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

Structure and detailed syllabus of the 8-semester Bachelor of Science in Zoology programme under NEP-2020

SEMESTER	MAJOR COURSE	CREDIT	FULL MARKS	MARKS		
				Theory	Practical	Internal
SEMESTER1	DSC100:NON-CHORDATES	3	50	40	-	10
	DSC101:PRACTICAL NON-CHORDATES	1	25		20	5
SEMESTER2	DSC102:CHORDATES	3	50	40	-	10
	DSC103:PRACTICAL CHORDATES	1	25		20	5
SEMESTER3	DSC200:BIOCHEMISTRY	3	50	40	-	10
	DSC201:PRACTICAL BIOCHEMISTRY	2	25		20	5
	DSC202:CELL BIOLOGY	3	50	40	-	10
	DSC203:PRACTICAL CELL BIOLOGY	2	25		20	5
SEMESTER4	DSC204:ANIMAL PHYSIOLOGY	3	50	40	-	10
	DSC205: PRACTICAL ANIMAL PHYSIOLOGY	2	25		20	5
	DSC206:DISEASE BIOLOGY	3	50	40	-	10
	DSC 207:PRACTICAL DISEASE BIOLOGY	2	25		20	5
	DSC208:COMPARATIVE ENDOCRINOLOGY	3	50	40	-	10
	DSC 209: PRACTICAL COMPARATIVE ENDOCRINOLOGY	2	25		20	5
SEMESTER 5	DSC 300:GENETICS	3	50	40	-	10
	DSC301:PRACTICAL GENETICS	2	25		20	5
	DSC302:EVOLUTIONARY BIOLOGY ETHOLOGY	3	50	40	-	10
	DSC 303: PRACTICAL EVOLUTIONARY BIOLOGY ETHOLOGY	2	25		20	5
	DSC304: ECOLOGY AND CONSERVATION BIOLOGY	3	50	40	-	10
	DSC305:PRACTICAL ECOLOGY AND CONSERVATION BIOLOGY	2	25		20	5
	DSC307:PRACTICAL MOLECULAR BIOLOGY	1	25		20	5
	DSC308:DEVELOPMENTAL BIOLOGY	3	50	40	-	10
	DSC 309:PRACTICAL DEVELOPMENTAL BIOLOGY	1	25		20	5
	DSC 310: ANIMAL BIOTECHNOLOGY	3	50	40	-	10
	DSC311: PRACTICAL ANIMAL BIOTECHNOLOGY	1	25		20	5
	DSC 312:HISTOLOGY & HISTOCHEMISTRY	3	50	40	-	10
	DSC313:PRACTICAL HISTOLOGY & HISTOCHEMISTRY	1	25		20	5
SEMESTER7	DSC400:ENTOMOLOGY	4	50	40	-	10

	DSC401: PRACTICAL ENTOMOLOGY	2	25	20		5
	DSC402:PARASITOLOGY AND VECTOR BIOLOGY	4	50	40	-	10
	DSC403: PRACTICAL PARASITOLOGY AND VECTOR	2	25	20		5
	BIOLOGY					
	DSC404: ICHTHYOLOGY	4	50	40	-	10
	DSC 405: PRACTICAL ICHTHYOLOGY	2	25	20		5
	DSC406:MICROBIOLOGY AND IMMUNOLOGY	4	50	40	-	10
	DSC407: PRACTICAL MICROBIOLOGY AND IMMUNOLOGY	2	25	20		5
SEMESTER8 (With Research)	DSC408:BIOINSTRUMENTATION AND RESEARCH METHODOLOGY	4	50	40	-	10
	DSC409: PRACTICAL INSTRUMENTATION AND RESEARCH METHODOLOGY	2	25	20		5
	PROJECT WORK /DISSERTATION	12	225[135+90]*		-	15
SEMESTER8 (Without Research)	DSC 410: ENVIRONMENTAL CHEMISTRY TOXICOLOGY	4	50	40	-	10
	DSC 411: PRACTICAL ENVIRONMENTAL CHEMISTRY TOXICOLOGY	2	25	20		5
	DSC 412: RESEARCH METHODOLOGY AND BIOSTATISTICS	3	50	40	-	10
	DSC 413: RESEARCH METHODOLOGY AND BIOSTATISTICS	1	25		20	5
	DSC414:BIOINSTRUMENTATION	3	50	40	-	10
	DSC 415: PRACTICAL BIOINSTRUMENTATION	1	25		20	5
	DSC416:COMPARATIVE ANATOMY	3	50	40	-	10
	DSC 417: PRACTICAL COMPARATIVE ANATOMY	1	25		20	5

*[Seminar Presentation, Preparation & Submission of Research Project / Dissertation -135 + Viva-90]

SEMESTER	MINOR COURSE	CREDIT	FULLMARKS	MARKS		
				Theory	Practical	Internal
SEMESTER1	NON-CHORDATES	3	50	40	-	10
	PRACTICAL NON-CHORDATES	1	25		20	5
SEMESTER2	CHORDATES	3	50	40	-	10
	PRACTICAL CHORDATES	1	25		20	5
SEMESTER3	WILDLIFE CONSERVATION	3	50	40	-	10
	PRACTICAL WILDLIFE CONSERVATION	1	25		20	5
SEMESTER4	APPLIED ZOOLOGY	3	50	40	-	10
	PRACTICAL APPLIED ZOOLOGY	1	25		20	5
SEMESTER5	ANIMAL FORM AND FUNCTION	3	50	40	-	10
	PRACTICAL ANIMAL FORM AND FUNCTION	1	25		20	5
SEMESTER6	CELL BIOLOGY & GENETICS	3	50	40	-	10
	PRACTICAL CELL BIOLOGY & GENETICS	1	25		20	5
SEMESTER7	VECTOR BORNE DISEASES AND EPIDEMIOLOGY	3	50	40	-	10
	PRACTICAL VECTOR BORNE DISEASES EPIDEMIOLOGY	1	25		20	5
SEMESTER8	DEVELOPMENTAL BIOLOGY	3	50	40	-	10
	PRACTICAL DEVELOPMENTAL BIOLOGY	1	25		20	5

SEMESTER	SEC	CREDIT	FULLMARKS	MARKS		
				Theory	Practical	Internal
SEMESTER1	SEC1:APICULTURE/VERMICULTURE	3	40	30	-	10
	PRACTICAL/FIELDVISIT/VIVAVOCE		10		10	
SEMESTER2	SEC2:SERICULTURE/AQUARIUM FISHKEEPING	3	40	30	-	10
	PRACTICAL/FIELDVISIT/VIVAVOCE		10		10	
SEMESTER3	SEC3:ANIMAL HUSBANDRY/PUBLIC HEALTH MANAGEMENT	3	40	30	-	10
	PRACTICAL/FIELDVISIT/VIVAVOCE		10		10	

SEMESTER	MDC	CREDIT	FULLMARKS	MARKS		
				Theory	Practical	Internal
SEMESTER1	INTRODUCTION TO ANIMALIA	3	40	30	-	10
	VISIT A MUSEUM/ZOOLOGICAL GARDEN, SUBMISSION OF REPORT/VIVA VOCE		10		10	
SEMESTER2	APPLIED ZOOLOGY I	3	40	30	-	10
	VISIT A SERICULTURE FARM & APIARY, SUBMISSION OF REPORT/VIVA VOCE		10		10	
SEMESTER3	APPLIED ZOOLOGY II	3	40	30	-	10
	VISIT A CATTLE/FISH/POULTRY/DAIRY FARM, AND SUBMISSION OF REPORT/VIVA VOCE		10		10	

NON CHORDATE (SEM-I) MAJOR SYLLABUS

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	**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 *Amoeba*, Conjugation in *Paramoecium*	5
3	**Unit3: Porifera** General characteristics and schematic classificationup to 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 *Obelia*, Coral Reef Types And Formation	4
5	**Unit5:Ctenophora** General Characteristics only	1
6	**Unit 6: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	**Unit 8: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	**Unit 12:Echinodermata** General characteristics and schematic classification up to class (Ruppert and Barnes1994), Water Vascular System of *Asteroidea*, 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). Invertebrate Zoology. 2ndEd. Oxford University
2. Press.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-A Text and reference book. JohnWiley&Sons.
4. Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4th Ed. Sinauer Associates...Dhami.S andJ.K. Dhami–Invertebrate Zoology–S. Chand And Co.
5. 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).TheInvertebrates (Vol-I). Mc.GrawHillBookCompany.
6. Jordan,E.L. &Verma,P.S.(2006).InvertebrateZoology.S.Chand&CompanyLtd. NewDelhi.
7. Kapoor, V. C. (2008). Theory and practice of animal taxonomy. 6th Ed. Oxford & IBH PubKotpal, R.L., 1988 – 1992. (All Series) Protozoa, Porifera, Coelentereta, Annelida, Arthropoda,Mollusca, Echinodermata,–RastogiPublications, Meerut – 250002.
8. Mayr,E.(1969).PrinciplesofSystematic Zoology.TataMcGraw-Hill.
9. Mayr, E. &Ashlock, P. D. (1991). Principles of Systematic Zoology. 2nd Ed., McGraw-Hill.Meglitsch,P.A. &Schram,F.R.(1991).Invertebrate Zoology.OxfordUniversityPress.
10. Chaki, Kundu, Sarkar IntroductiontoGeneralZoology.Vol1.NewCentralBookAgency (P)LTD.
11. Parker,T.J.&Haswell,W.(1972).TextBookofZoology,VolumeI.MacmillanPress,London.
12. Pechenik, J. A. (1998). Biology of the Invertebrates, 4th Ed. McGraw Hill..RuppertE.E.,Fox,R.&BarnesR.D.(2003).InvertebrateZoology: aFunctionalEvolutionaryApproach.7th Ed. Brooks Cole.
13. Sinha,K.S.,Adhikari,S.,&Ganguly, B.B.Biologyof Animals.Vol.I.NewCentralBookAgency.Kolkata.

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

NON-CHORDATE PRACTICAL(Credit:1)

1. Spot Identification of *Amoeba, Euglena, Paramoecium.* 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 lumbricoide*s.

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.andManna,B.(2015):PracticalZoology,NewCentralBookAgency,

Kolkata.

3. Sinha,J.K.,Chatterjee,A.K.andP.ChattopadhyayAdvancedPracticalZoology.

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.

CHORDATES (SEM-II) MAJOR SYLLABUS

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 *Ascidia* Feeding Mechanism In *Branchiostoma*	**2** **2** **1** **1**
3	**Agnatha** General characteristics and classification of Cyclostomes uptoSub-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** General characteristics and classification upto living Sub-classes Exoskeleton and migration in Birds Principles and aerodynamics of flight in Birds	**2** **2** **1**
8	**Mammalia** General characteristics and classification upto living Sub-classes Affinities of Prototheria Exoskeletal derivatives of Mammals Echolocation in Bat and Whale Adaptive radiation in mammals with reference To Locomotory Organs.	**2** **2** **2** **2** **2**
9	**Zoogeographical Realms** Distribution of Birds and Mammals different realms	**2** **2**

Reference books:

1. Arora,M.P.ChordataI. 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.McGrawHill.
6. Kotpal,R.L.,1988-1992.(AllSeries) Protozoa, Romer,A.S.&Parsons,T.S.(1986).The vertebrate body.6thEd.Saunders College Pub.
7. Saxena,R.A.& Saxena,S.Cooperative Anatomy in Vertebrates.Viva Publicatio n.
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,Exocetus,Echenis*
   - d. Amphibia*:Necturus, Bufo, Hyla, Axolotol larva, 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.

NON-CHORDATE (SEM-I) MINOR SYLLABUS

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)	TOTAL NO. 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 up to phylum (Levine et al. 1980) Locomotion in *Amoeba*, Conjugation in *Paramoecium*.	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 *Obelia*, 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 Barnes1994).	2
8	**Unit 8: Annelida** General characteristics and schematic classification up to class (Ruppert and Barnes1994) 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	**Unit 11: Mollusca** General characteristics and schematic classification up to class (Ruppert and Barnes1994), Modification of foot, Nervous system and torsion in Gastropoda.	5
12	**Unit 12: Echinodermata** General characteristics and schematic classification up to class (Ruppert and Barnes1994), Water vascular system of starfish.	4
13	**Unit 13: 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. 6thEd. Brooks Cole.
2. Barrington, E. J. W. (1981). Invertebrate Structure and Function. 2nd Ed. ELBS & Nelson.
   Blackwelder, 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.
   Meglitsch, P. A. &Schram, F. R. (1991). Invertebrate Zoology. Oxford University Press.
9. Chaki,Kundu,Sarkar Introduction to General Zoology . Vol 1. New Central Book Agency
10. (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..
    Ruppert E. E., Fox, R. & Barnes R. D. (2003). Invertebrate Zoology: a Functional Evolutionary Approach. 7th Ed. Brooks Cole.
13. Sinha, K. S., Adhikari, S., &Ganguly, B. B. Biology of Animals. Vol. I. New Central Book Agency. Kolkata.

NON CHORDATE 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: Mouth parts 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.

CHORDATES (SEM-II) MINOR SYLLABUS

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	**Origin of Chordata:** Dipleurula concept and the Echinoderm theory	2
2	**Introduction to Chordates** General characteristics and outline classification of Phylum Chordata up to living classes. Advanced features of Vertebrates over Protochordates.	2
3	**Agnatha** General features and outline classification up to classes (Young, 1981).	1
4	**Pieces** General features and outline Classification up to Subclasses (Romer, 1959). Accessory respiratory organs in fishes. Osmoregulation in fishes.	8
5	**Amphibia** General features and outline Classification up to living orders (Duellman Trueb,1986). Metamorphosis and Parental care in Amphibia	8
6	**Reptilia** 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	**Aves** General features and outline Classification up to orders (Young, 1981). Migration in birds.	8
8	**Mammalia** General features and outline Classification up to Subclasses (Young, 1981). Adaptive radiation in primates depends upon food. Echolocation 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 McGrawHill.
5. Kent,G.C. & Carr,R.K.(2001).Comparative anatomy of the Vertebrates.9thEd.McGrawHill.
6. Romer, A.S. & Parsons,T.S.(1986).The vertebrate body.6thEd.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, Tylototriton, 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.

APICULTURE (SEC, SEM-1) SYLLABUS

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.

SLNO.	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 ;genera lmorphology 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, royal jelly, 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 Ahsanand 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) **FullMarks:**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 bee hive and their uses for apiculture.
3. To know about different diseases on enemies of honey bees.
4. Able to know the techniques of honey extraction and handling of honey bees.
5. Get a brief idea about entrepreneurship in Apiculture.

VERMICULTURE (SEC, SEM-1) SYLLABUS

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 vermitechnology and its application in agriculture as well as entrepreneurship.

SL NO.	TOPICS (Credits:2)	TOTALNO. 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:*Eiseniafetida, Eudriluseugeniae,Lumbricus rubellus.*	**3**
4.	Importance Of Earthworm In Agriculture: Role Of earthworm to increase fertility of soil.	**3**
5.	Vermitechnology 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.	Vermicomposting Of Wastes: Different Methods, storage. Vermiwash: 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**

ReferenceBooks:

1. Edward,C.A.and Bohlen,P.J. Biology and Ecology and Earthworm. Chapman Hall. NY, USA.
2. Sultan Ahmed Ismail. TheEarthwormBook.OtherIndiaPress.
3. Bhatnagar and Patla. Earthworm Vermiculture and vermicomposting. Kalyani Publishers, New Delhi.
4. Sara's Vermitechnology, 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 l and 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 andVermicompost, Published by National Institute Industrial Research, Delhi-7, India.

VERMICULTURE PRACTICAL (Credit:1)

Full Marks:10

Visitpharm/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.

AQUARIUM FISHKEEPING (SEC, SEM-2) SYLLABUS

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 aquari-culturist.

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, or operation of an aquarium in the ornamental fish farms, hatcheries, and fish feed production plant as study tours or field visits.

SL NO.	TOPICS (Credits:2)	TOTAL NO. OF LECTURES (30)
1.	**Introduction to Aquarium Fish Keeping** The potential scope of Aquarium Fish Industry as Cottage Industry, Exotic and Endemic species of Aquarium Fishes	2
2	**Types of Aquaria** (Salinity, Temperature, Species Selection & Location) 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	6
3	**Biology Of Aquarium Fish** Aquarium Fish biology (Breeding, Feeding economic importance etc), sexual dimorphism of Freshwater and marine aquarium fish.	2
4	**Aquarium Fishes** 1. Freshwater ornamental fishes -Guppy, Gold fish and Angelfish. 2. Brackish ornamental fishes - Black Molly, Sword tail & Rayfish. 3. Marine ornamental fishes- Anemone fish, Moorish idol, Butterfly fish.	6

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

AQUARIUM FISH KEEPING PRACTICAL
(Credit:1)

Full Marks: 10

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 fish keeping as a cottage industry to a funding agency for self-employment of youths or for helping poor farmers; 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 C BL Srivastava Published by KitabMahal
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 Themin Captivity) Axelrod, Herbert R. Published by Chelsea House Publications (1998)
6.TheTropical Fresh water Aquarium Problem Solver: Practical and Expert Advice on Keeping Fish and Plants Sand ford, 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.

SERICULTURE (SEC, SEM-2) SYLLABUS

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 silkmoths; different species of silkmoths, their description.	**3**
2.	Biology of Mulberry Plants: Description Mulberry. Salient Features of family Moraceae; Phyto-geography and systematic of the genus *Morus*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 *Bombyx mori*. Silkworm Anatomy *Bombyx mori*: Digestive System: Larva, Circulatory system: Larva, pupa, adult, Nervous System: Larva, adult, Silk Gland: Larva, Reproductive System: Adult.	**3**
5.	Silkworm Diseases of *Bombyx mori*: Protozoan disease, Bacterial Disease, Fungal disease, Viral Disease, Sotto Silkworm Pests of *Bombyx mori*: Uzifly, Ants, Dermestid Beetles.	**3**
6.	Mulberry Silkworm Rearing: Model rearing house, Rearing appliances, disinfection, disinfectants, bed cleaning, feeding of	**4**

	worms. Rearing of larvae: techniques of rearing of different tages 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 Employment and 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- I Mulberry 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. SeriScientific Publishers, Bangalore.
7. Jolly,M.S., Chowdhury, S.NandSen.(1975).Non-mulberry Sericulture in India. Central Silk Board, Bombay, India.
8. WebsiteofCSB:https://silks.csb.gov.in/una/wp-ontent/themes/Common_District/una/sgf-frame.html

SERICULTURE PRACTICAL(Credit:1)

FullMarks: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.

INTRODUCTION TO ANIMALIA (MDC, SEM-1) SYLLABUS

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 an understanding and ability to apply basic zoological principles.

UNIT	TOPIC (CREDIT 3)	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, Nemathelminthes, 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**

PRACTICAL **CREDIT : 1; FM: 10**

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)

(Fifteen hours should be spent for the practicals)

APPLIED ZOOLOGY I (MDC, SEM-2) SYLLABUS

SLNO.	TOPICS (Credits:2)	TOTAL NO.OF LECTURES (30)
1	**Chapter 1. Sericulture:** • History and present status of sericulture in India and West Bengal. • Mulberry And Non-mulberry species in India. • Mulberry Cultivation. • Morphology and lifecycle of *Bombyx mori*. • Silkworm Rearing Techniques: Processing of cocoon, reeling. • Silkworm Diseases-pests and their control. **Chapter 2.Apiculture:** • Introduction and present status of apiculture in West Bengal. • Species of honey bees in India, lifecycle of *Apis indica* • 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 beeswax and their uses • Pests and Diseases Of Bees And Their Management.	15

Books & Suggested Readings:

1. Eikichi,H.(1999).Silk worm 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.
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. Yadav Manju(2003). Economic Zoology, Discovery Publishing House.
9. Jabde PradipV(2005).TextbookofappliedZoology,DiscoveryPublishingHouse,NewDelhi.
10. Cherian & Ramachandran Bee keeping in-South Indian Govt. Press, Madras.
11. Sathe, T.V. Vermiculture and Organic farming.
12. Bard. J (1986).Hand book 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)Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac Culture.
16. Animal Disease-Bairagi K. N.AnmolPublicationsPvt.Ltd2014
17. Economics Of Aquaculture-Singh (R.K.P)-DanikaPublishingCompany2003
18. AppliedandEconomicZoology(SWAYAM)webhttps:// swayam.gov.in/nd2_cec20_ge23/preview

CourseBookspublishedinEnglishandBengalimaybeprescribedbytheUniversitiesandColleges

APPLIED ZOOLOGY PRACTICAL(Credit:1)

FullMarks: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