3,4.) | (3x2=6) |
| 3. Mounting One Item from item no.6 | (5x1=5) |
| 4. Laboratory Note Book | (2) |

Suggested Readings:

1. Chatterjee and Chatterjee Practical Zoology.
2. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata.
3. Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay Advanced Practical Zoology.

Course Outcomes:

At the end of the syllabus students learn the Systematic and biology of non chordates through their adaptive features and their body organization. Comprehend the identification of species and their evolutionary relationships.

ZOOL1021: NON-CHORDATES

OBJECTIVES OF THE STUDY: The main objective of this syllabus is to acquaint the students with the diversity of animals (invertebrates) of this universe especially their taxonomic position of the animal kingdom as well as their physiology and organ system.

SL NO.	TOPICS (Credits:3)	TOTALNO. OF LECTURES (45)
1	Unit1:Basics of Animal Classification Definition: Classification, Systematics and Taxonomy. Codes of Zoological nomenclature.	2
2	Unit2: Protista and Metazoa Protozoa: General characteristics and schematic classification upto phylum (Levineetal.1980) Locomotion in <i>Amoeba</i> , Conjugation in <i>Paramecium</i> .	5
3	Unit3: Porifera General characteristics and schematic classification up to class (Hyman, 1951).The canal system in sponges.	5
4	Unit4: Cnidaria General characteristics and schematic classification up to class (Ruppert and Barnes.1994) Metagenesis of <i>Obelia</i> , Coral reef diversity, and conservation.	4
5	Unit5: Ctenophora General characteristics only	1
6	Unit6: Platyhelminthes General characteristics and schematic classification up to class (Ruppert and Barnes 1994).	2
7	Unit7: Nematoda General characteristics and schematic classification up to class (Ruppert and Barnes1994).	2
8	Unit8:Annelida General characteristics and schematic classification upto class (Ruppert and Barnes1994) Metamerism in Annelida, Nephridia: Structure and function	4
9	Unit9: Arthropoda General characteristics and schematic classification up to class (Ruppert and Barnes.1994) Vision in insects, Metamorphosis in Lepidopteran insects.	6
10	Unit10: Onychophora Evolutionary significance	2

11	Unit11: Mollusca General characteristics and schematic classification up to class (Ruppert and Barnes1994), Modification of foot, Nervous system and torsion in Gastropoda.	5
12	Unit12: Echinodermata General characteristics and schematic classification up to class (Ruppert and Barnes1994), Water vascular system of starfish.	4
13	Unit13: Hemichordata General characteristics of phylum Hemichordata, Relationship of non-chordates and chordates	3

Suggested Readings:

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

NONCHORDATE PRACTICAL (Credit:1)

Fullmarks:20

1. Spot Identification: Either from museum specimen or from photograph

Group I: *Amoeba, Euglena, Paramecium, Sycon, Obelia, Physalia, Aurelia, Taenia solium, Ascaris lumbricoides, Nereis, Hirudinaria*

Group II: *Macrobrachium, Scylla, Carcinuscorpius, Trigoniuulus, Chiton, Patella, Loligo, Sepia, Pentaceros Ophiura, Echinus, Balanoglossus*

2. Dissection–Digestive and nervous system of cockroach.

3. Mounting: Mouthparts of cockroach

4. Temporary staining and mounting of any zooplankton

1. Dissection (From item No.5)	6
2. Spot identification (two from each group)	(4x2)=8
3. Mounting (From 3 and 4)	4
4. Laboratory Notebook	2

Suggested Readings:

1. Chatterjee and Chatterjee Practical Zoology
2. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
3. Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay Advanced Practical Zoology

Course Outcomes:

At the end of the course students will learn about the systematics and biology of non chordates through their adaptive features and body organization and comprehend the identification of species and their evolutionary relationships.

ZOOL1031: INTRODUCTION TO ANIMALIA

Objectives of the Course:

- The specific learning goals for general zoological overview of the animal world is to provide students with a working knowledge of fundamental concepts that will help in further understanding of the course curriculum for further advanced studies, interests and works.
- This basic course makes students familiar with animal classification schemes and associated taxonomic group diagnostic features.
- This will also help in developing and understanding and ability to apply basic zoological principles.

UNIT	TOPIC(CREDIT3)	NUMBEROF CLASSES
1	Brief idea about animal kingdom; general characters and Basic features of Kingdom Protista upto Phyla	2
2	Outline classification and general basic characters of Phylum Porifera, Cnidaria, Platyhelminthes, Nematelminthes, Annelida, Arthropoda, Mollusca and Echinodermata upto Class	16
3	General features of Classes Pisces, Amphibia, Reptiles, Aves and Mammals	12
4	Basic idea of life cycles of butterfly and any one common Carp	2
5	Basic and brief idea about ecosystem, population, community, habits and habitats; types of adaptations	5
6	Overview of different interactions among animals like competition and predation. Commensalism, parasitism, mutualism, symbiosis, amensalism with examples	8
	All examples should be common names.	45
<p>PRACTICAL</p> <p>1. Visittozoologicalgardenoranimalmuseum,preparationofprojectreportofthevisit.(7)</p> <p>2. Preparation of an animal album taking any four animals as subjects.(3)</p> <p>(Fifteen hours should be spent for the practicals)</p>		<p>CREDIT:1;FM: 10</p>

ZOOL1051: APICULTURE

Objectives of the Course: The objective of this SEC course is to know the basic concepts of beekeeping by undergraduate students, and beginners. Students will get knowledge about different bees, culture techniques, honey harvesting, and knowledge diseases enemies of honey bees. The knowledge gained by the students can be utilized in the field or even to start their own enterprise after completion of the course.

SLN O.	TOPICS(Credits:2)	TOTAL NO. LECTURES (30)
1.	History and importance of apiculture; the systematic position of bees; different species of common honey bees and their Description.	3
2.	The life cycle of the honeybee; general morphology and anatomy of different castes of honeybees; emphasis on mouth parts; Non-Apis bee species.	4
3.	Structure Of Different Beehives Or Honeycomb; colonial Organization; bee language and communications.	3
4.	Methods Of Keeping: Indigenous methods and its Disadvantages.	2
5.	Apiary: selection of good apiary site; selection of good bee.	2
6.	Modern methods of Apiculture: Discovery of the movable hive; Langstroth and Newton hive; description of modern movable beehive; accessory equipment used in bee keeping industry. Extraction of honey; important points regarding the handling of bees.	4
7.	Products of Apiculture: Honey, wax, etc., chemical Compositions; use; other products like propolis, royaljelly, apitoxin, etc.	3
8.	Diseases And Enemies: parasitic diseases; other enemies.	3
9.	Types of Beekeeping, economics: Stationary and migratory; Economics Of Beekeeping, the position of this industry from the Indian perspective.	3
10.	Entrepreneurship in Apiculture: Beekeeping as a source of employment and livelihood; the role of KVIC for beekeeping in India; proposal preparation for funding.	3

Reference Books:

Handbook of Economic Zoology. Jawaid Ahsan and S.P. Sinha, S.C. Publication.
 Vinesh: A Text Book of apiculture (SEC) Dr. Hem Raj. S. Vinesh & Co.
 Sara Apiculture. K.V. Jayashree, C.S. Tharadevi, N. Arumugam.
 Textbook of Apiculture (Beekeeping). D.K. Belsara et al. Himalaya Publishing House. Modern
 Textbook of Zoology Invertebrates. R.L. Kotpal.
 Biology of Animal. Ganguly, Sinha, Adhikari. New Central Book Agency. Apiculture
 ICAR PDF Book, AgriMoon.com. Free Download.

APICULTURE PRACTICAL (Credit:1)**Full Marks:10**

Visit pharm/lab and submit report: 06

Viva-voce: 04

Course Outcomes:

1. Get complete knowledge of honeybees and their different casts.
2. Get knowledge about artificial beehive and their uses for apiculture.
3. To know about different diseases on enemies of honeybees.
4. Able to know the techniques of honey extraction and handling of honeybees.
5. Get a brief idea about entrepreneurship in Apiculture.

ZOO1051: VERMICULTURE

Objectives of the Course: Vermiculture is the study Commercial application of technologies that utilize earthworms for degrading waste organic materials for sanitation and agricultural re-use. Earthworms degrade organic waste materials and convert them into vermicompost. The main objective of this course is to provide the students with knowledge of vermiculture technology and its application in agriculture as well as entrepreneurship.

SL NO.	TOPICS (Credits:2)	TOTAL NO. OF LECTURES(30)
1.	Earthworm Morphology and Anatomy: Taxonomic Position, external features, internal anatomy.	3
2.	Habitat Ecology and reproduction: Burrowers, casts, nocturnal, poikilothermic, ecological grouping, Epigeic sp., Endogenics., Anecics.	3
3.	Description of some important earthworm sp: <i>Eisenia fetida</i> , <i>Eudriluseugeniae</i> , <i>Lumbricus rubellus</i> .	3
4.	Importance Of Earthworm In Agriculture: Role Of Earthworm to increase fertility of soil.	3
5.	Vermiculture and Vermiculture: Definition, History At Different countries and India.	3
6.	Vermiculture: Methods, wormery, breeding technique, indoor outdoor culture, mono-and Polyculture And Merits and Demerits.	5
7.	Vermi composting Of Wastes: Different Methods, storage. Vermi wash: preparation and application.	3
8.	Diseases and Predators/pathogen of earthworm. Maintenance Wormeries.	3
9.	Marketing and Future perspective: Marketing the products of Vermiculture, quality control, marketing techniques, demand study, advertisement, packing and transport, and financial support.	4

Reference Books:

1. Edward, C.A. and Bohlen, P.J. Biology and Ecology and Earthworm. Chapman Hall. NY, USA.
2. Sultan Ahmed Ismail. The Earth worm Book. Other India Press.
3. Bhatnagar and Patla. Earthworm Vermiculture and vermicomposting. Kalyani Publishers, New Delhi.
4. Sara's Vermiculture technology, M.S. Lekshmy, R. Santhi.
5. Modern Text Book of Zoology, Invertebrates. R.L. Kotpal.

6. Lee, K.E. Earthworm: Their ecology and relationship with soil and land use. Academic Press, Sydney.
7. Singh, Keshav. A Textbook of Vermicompost, Vermiwash, and Biopesticides. Publisher- Biotech, marketed by Meripustak.
8. National Institute of Industrial Research, (2010): The Complete Technology Book on Vermiculture and Vermicompost, Published by National Institute Industrial Research, Delhi-7, India.

VERMICULTURE PRACTICAL (Credit:1)

Full Marks:10

Visit pharm/lab and submit report: 06

Viva-voce: 04

Course Outcomes:

1. The Course Has A Broad scope for Employability.
2. Students will gather knowledge on soil earthworms; their characteristic features, occurrence, and their influence on soil fertility and solid waste management are included.
3. Students will gather knowledge on Vermicomposting technology in respect of the global level as well as the Indian perspective.
4. Application of Vermiculture products and their benefits in agriculture practice.

ZOO2011: CHORDATES

OBJECTIVES OF THE STUDY: This course is designed to give a learner the fundamental understanding of the diversity of Phylum Chordata with emphasis on their origin, key characteristics, classification, distribution, and function. This course will make the students enlightened with the concept of diversity, organization, adaptation, and taxonomic status of Chordates. The course will give an understanding of the systemic physiology of chordates. There will be a discussion about the affinities of chordates to different groups.

SL NO.	TOPICS (CREDIT:3)	TOTALNO.OF LECTURES (45)
1	Origin of Chordata Dipleura concept and the Echinoderm theory of Chordata	2
2	Introduction to Chordates General characteristics and outline classification of Phylum Chordata Upto living Subclasses Advanced features of Vertebrates over Protochordata Retrogressive Metamorphosis In <i>Ascidia</i> Feeding Mechanism In <i>Branchiostoma</i>	2 2 1 1
3	Agnatha General characteristics and classification of Cyclostomes upto Sub-class	2
4	Pieces General characteristics and classification of Chondrichthyes and Osteichthyes Upto Subclasses Accessory respiratory organs and swim bladder in fishes Osmoregulation And Parental Care in fishes	2 2 2
5	Amphibia General characteristics and classification upto living Sub-classes Metamorphosis and Parentalcare in Amphibia	2 2
6	Reptilia General characteristics and classification upto living Sub-classes General features of poisonous and non-poisonous snakes Poison Apparatus And Biting Mechanism In Snakes	2 2 2

7	Aves	2
	General characteristics and classification upto living Sub-classes Exoskeleton and migration in Birds Principles and aerodynamics of flight in Birds	2 1
8	Mammalia	2
	General characteristics and classification upto living Sub-classes	2
	Affinities of Prototheria	2
	Exoskeletal derivatives of Mammals	2
	Echolocation in Bat and Whale	2
	Adaptive radiation in mammals with reference To Locomotory Organs.	2
9	Zoogeographical Realms	2
	Distribution of Birds and Mammals different realms	2

Reference books:

1. Arora, M.P. Chordata I. Himalaya Pub House.
2. Chatterjee, A. & Chakraborty, C.S. Approach to a Text Book of Zoology. Nirmala Library, Kolkata.
3. Jordan, E.L. & Verma, P.S. (2006). Invertebrate Zoology & Chordate Zoology. S. Chand & Company Ltd. New Delhi.
4. Kardong, K.V. (2002). Vertebrates: Comparative Anatomy, Function & Evolution. Tata McGraw Hill.
5. Kent, G.C. & Carr, R.K. (2001). Comparative anatomy of the Vertebrates. 9th. McGraw Hill.
6. Kotpal, R.L., 1988-1992. (All Series) Protozoa, Romer, A.S. & Parsons, T.S. (1986). The vertebrate body. 6th Ed. Saunders College Pub.
7. Saxena, R.A. & Saxena, S. Cooperative Anatomy in Vertebrates. Viva Publication.
8. Sinha, K.S., Adhikari, S., Ganguly, B.B. Biology of Animals. Vol. I, II. New Central Book Agency. Kolkata.
9. Young, J.Z. (2004). The Life of Vertebrates. III Edition. Oxford University Press.

CHORDATES PRACTICAL (Credit:1)

1. Spot Identification of

Full Marks: 20

- a. Protochordate: *Balanoglossus, Branchiostoma*
- b. Agnatha: *Petromyzon*, Hagfish
- c. Fish: *Scoliodon, Sphyrna, Pristis, Torpedo, Labeo, Catla, Cirrhinus, Anabas, Ctenopharyngodon, Heteropneustes, Clarias, Exocoetis, Echinis*
- d. Amphibia: *Necturus, Bufo, Hyla, Axolotlarva, Tylotriton*.
- e. Reptilia: *Chelone, Varanus, Mabuya, Draco, Vipera, Naja, Hydrophis*.
- f. Mammalia: Bat, *Funambulus*.

2. Temporary staining and mounting of cycloid and ctenoid scales.

3. Identification of Poisonous and non-poisonous snake.

4. Power point presentation on the study of any two animals from two different classes by students. Power point Submission and demonstration.

Examination Pattern:

1. Spot identification (6 from Item)	(6×2) =12
2. Staining and mounting(1 from item 2)	(1×4) =04
3. Laboratory Note Book-	02
4. Power point presentation-----	02

Suggested Readings:

ChatterjeeandChatterjee:PracticalZoology
Ghosh,K.C.andManna,B.(2015):PracticalZoology,NewCentralBook Agency,
Kolkata.

Course Outcomes:

The students will get knowledge to explain the diversity of Protochordates and chordates. Identify the taxonomic position of chordates, their diversity, and their distribution. Gain insights about economic importance and significance Pieces and Pisciculture. Identify and distinguish between poisonous and non-poisonous snakes by observing characteristic features. Students gain knowledge about the composition and significance of venom. Gain insights About The Structural specialties of birds which will help them for Poultry (commercial application). Adaptive radiation of Mammals Will give the insight into diversity and distribution of Mammals.

ZOOL20211: CHORDATES

OBJECTIVES OF THE STUDY: This course is designed to give a learner the fundamental understanding of the diversity of Phylum Chordata with emphasis on their origin, key characteristics, classification, distribution and functioning. This course will make the students enlightened with the concept of diversity, organization, adaptation and taxonomic status of Chordates. The course will give the understanding of systemic physiology of chordates. There will be discussion about the affinities of chordates to different groups.

SL NO	TOPICS (CREDIT:3)	TOTAL NUMBER OF LECTURES:45
1	<p style="text-align: center;">Origin of Chordata:</p> Dipleurula concept and the Echinoderm theory	2
2	<p style="text-align: center;">Introduction to Chordates</p> General characteristics and outline classification of Phylum Chordata up to living classes. Advanced features of Vertebrates over Protochordates.	2
3	<p style="text-align: center;">Agnatha</p> General features and outline classification up to classes (Young, 1981).	1
4	<p style="text-align: center;">Pieces</p> General features and outline Classification upto Subclasses (Romer, 1959). Accessory respiratory organs in fishes. Osmoregulation in fishes.	8
5	<p style="text-align: center;">Amphibia</p> General features and outline Classification up to living orders (Duellman Trueb, 1986). Metamorphosis and Parental care in Amphibia	8
6	<p style="text-align: center;">Reptilia</p> General features and outline Classification up to living Subclass (Young, 1981). Venom types and Biting mechanism in venomous snakes. Clinical symptoms of snake bite.	8
7	<p style="text-align: center;">Aves</p> General features and outline Classification up to orders (Young, 1981). Migration in birds.	8
8	<p style="text-align: center;">Mammalia</p> General features and outline Classification upto Subclasses (Young, 1981). Adaptive radiation in primates depends upon food. Echo location in Bat	8

Reference books:

1. Arora, M.P. Chordata I. Himalaya Pub House
2. Chatterjee, A. & Chakraborty, C.S. Text Book of Zoology, Nirmala Library, Kolkata.
3. Jordan, E.L. & Verma, P.S. (2006). Chordate Zoology.. S. Chand & Company Ltd. New Delhi.
4. Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
5. Kent, G. C. & Carr, R. K. (2001). Comparative anatomy of the Vertebrates. 9th Ed. McGraw Hill.
6. Romer, A. S. & Parsons, T. S. (1986). The vertebrate body. 6th Ed. Saunders College Pub.
7. Saxena, R. A. & Saxena, S. Comparative Anatomy Vertebrates. Viva Publication.
8. Sinha, K. S., Adhikari, S., & Ganguly, B. B. Biology of Animals. Vol. I, II. New Central Book Agency. Kolkata.
9. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford University press.

CHORDATE PRACTICAL (Credit:1)**Full marks: 20**

1. Spot Identification: Either from Museum specimen or from photograph

Group I: *Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo, Labeo, Parexocoetus, Tylotriton, Duttaphrynus, Polypedates*

Group II: *Lissemys, Chamaeleo, Draco, Daboia, Lycodon, Ptyas, Naja, Passer, Psittacula, Alcedo, Pteropus, Funambulus, Suncus*

2. Temporary staining and mounting of cycloid and ctenoid scales.

3. Fish market survey to study different fish species and preparation of a survey report.

- | | |
|--|-----------|
| 1. Spot identification (Three from each group) | (6×2)= 12 |
| 2. Staining and mounting | (04) |
| 3. Laboratory Notebook | (02) |
| 4. Survey Report | |

Suggested Readings:

1. Chatterjee and Chatterjee: Practical Zoology
2. Ghosh, K. C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata

Course Outcomes:

The students will get knowledge to explain the diversity of Protochordates and chordates, identify the taxonomic position of chordates, their diversity and distribution. They will gain insight into the economic importance and significance of Pieces and Pisciculture, and identify and distinguish between poisonous and non-poisonous snakes by observing characteristic features. Students will gain knowledge about the composition and significance of venom and the structural specialities of birds which will help them with Poultry (commercial application). Adaptive radiation of Mammals will give them insight into the diversity and distribution of Mammals.

ZOOL2031: APPLIED ZOOLOGY I

SLNO.	TOPICS (Credits:2)	TOTAL NO.OF LECTURES (30)
1	<p>Chapter1.Sericulture:</p> <ul style="list-style-type: none">• History and present status of sericulture in India and West Bengal.• Mulberry And Non-mulberry species in India.• Mulberry Cultivation.• Morphology and lifecycle of <i>Bombyx mori</i>.• Silkworm RearingTechniques: Processing of cocoon, reeling.• Silkworm Diseases-pests and their control. <p>Chapter2.Apiculture:</p> <ul style="list-style-type: none">• Introduction and present status of apiculture in West Bengal.• Species of honeybees in India, lifecycle of <i>Apis indica</i>• Colony Organization, division of labour and communication.• Beekeeping as an agro-based industry; methods and equipments: indigenous methods, extraction appliances, extraction honey from the comb and processing.• Bee pasturage, honey and bees wax and their uses• Pests and Diseases of Bees And Their Management.	15

Books & Suggested Readings:

1. Eikichi, H. (1999). *Silkworm Breeding* (Translated from Japanese). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Ganga, G. (2003). *Comprehensive Sericulture Vol-II: Silkworm Rearing and Silk Reeling*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Mahadevappa, D., Halliyal, V. G., Shankar, D. G. and Bhandiwad, R., (2000). *Mulberry Silk Reeling Technology* Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
5. Roger, M. (1990). *The ABC and XYZ of Bee Culture: An Encyclopedia of Beekeeping*, Kindle Edition.
7. Shukla and Upadhyaya (2002). *Economic Zoology*, Rastogi Publishers.
8. Yadav Manju (2003). *Economic Zoology*, Discovery Publishing House.
9. Jabde Pradip V (2005). *Textbook of applied Zoology*, Discovery Publishing House, New Delhi.
10. Cherian & Ramachandran *Beekeeping in South Indian Govt. Press, Madras.*
11. Sathe, T. V. *Vermiculture and Organic farming.*
12. Bard, J. (1986). *Handbook of Tropical Aquaculture.*
13. Santhanam, R. A. *Manual of Aquaculture.*
14. Zuka, R. I and Hamiyn (1971). *Aquarium fishes and plants*
15. Jabde, P. V. (2005) *Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac Culture.*
16. *Animal Disease - Bairagi K. N. Anmol Publications Pvt. Ltd 2014*
17. *Economics of Aquaculture - Singh (R. K. P) - Danika Publishing Company 2003*
18. *Applied and Economic Zoology (SWAYAM) web https://swayam.gov.in/nd2_cec20_ge23/preview*

Course Books published in English and Bengali may be prescribed by the Universities and Colleges

APPLIED ZOOLOGY PRACTICAL (Credit:1)**Full Marks: 10**

Visit any pharm/lab and submit report: 06

Viva-voce : 04

Course Outcomes:

1. Comprehensive Knowledge of different aspects of applied Zoology.
2. Understanding about Culture processes and rearing of different economically important animals.
3. To know about different diseases on enemies of economically important animals.
4. Get a Brief Idea about the advantages and limitations of different economically important animals.

Abbreviations: SEC: Skill Enhancement Course, MDC: Multi Disciplinary/Inter-Disciplinary Course

ZOOL2051: SERICULTURE

Objectives of the Course: The syllabus for Sericulture at undergraduate SEC according to NEP has been framed. The main objective of framing this new syllabus is to give the students a proper understanding of Sericulture. Students will get knowledge about mulberry plant cultivation, different silkworms, culture techniques, silk production, and the knowledge of diseases and enemies of silkworms. The students can be utilized the knowledge in starting their own enterprise after completion of the course.

UNIT	TOPICS(Credits:2)	TOTAL NO.OF LECTURES (30)
1.	History Of Sericulture; the systematic position of silkmooths; different species of silkmooths, their description.	3
2.	Biology of Mulberry Plants: Description Mulberry. Salient Features of family Moraceae; Phyto-geography and systematic of the genus <i>Morus</i> L. And Its Species; Morphology and anatomy of mulberry plant; Different cultivars of mulberry; Floral Biology of mulberry: Structure of male and female flowers, catkins	4
3	Mulberry Cultivation: Processes Of Cultivation, irrigation process, application of fertilizer both inorganic and organic likes vermicomposting. Diseases of mulberry plants Leaf: Leaf spot, Powdery mildew, Leaf Rust, Leaf Blight. Diseases Of Mulberry Root:Root rot disease, Root knot disease. Pest management of Mulberry plants, Major and Minor: Name, pattern attack, prevention and control.	4
4.	Silkworm Morphology: of the egg, larva, pupa, adult of <i>Bombyx mori</i> . Silkworm Anatomy <i>Bombyx mori</i> : Digestive System: Larva, Circulatory system: Larva, pupa, adult, Nervous System: Larva, adult, Silk Gland: Larva, Reproductive System:Adult.	3
5.	Silkworm Diseases of <i>Bombyx mori</i> : Protozoan disease, Bacterial Disease, Fungal disease, Viral Disease, Sotro Silkworm Pests of <i>Bombyx mori</i> : Uzifly, Ants, Dermestid Beetles.	3
6.	Mulberry Silkworm Rearing: Model rearing house, Rearing appliances, disinfection, disinfectants, bedcleaning, feeding of	4

	worms. Rearing of larvae: techniques of rearing of different stages of larvae.	
7.	Harvesting of cocoon: Sex determination of cocoon, harvesting of cocoon.	2
8.	Post Cocoon And Silk Collection Technology: Cocoon Stifling (sun drying, steam stifling, hot air stifling) and storage. Deflossing, cocoon riddling, mixing or blending, cocoon cooking, brushing. Types Of Reeling Machines, reeling operation, reeling end formation. Degumming, bleaching, dyeing silk yarn. Twisting, Reeling, Re-reeling, lacing, skeining and testing of raw silk material Weaving Of silk.	4
9.	Entrepreneurship Sericulture: Sericulture Sasource Of Employmentand livelihood; the role of CSB in supporting and guiding entrepreneurship.	3

Reference Books:

1. Charsley, S.R. (1982). Culture and Sericulture. Academic Press Inc. New York, U.S.A.
2. FAO Manuals-IMulberry Cultivation. FAO Rome.
3. Ganga, G., and J. Sulochana Chetty. (1991) An Introduction to Sericulture. Oxford & IBH Publishing Company.
4. Jayaram, H. (2005) Mulberry Cultivation and Physiology. Central Silk Board, Bangalore.
5. Silkworm Crop Protection, Central Silk Board, Bangalore, India.
6. Govindan, R.; Ramakrishna Naika and Sannappa, B. (2004) Advances in Disease and Pest Management in Sericulture. Seri Scientific Publishers, Bangalore.
7. Jolly, M.S., Chowdhury, S. Nand Sen. (1975). Non-mulberry Sericulture in India. Central Silk Board, Bombay, India.
8. Website of CSB: https://silks.csb.gov.in/una/wp-content/themes/Common_District/una/sgf-frame.html

SERICULTURE PRACTICAL (Credit:1)

Full Marks: 10

Identification of any one stage of Mulberry silkworm with characters. : 02

Visit sericulture farm and submit reports. 05

Viva 03

Course Outcomes:

1. Get Complete Knowledge of Silkworms and their different types.
2. Get knowledge about technology of silkworm culture and making of silk.
3. To Know About Different Diseases On Enemies Of Silkworms.
4. Get a Brief Idea about entrepreneurship in Sericulture.

ZOOL2051: AQUARIUM FISH KEEPING

Objectives of the Course: The course will impart basic knowledge of the ornamental fish industry and inculcate its scope as an avenue for career development as an entrepreneur or as an aquariculturist.

1. Students will be able to know the fundamentals of aquarium fish industry.
2. Students will understand the biological features of aquarium fishes.
3. Student will get to know the food and feeding habits of aquarium fishes.
4. Student Will Get Aware About the Transportation of Fish
5. Students will have 'hands-on' experience through exposure to technology, production, functioning, operation of an aquarium in the ornamental fish farms, hatcheries, and fish feed production plant as study tours or field visits.

SLNO.	TOPICS(Credits:2)	TOTALNO. OF LECTURES (30)
1.	<p style="text-align: center;">Introduction to Aquarium Fish Keeping</p> <p>The potential scope of Aquarium Fish Industry as Cottage Industry, Exotic and Endemic species of Aquarium Fishes</p>	2
2	<p style="text-align: center;">Types of Aquaria(Salinity, Temperature, Species Selection & Location)</p> <p>1. Aquarium Setup and Accessories. 2. Aquarium Filters and types of filtration methods (Mechanical, Chemical & Biological–Nitrogen Cycle); Precautions to be taken for an ideal aquarium; 3. Criteria Of Selection For Aquarium Fishes</p>	6
3	<p style="text-align: center;">Biology Of Aquarium Fish</p> <p>Aquarium Fish biology (Breeding, Feeding, economic importance etc), sexual dimorphism of Freshwater and marine aquarium fish.</p>	2
4	<p style="text-align: center;">Aquarium Fishes</p> <p>1. Freshwater ornamental fishes-Guppy, Goldfish and Angelfish. 2. Brackish ornamental fishes-Black Molly, Swordtail & Rayfish. 3. Marine ornamental fishes-Anemone fish, Moorish idol, Butterfly fish.</p>	6

5	<p align="center">Food And Feeding Of Aquarium Fishes</p> <p>1. Use of Live Fish Food Organisms (Advantages And Disadvantages Of Live food),</p> <p>2. Preparation And Composition Of Formulated Fish Feeds</p> <p>3. Aquarium Fish As Larval Predator</p>	4
6	<p align="center">Aquarium Fish Diseases</p> <p>Parasitic, Bacterial, Viral, Protozoan, Fungal & Deficiency Diseases.</p>	2
7	<p>1. Breeding Habits.</p> <p>2. Hatching and production of monosex fishes.</p>	1
8	<p align="center">Maintenance of Aquarium</p> <p>General Aquarium maintenance; Water quality requirements: Maintenance and Temperature control; Budget for setting up an Aquarium/ornamental Fish Farm as a Cottage Industry</p>	2
9	<p align="center">Fish Transportation</p> <p>1. Live Fish Transport.</p> <p>2. Conditioning, Packaging and forwarding technique and aquarantine methods.</p> <p>3. Factors associated with live fish transport.</p>	3
10	<p align="center">Maintenance</p> <p>1. General Aquarium maintenance.</p> <p>2. Budget for setting upon Aquarium Fish Farm as a Cottage Industry.</p>	2
<p align="center">AQUARIUM FISHKEEPING PRACTICAL (Credit:1)</p> <p align="right">FullMarks:10</p> <p>1. Study of different species of Aquarium fish and biology(Breeding, Feeding Economic importance etc.) of exotic and endemic fish (Guppy, Molly, Sword tail, Goldfish, Angel fish, Bluemorph, Anemone fish, Butterfly fish).(Phylum, Class, Subclass, Genus). 1X3=3</p> <p>2. To write a project proposal for setting up a small aquarium fishkeeping as a cottage industry to a funding agency for self-employment of youths or for helping poor after visiting a farm/enterprise. 5</p> <p>3. Viva voce 2</p>		

Recommended Books:

1. Jhingran, V.G. (1982) Fish and Fisheries in India. Hindustan Publication Corp, India.
*Pandey, K.
2. J.P. Shukla (2013) Fish and Fisheries. Rastogi Publication.
3. Aquarium: Fish Keeping CBL Srivastava Published by Kitab Mahal
4. Marine Aquarium (Fish: Keeping and Breeding Them in Captivity) Boruchowitz, Davie. Published by Chelsea House Publications (1998)
5. Aquarium Setting Up (Fish: Keeping and Breeding Them in Captivity) Axelrod, Herbert R. Published by Chelsea House Publications (1998)
6. The Tropical Freshwater Aquarium Problem Solver: Practical and Expert Advice on Keeping Fish and Plants Sandford, Gina Published by Voyageur Press (MN) (1998)

Course Outcomes:

1. Know about Basic needs to setup an aquarium, i.e., dechlorinated water, reflector, filters, scavenger, aquatic plants etc. and the ways to make it cost-effective.
2. Manage fish diseases.
3. Prepare the proper dosage of different kinds of natural and synthetic fish feed.
4. Develop Personal Skills In the Maintenance of Aquarium.
5. Become aware of Aquarium as commercial, decorative items and of scientific values.

