

The University of Burdwan



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

**Under Curriculum and Credit Framework
for Undergraduate Programmes (CCFUP)
AS PER NEP, 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.

Semester	Course Type	Course Title with Code	Credit	Lect.	Tuto.	Pract. /Viva	Full Marks	Distribution of Marks		
								Theory	Pract. /Vivavoce	Internal Assessment
III	Major/DS Courses (Core)	ZOOL3011: Biochemistry	5	4	0	1	75	40	20	15
		ZOOL3012: Cell Biology	5	4	0	1	75	40	20	15
	Minor Course (Voc. Edn. & Trng.)	ZOOL3021:	4	3	0	1	75	40	20	15
	Inter/ Multi Disciplinary	ZOOL3031: Applied Zoology	3	2	1	0	50	40	0	10
	Ability Enhancement Course (AEC) [L1-2 MIL]	3041: Language	2	2	0	0	50	40	0	10
	Skill Enhancement Courses	ZOOL3051: Animal Husbandry and Management OR ZOOL3051: Medical Diagnostics	3	2	1	0	50	40	0	10
	Total		22				375			
IV	Major/DS Courses (Core)	ZOOL4011: Animal Physiology	5	4	0	1	75	40	20	15
		ZOOL4012: Disease Biology	5	4	0	1	75	40	20	15
		ZOOL4013: Comparative Endocrinology	5	4	0	1	75	40	20	15
	Minor Course	ZOOL4021: Wildlife	4	3	0	1	75	40	20	15

		Conservation								
	Minor Course (Other than Zoology)	4021:	4				75			15
	Ability Enhancement Course (AEC) [Eng L2-2]	4041: English	2	2	0	0	50	40	0	10
	Total		25				425			

ZOO11011: 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)	TOTAL NO. LECTURES (45)
1	Unit 1: Basics of Animal Classification Definition: Classification, Systematics, and Taxonomy, Code of Zoological Nomenclature.	2
2	Unit 2: 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	Unit 3: Porifera General characteristics and schematic classification upto order (Hyman, 1951) Canal System and Spicules Of Sponges	5
4	Unit 4: Cnidaria General characteristics and schematic classification upto class (Ruppert and Barnes, 1994); Metagenesis of <i>Obelia</i> , Coral Reef Types And Formation	4
5	Unit 5: Ctenophora General Characteristics only	1
6	Unit 6: Platyhelminthes General characteristics and schematic classification upto class (Ruppert and Barnes 1994)	2
7	Unit 7: Nematoda General characteristics and schematic classification upto class (Ruppert and Barnes, 1994)	2
8	Unit 8: Annelida General characteristics and schematic classification upto class (Ruppert and Barnes 1994), Metamerism, Nephridia: Structure And Function	4
9	Unit 9: Arthropoda General characteristics and schematic classification upto class (Ruppert & Barnes, 1994), Vision In Insects, Metamorphosis in Lepidopteran insect	6
10	Unit 10: Onychophora Evolutionary Significance	2

11	Unit 11: Mollusca General characteristics and schematic classification upto class (Ruppert and Barnes 1994), Modification Of foot, Nervous system and torsion in Gastropods	5
12	Unit 12: Echinodermata General characteristics and schematic classification up to class (Ruppert and Barnes 1994), Water Vascular System of <i>Asteroidea</i> , Structure Of Tube Feet, Larval forms in Echinodermata	4
13	Unit 13: Hemichordata General characteristics 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. Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4th Ed. Sinauer Associates... Dhami, S and J.K. Dhami – Invertebrate Zoology – S. Chand and Co.
5. Hickman, C.P.Jr., F.M. Hickman and L.S. Roberts, 1984. Integrated Principles of Zoology, 7th Edition, Times Mirror/Mosby College Publication. St. Louis. 1065pp.
6. Hyman, L.H.(1951). The Invertebrates (Vol-I). McGraw Hill Book Company.
7. Jordan, E.L. & Verma, P.S.(2006). Invertebrate Zoology. S.Chand & Company Ltd. New Delhi.
8. Kapoor, V.C.(2008). Theory and practice of animal taxonomy. 6th Ed. Oxford & IBH Pub Kotpal, R.L., 1988 – 1992. (All Series) Protozoa, Porifera, Coelenterata, Annelida, Arthropoda, Mollusca, Echinodermata, – Rastogi Publications, Meerut – 250002.
9. Mayr, E. (1969). Principles of Systematic Zoology. Tata McGraw-Hill.
10. Mayr, E. & Ashlock, P.D. (1991). Principles of Systematic Zoology. 2nd Ed., McGraw-Hill.
11. Meglitsch, P.A. & Schram, F.R. (1991). Invertebrate Zoology. Oxford University Press.
12. Chaki, Kundu, Sarkar Introduction to General Zoology. Vol 1. New Central Book Agency (P) LTD.
13. Parker, T.J. & Haswell, W. (1972). Text Book of Zoology, Volume I. Macmillan Press, London.
14. Pechenik, J.A. (1998). Biology of the Invertebrates, 4th Ed. McGraw Hill.
15. Ruppert E.E., Fox, R. & Barnes R.D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. 7th Ed. Brooks Cole.
16. Sinha, K.S., Adhikari, S., & Ganguly, B.B. Biology of Animals. Vol .I. New Central Book Agency. Kolkata.

Classification to be followed from Barnes and Ruppert 1994, 6th Edition

NON-CHORDATES PRACTICAL
(Credit:1)

1. Spot Identification of *Amoeba*, *Euglena*, *Paramecium*. Full marks: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, and 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	Unit 1: Basics of Animal Classification Definition: Classification, Systematics and Taxonomy. Codes of Zoological nomenclature.	2
2	Unit 2: Protista and Metazoa Protozoa: General characteristics and schematic classification upto phylum (Levine et al. 1980) Locomotion in <i>Amoeba</i> , Conjugation in <i>Paramecium</i> .	5
3	Unit 3: Porifera General characteristics and schematic classification up to class (Hyman, 1951). The canal system in sponges.	5
4	Unit 4: 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	Unit 5: Ctenophora General characteristics only	1
6	Unit 6: Platyhelminthes General characteristics and schematic classification up to class (Ruppert and Barnes 1994).	2
7	Unit 7: Nematoda General characteristics and schematic classification up to class (Ruppert and Barnes 1994).	2
8	Unit 8: Annelida General characteristics and schematic classification upto class (Ruppert and Barnes 1994) Metamerism in Annelida, Nephridia: Structure and function	4
9	Unit 9: Arthropoda General characteristics and schematic classification up to class (Ruppert and Barnes. 1994) Vision in insects, Metamorphosis in Lepidopteran insects.	6
10	Unit 10: 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 Barnes 1994), 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. Barnes, R. D. & Ruppert, E. E., (1994). Invertebrate Zoology. 6th Ed. Brooks Cole.
2. Barrington, E.J.W. (1981). Invertebrate Structure and Function. 2nd Ed. ELBS & Nelson. Black welder, R. E., (1967). Taxonomy- A text and reference book. John Wiley & Sons.
3. Brusca, R.C. & Brusca, G.J. (2002). Invertebrates. 4th Ed. Sinauer Associates... Dhami P.S and J.K. Dhami – Invertebrate Zoology – S. Chand and Co.
4. Hickman, C.P. Jr., F.M. Hickuman and L.S. Roberts, 1984. Integrated Principles of Zoology, 7th Edition, Times Merror/Mosby College Publication. St. Louis. 1065pp. Hyman, L. H. (1951). The Invertebrates (Vol-I). M McGraw-Hill c. Book Company.
5. Jordan, E.L.& Verma, P.S.(2006). Invertebrate Zoology .S.Chand & Company Ltd. New Delhi.
6. Kapoor, V.C.(2008). Theory and practice of animal taxonomy. 6th Ed. Oxford & IBH Pub Kotpal, R.L., 1988 – 1992. (All Series) Protozoa, Porifera, Coelentereta, Annelida, Arthropoda, Mollusca, Echinodermata, – Rastogi Publications, Meerut – 250 002.
7. Mayr, E.(1969). Principles of Systematic Zoology. Tata McGraw-Hill.
8. Mayr, E. & Ashlock, P.D.(1991). Principles of Systematic Zoology. 2nd Ed., McGraw-Hill.
9. Meglitsch, P. A. & Schram, F. R. (1991). Invertebrate Zoology. Oxford University Press.
10. Chaki, Kundu, Sarkar Introduction to General Zoology. Vol 1. New Central Book Agency (P) LTD.
11. Parker, T.J. & Haswell, W. (1972). Text Book of Zoology, Volume I. Macmillan Press, London.
12. Pechenik, J. A. (1998). Biology of the Invertebrates, 4th Ed. McGraw Hill.
13. Ruppert E.E. Fox, R. & Barnes R.D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. 7th Ed. Brooks Cole.
14. Sinha, K.S., Adhikari, S., & Ganguly, B.B .Biology of Animals. Vol. I. New Central Book Agency. Kolkata.

NONCHORDATE PRACTICAL (Credit:1)

Full marks: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*, *Carcinoscorpius*, *Trigoniulus*, *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 (CREDIT 3)	TOTAL NUMBER OF 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 FM: 10</p> <p>Internal Assessment of 10 marks in case of Multi/Inter Disciplinary will be based on Practical Portion of the course concerned.</p> <ol style="list-style-type: none"> 1. Visit to zoological garden or animal museum, preparation of project report of the visit.(7) 2. Preparation of an animal album taking any four animals as subjects.(3) 		

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: 3)	TOTAL NO. LECTURES (45)
1.	History and importance of apiculture; the systematic position of bees; different species of common honey bees and their Description.	5
2.	The life cycle of the honeybee; general morphology and anatomy of different castes of honeybees; emphasis on mouth parts; Non-Apis bee species.	6
3.	Structure Of Different Beehives Or Honeycomb; colonial Organization; bee language and communications.	4
4.	Methods Of Keeping: Indigenous methods and its Disadvantages.	3
5.	Apiary: selection of good apiary site; selection of good bee.	3
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.	6
7.	Productsof Apiculture: Honey, wax, etc., chemical Compositions; use; other products like propolis, royaljelly, apitoxin, etc.	4
8.	Diseases And Enemies: parasitic diseases; other enemies.	4
9.	Types of Beekeeping, economics: Stationary and migratory; Economics Of Beekeeping, the position of this industry from the Indian perspective.	5
10.	Entrepreneurship in Apiculture: Beekeeping as a source of employment and livelihood; the role of KVIC for beekeeping in India; proposal preparation for funding.	5

Reference Books:

1. 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.
2. Sara Apiculture. K. V. Jayashree, C.S. Tharadevi, N. Arumugam.
3. Textbook of Apiculture (Beekeeping). D. K. Belsaraet. al. Himalaya Publishing House. Modern Textbook of Zoology Invertebrates. R. L. Kotpal.
4. Biology of Animal. Ganguly, Sinha, Adhikari. New Central Book Agency. ApicultureICAR PDF Book, AgriMoon.com. Free Download.

APICULTURE PRACTICAL Full Marks:10

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

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:3)	TOTAL NO. OF LECTURES (45)
1.	Earthworm Morphology and Anatomy: Taxonomic Position, external features, internal anatomy.	5
2.	Habitat Ecology and reproduction: Burrowers, Casts, nocturnal, poikilothermic, ecological grouping, Epigeic sp., Endogenics., Anecics.	5
3.	Description of some important earthworm sp: <i>Eisenia fetida</i> , <i>Eudriluseugeniae</i> , <i>Lumbricus rubellus</i> .	5
4.	Importance Of Earthworm In Agriculture: Role Of Earthworm to increase fertility of soil.	5
5.	Vermiculture and Vermiculture: Definition, History At Different countries and India.	5
6.	Vermiculture: Methods, wormery, breeding technique, indoor outdoor culture, mono-and Polyculture And Merits and Demerits.	7
7.	Vermi composting Of Wastes: Different Methods, storage. Vermi wash: preparation and application.	4
8.	Diseases and Predators/pathogen of earthworm. Maintenance Wormeries.	4
9.	Marketing and Future perspective: Marketing the products of Vermiculture, quality control, marketing techniques, demand study, advertisement, packing and transport, and financial support.	5

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

Full Marks: 10

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

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.

ZOOL2011: 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)	TOTAL NO. 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 Parental care 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. 3rd 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*, *Exocetus*, *Echenis*
- d. Amphibia: *Necturus*, *Bufo*, *Hyla*, *Axolotllarva*, *Tylototriton*.
- e. Reptilia: *Chelone*, *Varanus*, *Mabuya*, *Draco*, *Vipera*, *Naja*, *Hydrophis*.
- f. Mammalia: Bat, *Funumbulus*.

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:

Chatterjee and Chatterjee: Practical Zoology 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 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.

ZOOL2021: 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, Tylostotriton, 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 specialties 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.

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). *Text book of applied Zoology*, Discovery Publishing House, New Delhi.
10. Cherian & Ramachandran *Bee keeping 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,*
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)*
[webhttps://swayam.gov.in/nd2_cec20_ge23/preview](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**Full Marks: 10**

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

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.

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: 3)	TOTAL NO. OF LECTURES (45)
1.	History Of Sericulture; the systematic position of silk moths; different species of silk moths, their description.	5
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	6
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.	6
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.	5
5.	Silkworm Diseases of <i>Bombyx mori</i> : Protozoan disease, Bacterial Disease, Fungal disease, Viral Disease, Sototo Silkworm Pests of <i>Bombyx mori</i> : Uzifly, Ants, Dermestid Beetles.	5
6.	Mulberry Silkworm Rearing: Model rearing house, Rearing appliances, disinfection, disinfectants, bed cleaning, feeding of worms.	6

	Rearing of larvae: techniques of rearing of different stages of larvae.	
7.	Harvesting of cocoon: Sex determination of cocoon, harvesting of cocoon.	3
8.	<p>Post Cocoon And Silk Collection Technology: Cocoon Stifling (sun drying, steam stifling, hot air stifling) and storage.</p> <p>Deflossing, cocoon riddling, mixing or blending, cocoon cooking, brushing.</p> <p>Types Of Reeling Machines, reeling operation, reeling end formation.</p> <p>Degumming, bleaching, dyeing silk yarn.</p> <p>Twisting, Reeling, Re-reeling, lacing, skeining and testing of raw silk material</p> <p>Weaving Of silk.</p>	5
9.	Entrepreneurship Sericulture: Sericulture Source Of Employment and livelihood; the role of CSB in supporting and guiding entrepreneurship.	4

Reference Books:

1. Charsley, S.R.(1982).Culture and Sericulture. Academic Press Inc. New York, U.S.A.
2. FAO Manuals-I Mulberry Cultivation. FAO Rome.
3. Ganga,G.,andJ.SulochanaChetty.(1991)AnIntroductiontoSericulture.Oxford&IBH Publishing Company.
4. Jayaram,H.(2005)MulberryCultivationandPhysiology.CentralSilkBoard,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.NandSen.(1975).Non-mulberrySericultureinIndia.CentralSilk Board, Bombay, India.
8. WebsiteofCSB:https://silks.csb.gov.in/una/wp-content/themes/Common_District/una/sgf-frame.html

SERICULTURE PRACTICAL

Full Marks:10

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

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 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: 3)	TOTALNO. OF LECTURES (45)
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>	4
2	<p style="text-align: center;">Types of Aquaria (Salinity, Temperature, Species Selection & Location)</p> <p>1. Aquarium Setup and Accessories.</p> <p>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>	8
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>	4
4	<p style="text-align: center;">Aquarium Fishes</p> <p>1. Freshwater ornamental fishes-Guppy, Goldfish and Angelfish.</p> <p>2. Brackish ornamental fishes-Black Molly, Swordtail & Ray fish.</p> <p>3. Marine ornamental fishes-Anemone fish, Moorish idol, Butterfly fish.</p>	8

5	Food And Feeding Of Aquarium Fishes 1. Use of Live Fish Food Organisms (Advantages And Disadvantages Of Live food), 2. Preparation And Composition Of Formulated Fish Feeds 3. Aquarium Fish As Larval Predator	6
6	Aquarium Fish Diseases Parasitic, Bacterial, Viral, Protozoan, Fungal & Deficiency Diseases.	4
7	1. Breeding Habits. 2. Hatching and production of monosex fishes.	3
8	Maintenance of Aquarium General Aquarium maintenance; Water quality requirements: Maintenance and Temperature control; Budget for setting up an Aquarium/ornamental Fish Farm as a Cottage Industry	3
9	Fish Transportation 1. Live Fish Transport. 2. Conditioning, Packaging and forwarding technique and a quarantine methods. 3. Factors associated with live fish transport.	3
10	Maintenance 1. General Aquarium maintenance. 2. Budget for setting upon Aquarium Fish Farm as a Cottage Industry.	2

AQUARIUM FISHKEEPING PRACTICAL

Full Marks:10

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

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
2. To write a project proposal for setting up a small aquarium fishkeeping as acottage industry to a funding agency for self-employment of youths or for helping poor farmeis; after visiting a farm/enterprise. 5
3. Viva voce 2

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.

SEMESTER-III
MAJOR/DS COURSES (CORE)

ZOOL3011: BIOCHEMISTRY

Objectives of the study: The objective of this study is to foster enthusiasm among students for Biochemistry, highlighting its significance within the broader context of Zoology. Through this course, learners will gain an understanding of the fundamental chemistry that drives biological processes, enabling them to independently address challenges in both biology and chemistry. The curriculum covers the analysis of molecular structure and function, as well as the myriad chemical reactions occurring within living cells. It aims to ignite a sense of curiosity in students, encouraging them to explore the intricate mechanisms of various biomolecules and their interconnections. This program also seeks to motivate students to pursue advanced studies in Biochemistry and related interdisciplinary fields, thereby equipping them with the skills necessary for both salaried and entrepreneurial ventures.

Credits 5 (Theory: 4, Practical: 1)

Full Marks 75 (Theory: 40+Internal 15;Practical: 20)

Number of Lectures: 60

Sl. No.	Topics/Contents	Classes
1.	Water: Unique properties, weak interactions in aqueous systems, ionization of water, buffers, water as a reactant and fitness of the aqueous environment.	3
2.	Carbohydrates: Structure and Biological importance of Carbohydrates: Monosaccharides, Disaccharides, Polysaccharides. Derivatives of Monosaccharides. Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis.	10
3.	Protein: General and Electrochemical properties of α -amino acids; Essential and non-essential amino acids and their physiological importance. Structures and classification of proteins. Protein metabolism: Transamination, Deamination, Urea cycle.	15
4.	Lipid: Structure and Significance of lipids: Physiologically important saturated and unsaturated fatty acids, Tri- acyl glycerol's, Phospholipids, Sphingolipid, Glycolipids, Steroids.Lipid metabolism: β -oxidation of fattyacids.	10
5.	Nucleic acid: Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids. Types of DNA and RNA, Complementarity of DNA, Hypo-Hyper chromaticity of DNA.	10
6.	Enzymes: Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes. Mechanism of enzyme action; Enzyme kinetics; Derivation of Michaelis-Menten Equation, Lineweaver-Burk plot; Factors affecting rate of enzyme-catalyzed reactions; Enzymeinhibition;AllostericenzymesandtheirFactorsaffectingrateofenzyme-catalyzed reactions.	10
7.	Oxidative Phosphorylation: Redox systems; Overview of the mitochondrial respiratory chain, Mitochondrial Uncoupling.	2
1. Suggested Readings: 2. Cox, M. MandNelson, D.L.(2008). Leininger's Principles of Biochemistry Edition, W.H. Freeman and Co. NewYork. 3. Campbell and Farrell (2012). Biochemistry. 7th Edn. Brooks andCole.		

4. Das, D. (2022). Biochemistry. Academic Publisher.
5. Chatterjee, MN and Shinde, R (2012). A Textbook on Medical Biochemistry. 8th Edn. Jaypee Pub., N. Delhi
6. Berg, J.M., Tymoczko, J.L. and Stryer, L (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
7. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
8. Voet, D & Voet, J.G, (2004). Biochemistry –3rd edition, 2004, John Wiley & Sons, Inc.
9. Jain, J.L., Jain, M. S and N. Jain. Fundamentals of Biochemistry. S. Chand Pub. N. Delhi
10. Maheswari, N (2008). Clinical Biochemistry. Jaypee Pub., New Delhi
11. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009).
12. Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.
13. Sathyanarayana U. and Chakrapani, (2002). Biochemistry –Books & Allied (P) Ltd, Kolkata
14. Zubay G.L, (1998). Biochemistry –4th edition, McGraw-Hill.

Practical Components:

1. Qualitative tests of functional groups in carbohydrates (Benedict's test), proteins (Biuret's test), and lipids (Saponification number).
2. To study the enzymatic activity of Salivary amylase.
3. Quantitative estimation of protein by Lowry Method.
4. Paper chromatography of Amino acids. (hands-on/virtual).
5. Demonstration of protein sample preparation and separation by SDS-PAGE (hands-on/virtual).

Practical Examination Pattern:

Full Marks : 20

One question from items 1 and 2. (6 x 1 = 6)

One question on the quantitative test (from item 3) (8 x 1 = 8)

One question from items 4 and 5 (4 x 1 = 4)

Laboratory Notebook (2)

OUTCOME OF THE COURSE

1. This topic is designed to help learners to understand the objectives of studying Biochemistry.
2. The learner will get a clear concept of the structures and reactions of different biomolecules in the living system.
3. Learners will cope with the fast and far-reaching advancement of biological sciences in this century and be able to update themselves with the emerging concept of biochemistry.
4. Students will develop a deep interest in this subject, which is very important for daily life and also for different competitive examinations.

ZOOL3012: CELL BIOLOGY

Objectives of the study: To give an idea of the different structures involved in cellular organization, both within and outside the cell; outline knowledge of division and signaling at cellular level and a detailed idea of the important subcellular components that are involved in the process of transportation of molecules to and from the cell, as well as synthesis of various proteins and ATP.

Credits 5 (Theory: 4, Practical: 1)

Full Marks 75 (Theory: 40+ Internal15; Practical: 20)

Number of Lectures: 60

Sl. No.	Topics/Contents	Classes
1.	Plasma Membrane: Membrane Lipids and Proteins. Architecture of Plasma membrane on the basis of Fluid Mosaic Model (Singer and Nicolson, 1972, Nicolson 2014). Transport across membrane: LDL Receptor mediated Endocytosis, Simple diffusion (O_2 and CO_2 transport), Facilitated diffusion (Glucose transportation, Na^+ and K^+ transportation), primary active transport (Na^+ - K^+ anti-transportation) and secondary active transports (Na^+ - glucose co-transportation).	12
2.	Cellular Organization: Extracellular Matrix: Components and their role. Cytoskeleton: Basic structure and dynamics of Actin, Microtubule, and Lamin. Microtubule associated motor proteins. Cell junctions: Occluding junction (tight junction and septate junction), anchoring junction (cell-cell and cell-matrix) and communicating junction (gap junction)	10
3.	Cytoplasmic Organelles- I: Endoplasmic Reticulum: Structure and Function (Co-translational translocation of proteins through ER membrane, Glycosylation and Chaperone mediated folding of protein). Golgi Apparatus: Structure and functions of individual compartments, vesicular transport and cisternal maturation model of Golgi. Lysosome: Structure and functions. Protein sorting and mechanisms of vesicular transport.	12
4.	Cytoplasmic Organelles -II: Mitochondria: Outline structure, Mitochondrial respiratory chain, and generation of proton motive force. Structure of F_0F_1 complex, chemiosmotic and Binding-change hypotheses of ATP Synthesis. Nucleus: Nuclear pore complex and transportation of mRNA through nuclear pore complex. Nucleosome, solenoid, and zigzag model of DNA packaging, nucleolus.	10
5.	Cell Division: Cell cycle and its regulation in vertebrates; role of cyclins. Mitotic and Meiotic Cell divisions. Types and basic process; MTOC and its role in chromosome movement. Cancer: Properties of cancer cells in brief.	10
6.	Cell Signaling: Overview of cell signaling transduction pathways; Types of signaling molecules and receptors (Classification and examples only). Basic concept of Apoptosis, cytological features of an apoptic cell.	6

Suggested Readings:

1. Albert Bruce, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). Molecular Biology of the Cell, V Edition, Garland publishing Inc., New York and London.
2. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
3. Hardin, J. Bertoni, G and Klein smith, J. L. (2012). Becker's World of the Cell. 8th Edn, Pearson Benjamin Cummings, San Francisco.
4. Harvey, L. (2004). Molecular Cell Biology. 5th Edn. W.H. Freeman
5. Karp, G. (2008). Cell and Molecular biology: Concepts and Application. 5th Edn, John Wiley.
6. Lodish, Berk, Matsudaira, Kaiser, Bretscher, Ploegh, Amon, and Martin (2016) Molecular Cell Biology. 8th Edn. W.H. Freeman
7. Pal, A. (2011). Textbook of Cell and Molecular Biology 3rd Edn, Bokks and Allied, Kolkata.
8. Plopper, G, D. Sharp, Siroski, E (2015) Lewin's Cell 3rd Edition—Johns & Bartlett Publishers Pollard and Earnshaw (2007). Cell Biology. 2nd. Edn Saunders.
9. Reed, J.C., and Green, D.R. (2011). Apoptosis: Physiology and Pathology. Cambridge Univ. Press
10. Verma and Agarwal. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand Pub, Weinberg R.A. (2014). Biology of Cancer. 2nd edition. Garland Science, Taylor, and Franklin.

Practical Components:

1. Basic idea of light and dark field of microscopy (demonstration).
2. Preparation of squamous epithelial cell (fixation and staining).
3. Standardization of ocular and stage micrometer and measurement of any cell.
4. Preparation of temporary stained squash of onion root tip to study various stages of mitosis.
5. Squash preparation of grasshopper testis and study of the various stages of meiosis.
6. Study of Mitotic index from onion root tip cells

Examination Pattern:

Full Marks: 20

One question on squash preparation (from Item No. 4, 5 and 6) (6X 1) = 06

Preparation of slide/ measurement (From Item 2 and 3) (4X 1) = 04

Identification of stages of mitosis and meiosis cell division (2X4) = 08

Laboratory Notebook ----- 02

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:

1. The students will learn about the different subcellular components—their structure, function and biochemical properties, organization at cellular level with respect to extracellular matrix, cytoskeleton, cell junction, cell signaling and cell division.
2. They will also have an outline knowledge of cancer cells and apoptosis.

MULTI/INTER DISCIPLINARY

ZOOL3031: APPLIED ZOOLOGY

Objectives of the study: The study programme Applied Zoology is focused on the use of combined methods in scientific disciplines of zoology and enables the interconnection of topical issues and scientific approaches in the management of natural resources and their protection. Students of the programme gain theoretical and practical knowledge from the field of data gathering and analysis. Based on the acquired experience, they will be able to formulate progressive procedures and identify trends in sustainable development in the use of natural resources and simultaneously avoid decreased animal welfare and deterioration of the health conditions of stocked animals, the risk of biological invasions, the occurrence of parasitic diseases and irreversible resource exhaustion.

Credits 3 (Theory: 3)

Full Marks 50 (Theory: 40+ Internal: 10)

Number of Lectures: 45

Sl. No.	Topics/Contents	Classes
1	<p>Fish culture: Common fishes used for culture. Fishing crafts and gears. Ornamental fish culture: Fresh water ornamental fishes- biology, breeding techniques Construction and maintenance of aquarium: Construction of home aquarium, materials used, setting up of freshwater aquaria, aquarium plants, ornamental objects, cleaning the aquarium, maintenance of water quality. control of snail and algal growth. Modern techniques of fish seed production</p>	15
2	<p>Prawn culture. Culture of fresh and marine water prawns. Preparation of farm. Preservation and processing of prawn, export of prawn.</p>	5
3	<p>Vermiculture Scope of Vermiculture. Types of earthworms. Habit categories - epigenic, endogenic and anecic; indigenous and exotic species. Methodology of vermicomposting: containers for culturing, raw materials required, preparation of bed, environmental pre-requisites, feeding, harvesting and storage of Vermicompost. Advantages of vermicomposting. Diseases and pests of earthworms.</p>	12
4	<p>Lac Culture History of lac and its organization, lac production in India. Life cycle, host plants and strains of lac insect. Lac cultivation: Local practice, improved practice, propagation of lac insect, inoculation period, harvesting of lac. Lac composition, processing, products, uses and their pests.</p>	13
<p>Suggested Readings: 1. Eikichi, H. (1999). Silkworm Breeding (Translated from Japanese). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.</p>		

2. Ganga, G. (2003). Comprehensive Sericulture Vol-II: Silkworm Rearing and Silk Reeling.
3. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Mahadevappa, D., Halliyal, V.G., Shankar, D.G. and Bhandiwad, R., (2000). Mulberry Silk
5. Reeling Technology Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
6. 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. YadavManju (2003). Economic Zoology, Discovery Publishing House.
9. JabdePradip V (2005). Textbook of applied Zoology, Discovery Publishing House, New Delhi.
10. Cherian & Ramachandran Bee keeping 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.1 and Hamiyn (1971). Aquarium fishes and plants
15. Jabde, P.V. (2005) Textbook 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. 18. Applied and Economic Zoology (SWAYAM) web https://swayam.gov.in/nd2_cec20_ge23/preview

Course outcomes:

Applied Zoology deals with the application of Zoological knowledge for the benefit of mankind. It also deals with animal world that is associated the economy, health and welfare of human. So,

1. The students can understand concepts of fisheries, fishing tools and site selection.
2. Can understands about parasites and epidemiology of parasites in human and animals, Types of breeds in animal farming and poultry farming along with their management.
3. Students also become efficient about Aqua culture systems, induced breeding techniques and post harvesting techniques.

SKILL ENHANCEMENT COURSE (SEC)

ZOOL3051: ANIMAL HUSBANDRY AND MANAGEMENT

Objectives of the study: The course is aimed with the objective of providing knowledge of the Animal Husbandry, their significance, types & breeds. Modern system of rearing and breeding of animals have been incorporated so that the students will get interest on this topic and also able to start entrepreneurship either for regular earning or for extra earning along with their regular source of income in future.

Credits: 4 (Theory: 3, Practical: 1)

Full Marks: 50 (Theory: 40+Internal 10)

Number of Lectures: 45

Sl. No.	Topics/Contents	Classes
1.	<p>DAIRY SCIENCE: Different breeds of livestock viz, Cattle, Buffalo, Sheep, Goat and Pigs both Indian and exotic. Types of housing, space requirement of different categories of livestock importance of sanitation in Livestock farm.</p> <p>Types of animal farming: Mixed farming, Integrated farming, Specialized dairy farming and their relative economic merits.</p> <p>Importance of clean milk production: Definition of milk and colostrum, Factors affecting quality and quantity of milk. Legal standards of milk, Source of adulteration and its detection in milk.</p> <p>Pasteurization, sterilization, homogenization, and their importance. Different Milk products and other milk beverages.</p> <p>Rearing of young stocks, importance of colostrum feeding in young ones, management of pregnant cows, the goats, ewes, care and management of breeding heifers and young bulls.</p>	9
2.	<p>POULTRY SCIENCE: Different Breeds of chicken for modern poultry farming. Broiler chicken, incubation of its eggs, breeding techniques.</p> <p>Different breeds of duck, farming of ducks in India.</p> <p>Brief idea of Quail farming in India.</p>	8
3.	<p>ANIMAL BREEDING: Inbreeding: homozygosity, inbreeding depression. Out-breeding: out crossing, crossbreeding, Interspecific hybridization.</p> <p>Controlled breeding experiments, Multiple Ovulation Embryo Transfer Technology (MOET).</p>	7
4.	<p>ANIMAL NUTRITION: Different types of Animal feeds of cattle, goat, sheep, pig, chicken, duck. Composition and nutritive value.</p>	6
5.	<p>VETERINARY SCIENCE: Definition: Infectious and contagious diseases. Symptoms and causative agents of different parasitic, bacterial, and viral diseases of cattle, sheep, pig, goat. Diagnosis, immunization, and vaccination to control different diseases of cattle.</p> <p>Measures to be adopted during outbreak of Diarrhoea, Anthrax, Foot, and Mouth diseases.</p>	8
6.	<p>POULTRY DISEASES: Diseases – types, symptoms, prevention. Vaccination</p> <p>Diagnosis, immunization, and vaccination programme to control different diseases of chicken.</p>	7

Suggested Readings:

1. G.C. Banerjee. 2019. Textbook of Animal Husbandry. Eight Edition. Oxford & IBH Publishing Co Pvt.Ltd
2. Dr Jainendra Suryavanshi.2022. Animal Husbandry: Handbook of Dairy, Poultry, sheep, Goat,

Pig. Shashwat Publication.

3. N S R Sastry and C K Thomas . 2016. Livestock Production Management. Paperback. Kalyani Publisher.
4. G.C. Banerjee 2019. Principles Of Animal Nutrition and Feeds Revised Edition, Oxford & IBH Publishing.
5. Debiprasanna Das, Bhabesh Chandra Das, Nibedita Nayak, Basanti Jena, Amiya Ranju Sahu. Textbook on Poultry Management. Narendra Ppublishing House.
6. Chuhan, H.V.S. and Roy, S. 2018. Poultry Diseases, Diagnosis and Treatment. New Age International Publishers.
7. Vijay Kumar.2023. Pig Production and Management. New India Publishing Agency.
8. Pavan Kumar Yadav Dinesh Kumar, Rashmi Kumar, MS Mahesh. 2024. Handbook of Livestock & Poultry Production and Management. Narendra Publishing House.
9. Karen June P. 2018.Quail Farming for Beginners: The Ultimate Comprehensive Guide. Create Space Publishing.

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

Practical must include a visit to any Poultry farm or Animal Husbandrylab by students.

Submit report and viva voce (7 + 3 = 10)

OUTCOME OF THE COURSE

1. This paper is designed to understand the objectives of studying Husbandry and its management techniques. Students will cope with the topic and update themselves with the emerging concept of this topic.
2. Students will get knowledge about the technique of farming different economically important animals.
3. Students will get encouragement about entrepreneurship in Husbandry.

ZOOL3051: MEDICAL DIAGNOSTICS

Objectives of the study: This Skill Enhancement Course aims to enlighten students on the health status of patients with simple diagnostic tests and evaluations. This course will help to make students self-sufficient in future. They are expected to be adept in laboratory techniques.

Credits: 4 (Theory: 3, Practical: 1)

Full Marks: 50 (Theory: 40 + Internal 10)

Number of Lectures: 45

Sl.No.	Topics/Contents	Classes
1	: Introduction to Medical Diagnostics and its Importance	3
2	Diagnostics Methods Used for Analysis of Blood: Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain. Platelet count using hemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.)	10
3	Diagnostic Methods Used for Urine Analysis: Urine Analysis: Physical characteristics; Abnormal constituents	4
4	Non-infectious Diseases: Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit	6
5	Infectious Diseases: Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis, Malarial parasite; Microscope based, and ELISA based)	6
6	Clinical Biochemistry: LFT, Lipid profiling	3
7	Clinical Microbiology: Antibiotic Sensitivity Test	3
8	Tumors: Types (Benign/Malignant), Detection and metastasis. Medical imaging: X-Ray of Bone fracture, PET, MRI, and CT scan (using photographs).	6
9	Visit to Pathological Laboratory and Submission of Project (Internal assessment) *	4
Suggested Readings: 1. Prakash, G. (2012), Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand, and Co. Ltd. 2. Papadakis, M.A., McPhee, S.J. and Rabow, M.W. ed. (2016). Current Medical Diagnosis and Treatment McGraw Hill.		
**Practical Components: (Internal Assessment of 10 marks in case of SEC will be based on Practical Portion of the course concerned.) Visit to pathological laboratory and submission of a report.		

Outcomes:

After completion of course, students will be able to:

1. Learn basic understanding of the structure of the human body.
2. Learn aspects related to medical diagnosis.
3. Learn to perform tests which help in the diagnosis and treatment of diseases.
4. Handle laboratory instruments.
5. Students are expected to be economically self-sufficient.

SEMESTER-IV
MAJOR/DS COURSES (CORE)

ZOOL4011: ANIMAL PHYSIOLOGY

Objectives of the study: To understand various functional components of an organism. To explore the complex network of these functional components. To comprehend the regulatory mechanisms for maintenance of function of the body.

Credits 5 (Theory: 4, Practical: 1)

Full Marks 75 (Theory: 40 + Internal 15; Practical: 20)

Number of Lectures: 60

Sl. No.	Topics/Contents	Classes
1.	Digestion: Structural organization and functions of Gastrointestinal tract and Associated glands; Importance of GI tract hormones. Digestion and absorption of Carbohydrates, Lipids, Proteins.	10
2.	Respiration: Mechanism of Respiration; Respiratory volumes and capacities; Transport of Oxygen and Carbon-dioxide in blood; Dissociation curves and the factors influencing it; Respiratory pigments; Carbon monoxide poisoning.	8
3.	Circulation: Structure of mammalian heart; Cardiac Cycle and cardiac output. Components of Blood; Structure and functions of hemoglobin; Homeostasis; Blood clotting system; Hemopoiesis and its regulation.	8
4.	Thermoregulation and Osmoregulation: Physiological classification based on thermal biology; Osmoregulation in aquatic vertebrates; External osmoregulatory organs invertebrates.	5
5.	Renal system: Structure of nephron; Juxta-glomerular apparatus, Mechanism of counter current exchange and urine formation. Regulation of acid-base balance	5
6.	Nervous System: Structure of neuron; Resting membrane potential; Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapses, Synaptic transmission and Neuro-muscular junction; Reflex action and its types.	6
7.	Muscular System: Different types of muscle; Ultrastructure of skeletal muscle; Molecular and chemical basis of muscle contraction. Origin and conduction of cardiac impulses.	6
8.	Reproductive System: Basic structure of testis and ovary. Hormones of testis and ovary; Physiology of Reproduction (Estrus and Menstrual cycle).	5
9.	Sensory system: Eye: Physiological anatomy, Photoreceptors, Visual pathway, visual reflexes, Defects of image formation. Ear: Physiological anatomy, Auditory pathway, Mechanism of hearing.	7

Suggested Readings:

1. Guyton, A.C & Hall, J.E. Textbook of Medical Physiology, XI Ed. W.B. Saunders Co. (2006).
2. Tortora, G.J. & Grabowski, S. Principles of Anatomy & Physiology. XI Ed. John Wiley & sons (2006).
3. Christopher D. Moyes, Patricia M. Schulte. Principles of Animal Physiology. 3rd Ed. Pearson Education

(2016).

4. Hill, Richard W., et al. Animal physiology. Vol. 2. Sunderland, MA: Sinauer Associates, (2004).
5. Chatterjee CC Human Physiology Volume 1 & 2, 11th edition, CBS Publishers (2016).
6. Ganong's Review of Medical Physiology (2019).
7. Eckert. ANIMAL PHYSIOLOGY.

Animal Physiology: Practical

1. Estimation of Hemoglobin in human blood using Sahli 's hemoglobin meter
2. Differential staining of human blood corpuscles using Leishman stain
3. Determination of Bleeding Time & Clotting Time using suitable method.
4. Determination of Blood Group.
5. Determination of Erythrocyte Sedimentation rate.
6. Experiment of knee jerk by suitable method.

Examination pattern: Full Marks: 20

- | | |
|-----------------------------------|----|
| 1. One question from item no. 1&4 | 05 |
| 2. One question from item no. 2&5 | 05 |
| 3. One question from item no. 3 | 04 |
| 4. One question from item no. 6 | 04 |
| 5. Laboratory notebook | 02 |

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
- 4.. Chatterjee CC Human Physiology Volume 1 & 2, 11th edition, CBS Publishers (2016).

Virtual Labs (Suggestive sites)

<https://www.vlab.co.in>

<https://sites.dartmouth.edu>

Course Outcomes:

1. At the end of course the student should be able to understand:
2. Develop the skills to identify different types of blood cells.
3. Enhance basic laboratory skills like keen observation, analysis and discussion.
4. Learn the functional attributes of different organ systems of the body.

ZOOL4012: DISEASE BIOLOGY

Objectives of the study: The specific learning goals for disease biology are to explore the causes of diseases of the animal world and to provide students with a working knowledge of fundamental concepts and molecular mechanisms leading to diseases. This will help in further understanding of the immune responses facilitating recovery and protection, also examine the mechanism of action of disease therapies and investigate the physiological and ecological factors that influence the frequency of disease occurrence.

Credits 5 (Theory: 4, Practical: 1)

Full Marks 75 (Theory: 40 + Internal 15; Practical: 20)

Number of Lectures: 60

Sl. No.	Topics/Contents	Classes
1.	Basic concepts of disease: Endemic, epidemic, pandemic; acute and chronic, communicable, and non-communicable; infectious and contagious; zoonotic, water borne and nosocomial diseases.	3
2.	Communicable Diseases: Mode of transmission, pathogenesis, and management of: Bacterial; Cholera, Tuberculosis. Viral; (RNA (AIDS, SARS), DNA (Pox) & Naked (rhinovirus). Protozoan; Malaria, Amoebiasis Helminth: Lymphatic Filariasis, Taeniasis	20
3.	Non-Communicable Diseases: Risk Factors, Pathophysiology & management of: Gastro-intestinal diseases: Diarrhea, Irritable Bowel Syndrome, Cirrhosis of liver. Cardio-vascular diseases: Atherosclerosis, Ischemic heart, and Myocardial infarction. Diabetes: Types 1 & 2, Gestational diabetes. Kidney diseases like Glomerular Nephritis, Nephrolithiasis. Respiratory; COPD	18
4.	Asthma and Allergy; Basic concept and types. Mechanism of allergic reaction, Diagnostic test, and prophylactic measure.	4
5.	Epidemiology, Prevalence, Clinical Features and Preventive Strategies of: Protein Energy metabolism (PEM), Vitamin A Deficiency (VAD), Iron Deficiency Disorders (IDD).	
Suggested Readings:		
<ol style="list-style-type: none"> 1. Kathryn L., Mc Cance & Sue E. Huether, Pathophysiology: The Biologic Basis for Diseases in Adults and Children. Publisher: Elsevier 2. K. D. Tripathi, Essentials of Medical Pharmacology. 6th Edition; Publisher: Jaypee 3. N. J. Dimmock and S. B. Primrose; Introduction to Modern Virology; 4th Edition; Blackwell Scientific Publications, London. 4. L. M. Prescott; L. M. Harley et. al. Microbiology; 3rd Edition; Mc Graw Hill, New York. 5. Modern Nutrition in Health and Disease; 10th Edition; Lippincott, William, and Wilkins. 6. The Nutrition Society Textbook Series; Blackwell Publishing Company. 		
Disease Biology: Practical		
<ol style="list-style-type: none"> 1. Identification of <i>Ascaris sp.</i> Male and Female, <i>Taenia sp.</i>, <i>Entamoeba histolytica</i>, <i>Plasmodium vivax</i> 2. Quantitative estimation of glucose by GOD-POD. 3. Demonstration of estimation of total IgE (EIA method) 		

4. TC and DC of blood.	
5. A survey report of Diabetes mellitus distribution among different age groups and income groups.	
6. Identification of patients with reasons (photographs): Rickets, Marasmus, Kwashiorkor.	
Identification of Salmonella antigen in serum (Using Widal Test teaching kit)	
Examination Pattern	Full Marks: 20
One question from Item No.2 -----	05
One question from Item No. 4 -----	05
Identification any four from Item No.1 and 4 ---1 ^{1/2} x4 =	06
Laboratory Notebook -----	04

Outcome of the Study:

1. Demonstrate a knowledge of innate and adaptive immunity, including the process of inflammation;
2. Demonstrate a knowledge of how microbial pathogens (viruses, bacteria, and parasites) evade host defences and cause disease;
3. Demonstrate a knowledge of how deregulation of cellular growth and differentiation cause disease;
4. Demonstrate a knowledge of the pathobiology of the circulation, including the process of thrombosis and infarction.
5. Demonstrate a knowledge of interactions between infectious organisms and their hosts, with particular reference to emerging infections;
6. Recognize and identify a number of common bacterial species that may be associated with human and animal diseases.

ZOOL4013: COMPARATIVE ENDOCRINOLOGY

Objectives of the study: To introduce basic terms of Endocrinology. To develop conceptual clarity of Endocrinology. To familiarize the learners with the structure, types, and classification of chromosomes. To introduce the concept of sex determination and its types, sex-linked, sex-influenced, and sex-Limited Genes. To develop an understanding of genetic variability within a population and learn as to how the changes take place.

Credits 5 (Theory: 4, Practical: 1)

Full Marks 75 (Theory: 40 + Internal 15; Practical: 20)

Number of Lectures: 60

Sl. No.	Topics/Contents	Classes
1:	Introduction to Endocrinology: Endocrine system, Classification of Hormones. Modes of hormone secretion and transport, feedback mechanism.	7
2:	Invertebrate Endocrine System and Physiology: Insect hormones: types and their release sites Endocrine regulation of insect growth and metamorphosis, moulting, diapauses Vertebrate-type hormones in Crustaceans: X-organ, Y-organ and associated neurochemical organs.	8
3:	Vertebrate Endocrine System: Hypothalamus-hypophysial Axis; Pituitary gland(cell types), hormones and their functions. Pineal gland, biosynthesis of melatonin and its functions Cellular characteristics, Secretion, and functions of hormones from (a) Thyroid, (b) Pancreas, (c) Adrenal, (d) Testis and (e) Ovary Metamorphosis in Amphibians; Neoteny and Progenesis/ Pedogenesis Role of hormones in homeostasis: Glucose and Calcium. Hormonal control of Osmoregulatory Functions Endocrinology of Mammalian reproduction: Regulation of spermatogenesis; Oogenesis; Endocrine control of gestation, parturition, and lactation.	25
4	Molecular mechanism of hormone actions at cellular level: endocrine receptors, mechanism of actions of steroid and peptide hormones (emphasizing the role of second messengers)	10
5:	Special topics in Endocrinology: Endocrine disorders in Human, Endocrine disrupting chemicals (EDCs) Hormone mimics and their applied values (with special reference to Insect pest management. Bioassays of hormones using RIA & ELISA.	10
Suggested readings:		
<ol style="list-style-type: none"> Endocrine Physiology by Patricia E. Molina, 5th ed (2018), McGraw Hill. Vertebrate Endocrinology by David O. Norris, 4th ed. (2006), Academic press. Comparative Vertebrate Endocrinology by P.J. Bentley, 3rd ed. (1998), Cambridge University Press. The Insects: Structure and Function by R.F. Chapman, 4th ed. (1998), Cambridge University Press. Basic Medical Endocrinology by H.M. Goodman, 4th ed. (2009), Academic Press. Developmental Biology by Michael J.F. Barresi, Scott F. Gilbert, 12thed. (2019), Sinauer Associates. 		

7. Invertebrate endocrinology by DB Tembhare (2012) Himalaya Publishing House.

Comparative Endocrinology Practical:

1. Dissect and display of Endocrine glands in laboratory bred Rat.
2. Study of permanent slides of all the endocrine glands (Thyroid, Adrenal, Pancreas, Testis, and Ovary).
3. Tissue fixation, embedding in paraffin, microtomy and slide preparation of mammalian Testis.
4. Study of vaginal smear of rats for identification of different stages of estrous cycle.
5. Effect of hormone mimic on the metamorphosis of Lepidopteran insect.
6. Demonstration of hormone assay through ELISA from available teaching kit.

Examination Pattern: Full Marks: 20

One question from Item No.1 -----	04
One question from Item No. 3 -----	04
One question from Item No. 4 -----	04
Identification any four from Item No.2 and 6 ---1 ^{1/2} x4 =	06
Laboratory Notebook -----	02

Course outcome:

1. Students understand how the endocrine system is functioning.
2. They know the structures and molecular modes of action of a large variety of vertebrate and invertebrate hormones and understand how metazoan hormones and their functional mechanisms have evolved.
3. Hormones as mediators of growth, development, phenotype, behavior, reproduction, and epigenetic effects are covered and connected to relevant current events.

MINOR COURSE

ZOOL4021: WILDLIFE CONSERVATION

Objectives of the study: To provide a knowhow of the (a) various aspects of wildlife, including their values, depletion, conflicts with human beings and principles of conservation and various ecological attributes, (b) management and legal protection of different natural habitats and threatened species, and (c) different tools and techniques related to wildlife study.

Credits 4 (Theory: 3, Practical: 1)

Full Marks 75 (Theory: 40+ internal 15; Practical: 20) **Number of Lectures:** 60

Sl. No.	Topics/Contents	Classes
1.	Introduction to wildlife Conservation: Definition and importance of wildlife; Threatened wildlife and IUCN status — Concept of Extinct, Critically Endangered, Endangered, Vulnerable and near threatened species with examples; Red data book Concept of conservation: <i>in situ</i> (National parks, Sanctuaries, Community reserve, Conservation Reserves) & <i>ex-situ</i> methods of conservation. Biosphere Reserves: Concept of MAB, characteristics, examples from India.	15
2.	Basic Concepts in Wildlife Ecology Energy flows through ecosystems: linear and Y-shaped food chains, food webs and ecological pyramids. Population attributes: density, natality rate, mortality rate, sex ratio and age; survivorship curves. Population growth: exponential and logistic growth Community characteristics: species diversity (richness and abundance), keystone species, ecotone, and edge effect; concept of niche.	20
3.	Species-specific Conservation. Conservation status, habit & habitat, threats, and conservation management of the following animals in India: Tiger/Olive ridley turtles/Great Indian bustard/Himalayan musk deer/Greater one-horned rhinoceros /Ganges River dolphin.	10
4.	Man, and Wildlife: Causes, consequences of human-wildlife conflicts and mitigation of conflict with special reference to project elephant in India	5
5.	Management Planning of Protected Areas: Design and management of nature reserve; concept of wildlife corridor; joint forest management. Ecotourism / Wildlife Tourism in forests: Positive and Negative impacts Wildlife (Protection) Act, 1972 [with amendments], problems in wildlife protection, role of WWF, WCU, CITES, TRAFFIC	10

Suggested Readings:

1. Bookhout, T. A. (1996). Research and Management Techniques for Wildlife and Habitats, 5th edition. The Wildlife Society, Allen Press.
2. Caughley, G., and Sinclair, A.R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
3. Krebs, C. J. (2001). Ecology. Benjamin Cummings.
4. Molles, Jr. M.C. (2005). Ecology: Concepts and Applications. 3rd Ed. McGraw- Hill.
5. Pullin, A.S. (2002). Conservation Biology. Cambridge University Press.
6. Smith, R. L. & Smith, T. M. (2001). Ecology and Field Biology. Benjamin Cummings.
7. Smith, T. M & Smith, R. L. (2006). Elements of Ecology. 6th Ed. Pearson Education.

Practical Components:

1. Calculation of density and diversity indices (using Shannon-Weiner index) from natural/hypothetical community by quadrat method.
2. Study of animal evidence (pawmarks and hoofmarks, horns and antlers, scats and pellets, nests, etc. by photographs) and equipment in the field (GPS, binocular, camera trap, compass, radio tracker).
3. Pug mark analysis and census method.
4. Visit to any habitat of wildlife importance (Protected Areas, Biosphere Reserves, Wetlands and Ramsar Sites, Zoological and Botanical Gardens) and submission of field report.

Examination Pattern:**Full Marks 20**

One question from Item no. 1	-----	(7 X 1) = 07
Identification from Item No. 2 (any three)-----	(3 X 2) = 06	
One question from Item No. 3	-----	= 02
Field Visit Report	-----	03
Lab Notebook	-----	02

Course outcome:

At the end of the course, students should learn about the importance of wildlife and conservation in and around our surroundings as well as wild habitats and their relation to different ecological principles, emerging cases of man – animal conflict and impact of ecotourism on wild animals, with a general knowledge on the different legal structures associated with wildlife fauna.