



Syllabus for Four Years Undergraduate Courses in Zoology

[New Curriculum and Credit Framework for undergraduate Programme]

Following NEP 2020

With effect from the Academic Session 2023-2024]



BANKURA UNIVERSITY

BANKURA

WEST BENGAL

PIN 722155



CONTENTS

Sl. No.	Subject Matter	Page No.
1.	Introduction	03
2.	Scheme for NEP Curriculum	
	Credit Distribution across Courses	04
	Scheme for NEP Curriculum in Zoology	05
	Question Pattern for Zoology	06
	Programme Outcome of Zoology	07
	Programme Specific Outcome of Zoology	08-09
3.	Major Stream: Discipline Specific Core (DSC) Courses of Zoology	10-15
4.	Minor Stream Courses of Zoology	16-19
5.	Skill Enhancement Courses	20-21
6.	Multidisciplinary Courses	22-23



Introduction

The syllabus for Zoology at undergraduate level using the NEP-2020 and formulation of a new student-centric “**Curriculum and Credit Framework for Undergraduate Programmes (CCFUD)**”, the syllabus for Zoology has been framed following the UGC guidelines facilitating students to pursue their career path by choosing the subject. While framing the syllabus as per the UGC guideline, the topics have been kept as generic as possible in order to provide enough freedom to the individual Universities to detail out their own syllabus as per their own infrastructure, expertise and strength.

The main objective of framing this new syllabus is to give the students a holistic understanding of the subject giving substantial weightage to both the core content and techniques used in Zoology. The incorporation of a flexible choice-based credit system, a multidisciplinary approach, and many entry and exit alternatives with a focus on the students' chosen majors and minors has been done correctly in accordance with our own infrastructure, competence, and strength.

Keeping in mind and in tune with the changing nature of the subject, adequate emphasis has been given on new techniques and understanding of the subject.

The syllabus has also been framed in such a way that the basic skills of subject are taught to the students, and everyone might not need to go for higher studies and the scope of securing a job after graduation will increase.

There is wide deviation in the infrastructure, be it physical or in human resource, in the form of teachers' expertise and ability and aspiration of the students. In addition scope of research and summer internship has been introduced in the new syllabus.



Course Code Format
Programme and Course Structure with Credit Distribution: UG Degree Programme with Single Major (Zoology)

Category of Course (Credit)	Major (4)		Minor Stream(4)	Multidisciplinary (3)	Skill Enhancement Courses (SEC) (3)	Ability Enhancement Courses (AEC) (2)	Value Added Courses common for all (4)	Summer Internship (2)	Research Project / Dissertation* (12)	TOTAL CREDIT / NUMBER OF COURSES
	DSC	DSE								
I	1 x4=4 S/ZOO/101/MJC-1		1 x4=4 S/ZOO/102/MN-1	1 x3=3 S/ZOO/103/MD-1	1 x3=3 S/ZOO/104/SEC-1	1 x2=2 ACS/105/AEC-1	1 x4=4 ACS/106/VAC-1			20/6
II	1 x4=4 S/ZOO/201/MJC-2		1 x4=4 S/ZOO/202/MN-2	1 x3=3 S/ZOO/203/MD-2	1 x3=3 S/ZOO/204/SEC-2	1 x2=2 ACS/2105/AEC-2	1 x4=4 ACS/206/VAC-2			20/6
CERTIFICATE (Total Credit)	8		8	6	6	4	8	4*(ADDITIONAL) ACS/207/INT-1		40
III	2 x4=8 S/ZOO/301/MJC-3 S/ZOO/302/MJC-4		1x4=4 S/ZOO/303/MN-3	1 x3=3 S/ZOO/304/MD-3	1 x3=3 S/ZOO/305/SEC-3	1 x2=2 ACS/306/AEC-3				20/6
IV	4 x4=16 S/ZOO/401/MJC-5 S/ZOO/402/MJC-6 S/ZOO/403/MJC-7 S/ZOO/404/MJC-8		1x4=4 S/ZOO/405/MN-4			1 x2=2 ACS/406/AEC-4				22/6
DIPLOMA (Total Credit)	32		16	9	9	8	8	4*(ADDITIONAL) ACS/407/INT-2		82
V	2 x4=8 S/ZOO/501/MJC-9 S/ZOO/502/MJC-10	2 x4=8 S/ZOO/503/MJE-1 S/ZOO/504/MJE-2	1x4=4 S/ZOO/505/MN-5					1 x2=2 ACS/506/INT-3		22/6
VI	2 x4=8 S/ZOO/601/MJC-11 S/ZOO/602/MJC-12	2 x4=8 S/ZOO/603/MJE-3 S/ZOO/604/MJE-4	1x4=4 S/ZOO/605/MN-6							20/5
UG DEGREE (Total Credit)	64		24	9	9	8	8	2		124
VII	1 x4=4 S/ZOO/701/MJC-13	3 x4=12 S/ZOO/702/MJE-5 S/ZOO/703/MJE-6 S/ZOO/704/MJE-7	1x4=4 S/ZOO/705/MN-7							20/5
VIII	1 x4=4 S/ZOO/7801/MJC-14	3 x4=12** S/ZOO/802/MJE-8 S/ZOO/803/MJE-9 S/ZOO/804/MJE-10	1x4=4 S/ZOO/805/MN-8							20/5
UG HONS. (Total Credit)	96		32	9	9	8	8	2		164
UG HONS. With Research (Total Credit)	84		32	9	9	8	8	2	12** S/ZOO/806/RPD-1	



Curriculum and Credit Framework for ZOOLOGY

(Basic, Honours and Honours with Research)
With effect from the Academic Year 2023-2024

SEMESTER-I									
Sl. No.	Course Code	Course Title	Credit	Marks			No. of Hours		
				IA	ESE	Total	L	T	P
1	S/ZOO/101/MJC-1	Non chordate Diversity (Theory & Practical)	4 (T+P)	10	40 T:25 P:15	50	3	0	2
2	S/ZOO/102/MN-1	Non chordate (Theory & Practical)	4 (T+P)	10	40 T:25 P:15	50	3	0	2
3	S/ZOO/103/MD-1	Sericulture and Silk Production Technology (For students of other discipline)	3 (T)	10	40	50	3	NA	NA
4	S/ZOO/104/SEC-1	Sericulture	3(T)	10	40	50	3	NA	NA
5	ACS/105/AEC-1	Compulsory English: Literature and Communication	2	10	40	50	2	NA	NA
6	ACS/106/VAC-1	Environmental Studies	4	10	40	50	4	NA	NA
Total in Semester-I			20	60	240	300			

SEMESTER-II									
Sl. No.	Course Code	Course Title	Credit	Marks			No. of Hours		
				IA	ESE	Total	L	T	P
1	S/ZOO/201/MJC-2	Chordate Diversity and Comparative Anatomy of Vertebrates (Theory & Practical)	4 (T+P)	10	40 T:25 P:15	50	3	NA	2
2	S/ZOO/202/MN-2	Chordate and Comparative Anatomy (Theory & Practical)	4 (T+P)	10	40 T:25 P:15	50	3	NA	2
3	S/ZOO/203/MD-2	Environment and Public Health Management	3 (T)	10	40	50	3	NA	NA
4	S/ZOO/204/SEC-2	Aquarium Fish Management	3 (T)	10	40	50	3	NA	NA
4	ACS/205/AEC-2	MIL- I (Santali, Sanskrit and Bengali)	2	10	40	50	2	NA	NA
6	ACS/206/VAC-2	Any one of the following: a) Health and wellness b) Understanding India: Indian Philosophical Traditions and Value Systems c) Basics of Indian Constitution d) Arts and Crafts of Bengal e) Historical Tourism in West Bengal.	4	10	40	50	4	NA	NA
Total in Semester-II			20	60	240	300			

**Question pattern for Zoology****For 25 Marks paper**

Sl No.	Questions to be answered	Out of	Marks of each question	Total Marks
1	5	8	1	5 x1=5
2	2	4	5	2 x 5=10
3	1	2	10	1 x 10= 10

For 40 Marks paper

Sl No.	Questions to be answered	Out of	Marks of each question	Total Marks
1	5	8	2	5 x2=10
2	4	6	5	4x 5=20
3	1	2	10	1 x 10= 10

Programme Outcome of Zoology (PO)



P O	Programme Outcome	Description
PO. 1	Sound knowledge in different fields of Zoology	Students are expected to learn the fundamental concepts, principles and processes underlying the academic field of Zoology with special reference to the characteristics of animal diversity, ecological aspects, comparative anatomy and development, physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, applied zoology, aquatic biology, immunology, reproductive biology, insect, vectors and diseases, apiculture, aquarium fish keeping, medical diagnostics, sericulture and microbiological relationship.
PO. 2	Professional skills	Professional skills in the field of Zoology in relation to academia and industry require sound knowledge of the core courses as well as related fields of study such as chemistry, physics, mathematics etc. and above all interest in studying with the habit of asking questions to find out the cause and effect. Therefore, there must be the sincerity from both the teachers and learners to extend curiosity and grasp knowledge.
PO. 3	Environmental awareness	Going through the courses as enshrined in the syllabus concerned students would generously and spontaneously develop the characteristics of thinking on the global environmental aspects.
PO. 4	Designing and conducting experiments to test a hypothesis	On obtaining wholesome knowledge from learning the courses it would be possible for the learners to step into higher learning which requires designing experiments to prove hypotheses.
PO. 5	Job opportunity	Biological Sciences today extend great opportunity towards sincere learners for healthy jobs in different fields beside academia such as health, medicines, research, biotechnological industry and such many. Therefore the students must be prepared in such a way so that they may able to face these competitive fields.

Programme Specific Outcomes of Zoology (PSO)



PSO	Description
PSO. 1	<p>The core courses include diversified fields of life sciences viz:</p> <ul style="list-style-type: none"> a) Overall concept of living organisms with special reference to animal kingdom; wherein it would be possible for the learners to have an idea of diverse group of animals, their structural aspects with functional anatomy . b) Concept of classifying these diversified groups of animals using taxonomical approaches. Evolution of animals are studied by following evolutionary principles. c) Idea of developing ecological concepts in relation to individual, population and community along with the roles in organizing ecosystems and other structural and functional components. d) Similarities in Biochemistry ,physiology and molecular aspects of all living organisms are taught in the light of modern approaches to develop the concept and generate interest . e) Molecular biological parameters in the form of DNA,RNA and proteins and their similarities and uniqueness in all living organisms. f) Protective approaches of animals against infectious diseases termed as immunity are studied to develop global concept of immunity following immunological principles. g) Development of animals from fertilized embryo is studied in relation to amphibian and avian embryonic development to have an overall concept of developmental pattern in animals.. h) Endocrine regulation and coordination of different physiological system are studied in an independent course in the form of endocrinology. i) Heredity and variation of animals are studied following the general principles of genetics. Therefore using these study materials it becomes possible for the learners to develop improved knowledge on the field.
PSO.2	Applied zoology in the form of fish farming, poultry etc. are studied independently by including separate programme called department specific elective in broader perspective so that the learners become seriously devoted to the subject.
PSO. 3	Skill enhancement courses are introduced such as medical technology.....etc. to develop specific skill in the area of self development to start the learners own laboratories.
PSO. 4	Generic Elective courses have been incorporated as interdisciplinary to teach overall concept of the subject so that student from other department of study may choose the courses according to their interest.
PSO. 5	Students ripen their investigative proficiency so that they can open up the entrances of the future knowledge world.
PSO. 6	To help the students for development of essential academic skills like critical thinking, analytical reasoning, research skills to identifying various Invertebrate and Vertebrate fauna and their classification as well as to understand the relations among these organisms with an evolutionary perspective.
PSO.7	Students will be able to analyze and solve the problems related to animal sciences without relying on assumptions and guesses.



PSO 8	Students will be able to make solutions of biological problems by experimentation and subsequent data processing by modern technologies and computer applications.
PSO 9	The programme will fortify the students to develop fundamental knowledge in biodiversity and their conservation, pollution of environment and their control measures.
PSO 10	They will be able to understand the basic zoological principles with critical understanding and analytical skills as well as to develop effective methods for experimentation and problem solving.
PSO 11	The programme will help the students to learn the safety measures in animal handling and management programmes in laboratories. Students will be able to learn the field survey for ecological studies as well as they will be capable of designing precise experimental setup for studying animal behaviour.
PSO 12	The programme will strengthen the students for developing laboratory skills for Genetics and Molecular Biology. The laboratory programme will enable them to learn the techniques for the qualitative as well as quantitative assays of bio molecules.
PSO 13	They will understand the importance and role biodiversity and can recognize the economically important animals around us.
PSO 14	Students will be able to learn about different diseases, causative organisms, parasites, hosts, vectors as well as the basic principles of immunology including vaccinations and genetic basis several diseases like cancer.
PSO 15	The programme will strengthen the students to understand the structure and function of the gene, chromosomes, genome, cell, tissue, organ and organ-system.
PSO 16	They will understand the importance of the physiological adaptations, development pathways, hormonal regulation of reproduction and other physiological mechanisms.
PSO 17	Another important programme outcome will be the ability of students to estimate various important environmental parameters like O ₂ , CO ₂ content, Ph, water turbulence, temperature, salinity, nutrient content .
PSO 18	Some special courses of the programme will help the students to develop essential skill and practical knowledge in application of economic Zoology in fishery, sericulture, apiculture which will provide gainful employment and economic development.
PSO 18	Project work and field study provide them with an encouragement for self-learning.
PSO 18	Research Motivation is also another significant outcome that the students are endowed with on the completion of the programme.

Zoology Major

**Semester- I****Paper I : Non chordate Diversity (Theory)****3 Credits****Course Outcomes:**

1. This course includes the concept of living organisms which are grouped into six kingdoms and the idea behind such grouping. Knowing the differences among other five non-animal to that of animal kingdom enables to have a clear idea of animal characteristics.
2. To study animals in systematic pattern it needs to classify animal groups using taxonomical principles. Therefore Taxonomy is incorporated in the course.
3. The common structural pattern of all animals is considered in the form of symmetry.
4. The protozoans are animal protists therefore these find inclusion in studying zoology and this course includes Protozoans to Pseudocoelomates. Pseudocoelomates are triploblastic animals without true coelom and therefore the topic of development of coelome is also included. Thus non-chordate I contents teaches on the basics of animal characters and their organized study methods.
5. Non-chordates includes topics of metamerism in animals with special reference to annelids to know the metamerism in all higher groups which is not present in earlier groups already studied in non-chordate-I.
6. The course also includes classificatory schemes ,structural and functional aspects of the non-chordate groups from annelids to echinoderms.

Unit 1: Introduction

Coelom: Types, Evolution and significance

Unit 2: Basics of Animal Classification

1. Definitions: Classification, Systematics and Taxonomy: Taxonomic Hierarchy, Taxonomic types
2. Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy; Six kingdom concept of classification (Carl Woese)

Unit 3: Protista

Protozoa:

General characteristics and classification up to phylum (Levine et. al., 1981)

Locomotion in Protozoa with special reference to *Euglena*, *Paramecium* and *Amoeba*; Conjugation in *Paramecium*.

Unit 4: Porifera

1. General characteristics and classification up to Classes (Hyman 1940)
2. Canal system and spicules in sponges

Unit 5: Cnidaria

1. General characteristics and classification up to classes
2. Metagenesis in *Obelia*
3. Corals and coral reef diversity, function & conservation

Unit 6: Platyhelminthes

General characteristics and classification up to classes

Unit 7: Nematoda

1. General characteristics and classification up to classes
2. Parasitic adaptations in helminthes

Unit 8: Annelida

1. General characteristics and classification up to classes
2. Reproduction in earthworm.

Unit 9: Arthropoda

1. General characteristics and classification up to classes
2. Social life in termite
3. Insect Metamorphosis

Unit 10: Onychophora

General characteristics and Evolutionary significance of *Peripatus*



Unit 11: Mollusca

1. General characteristics and Classification up to classes
2. Nervous system and torsion in Gastropoda

Unit 12: Echinodermata

1. General characteristics and Classification up to classes
2. Water-vascular system in *Asterias*

Unit 13: Hemichordata

1. General characteristics of phylum Hemichordata.
2. Evolutionary significance of Hemichordates

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

Reference Books

- Barnes, R. D. & Ruppert, E. E., (1994). Invertebrate Zoology. 6th Ed. Brooks Cole
Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4th Ed. Sinauer Associates
Mandal FB (2015), Human Parasitology 2nd Edition, PHI Learning
Kapoor, V. C. (2008). Theory and practice of animal taxonomy. 6th Ed. Oxford & IBH Pub
Mayr, E. (1969). Principles of Systematic Zoology. Tata McGraw-Hill.
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
Pechenik, J. A. (1998). Biology of the Invertebrates, 4th Ed. McGraw Hill
Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
Sinha, K. S., Adhikari, S., & Ganguly, B. B. Biology of Animals. Vol. I. New Central Book Agency. Kolkata

**Course Outcomes:**

The Laboratory on the course approaches to teach the diverse kinds of animals from protozoans to Hemichordata by observing the real animal groups and their identifying characters.

Practicals

1. Identification of following specimen
Amoeba, Euglena, Paramaecium, Sycon, Fasciola, Ascaris Physalia, Aurelia, Gorgonia, Metridium, Pennatula, Fungia, Aphrodite, Pheretima, Hirudinaria, Balanus, Eupagurus, Scolopendra, Peripatus, Chiton, Pinctada, Octopus, Nautilus, Asterias, Balanoglossus
2. Identification of T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm
3. Dissection of digestive system and nervous system of earthworm
4. Dissection of reproductive system of earthworm
5. Dissection: digestive system and nervous system of Cockroach
6. a. Mounting of mouth parts of Cockroach
b. Staining and mounting of any protozoa/helminthes from gut of cockroach.
7. Submission of Laboratory Note Book

Distribution of Marks**Examination Pattern:**

	Full marks: 15
1. Identification with reasons (any three):	3x2= 6
2. Dissection (any one) (From Item no. 3, 4 and 5)	4 [2+1=1]
3. Staining/ Mounting (any one) (From Item no. 6):	3 [1+1+1]
4. Laboratory Note book	2

***Note:**

Q1. For Item (1), Sc. name:0.5 mark, Systematic Position 0.5 and Reasons: 1 marks.

For Item (2) 1 mark is allotted for both identification and characters.

Suggested readings:

Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
Poddar T. K., S. Mukherjee & S. K. Das (2002) An Advanced Laboratory Manual of Zoology, Laxmi Publications
Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay (2015) Advanced Practical Zoology

**Semester -II****Paper II : Chordate Diversity and Comparative Anatomy of Vertebrate (Theory)****3 Credits****Course Outcomes:**

This course is intended to provide students with a fundamental grasp of the diversity of the Phylum Chordata, with a focus on their origin, major traits, classification, distribution, and functioning. This course will enlighten students on the concept of Chordate diversity, organisation, adaptation, and taxonomic position. The course will teach students about chordate systemic physiology and comparative anatomy of chordates. There will be a discussion regarding the chordate's affinities to various groups. Students learn about venom's composition and significance. Learn about the structural characteristics of birds that will aid them in Poultry (commercial application). Mammal adaptive radiation will shed light on the diversity and distribution of mammals.

Group A**Unit 1: Introduction to Chordates**

Origin of Chordate (Dipleurula concept and the Echinoderm theory)

Unit 2: Urochordata and Cephalochordata

1. General characteristics and classification of Urochordata and Cephalochordata up to Classes.
2. Retrogressive metamorphosis in *Ascidia*.

Unit 3: Agnatha

General characteristics and classification of cyclostomes up to order

Unit 4: Pisces

1. General characteristics and classification of Chondrichthyes and Osteichthyes up to Subclasses
2. Migration in fishes
3. Structure and function of Swim bladder

Unit 5: Amphibia

1. General characteristics and classification up to living Orders.
2. Parental care in Amphibia

Unit 6: Reptilia

1. General characteristics and classification up to living Orders.
2. Poison apparatus and biting mechanism in snakes

Unit 7: Aves

1. General characteristics and classification up to Sub-Classes
2. Migration in birds
3. Aerodynamics of flight

Unit 8: Mammals

1. General characters and classification up to living orders
2. Affinities and phylogeny of Monotremata
3. Echolocation in micro chiropterans



GROUP B

Unit 9: Integumentary System

Structure, function and derivatives of integument in amphibian, birds and mammals

Unit 10: Skeletal System

General idea of Axial and appendicular Skeleton

Unit 11: Digestive System

Ruminating stomach; dentition in mammals

Unit 12: Respiratory System

Respiratory organs in fish, amphibian, and birds

Unit 13: Circulatory System

Comparative account of heart and aortic arches

Unit 14: Urinogenital System

Archinephros, Pronephros, Mesonephros and Metanephros Evolution of urinogenital ducts,

Unit 15: Nervous System

Comparative account of brain, Cranial nerves in mammals

Unit 16: Sense Organs

Classification of receptors

Note: Classifications for Protochordata, Agnatha, Reptilia, Aves and Mammalia to be followed from Young (1981), for Pisces to be followed from Romer (1959), for Amphibia to be followed from Nobel (1924).

Reference Books

- Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.
Futuyma, D. (1997). Evolutionary Biology. 3rd Ed. Sinauer Associates, INC.
Hall B.K. and Hallgrímsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
Jordan, E.L. & Verma, P.S. (2003). Chordate Zoology. S. Chand & Company Ltd. New Delhi.
Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
Kent, G. C. & Carr, R. K. (2001). Comparative anatomy of the Vertebrates. 9th Ed. McGraw Hill.
Mandal FB (2013) Vertebrate Zoology, Oxford and IBH Co Pvt Ltd, New Delhi
Nelson, J.S., (2006): Fishes of the World, 4th Edn., Wiley.
Parker, T. J. & Haswell, W. (1972). Text Book of Zoology, Volume II: Marshall and Wiliam (Eds.) 7th Ed. Macmillan Press, London.
Pough H. Vertebrate life, VIII Edition, Pearson International.
Romer, A. S. & Parsons, T. S. (1986). The vertebrate body. 6th Ed. Saunders College Publishing.
Sinha, K. S., Adhikari, S., Ganguly, B. B. & Bharati Goswami, B. D. (2001). Biology of Animals. Vol. II. New Central Book Agency (p) Ltd.
Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education
Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies
Hilderbrand, M (1988) . Analysis of Vertebrate Structure. 3rd Edition, John Wiley and Sons
Saxena, R.K. & Saxena, S.C. (2008): Comparative Anatomy of Vertebrates, Viva Books Pvt. Ltd.

**Paper II : Chordate Diversity and Comparative Anatomy of Vertebrates (Practical)****1 Credits****Course Outcomes:**

Students will learn how to explain the differences between Protochordates and Chordates. Students can able to recognise chordates' taxonomic place, diversity, and distribution. Learn about the economic value and significance of fishes. Identify and differentiate deadly and non-poisonous snakes by examining distinguishing characteristics.

Practicals

1. Identification of following specimen
Branchiostoma, Petromyzon, Scoliodon, Torpedo, Heteropneustes, Exocoetus, Hippocampus, Necturus, Bufo, Tylotriton, Chelone,, Chamaeleon, Draco, , Vipera, Naja, Alcedo, Psittacula, Pteropus, Funambulus,
2. Identification of disarticulated skeleton of Pigeon and Guinea pig [Skull, Vertebrae (Atlas, Axis) , Pectoral girdle, Pelvic girdle],
3. Mounting of Pecten from Fowl head
4. Staining and mounting of Placoid, Cycloid and Ctenoid scales
5. Dissect out brain of carp
6. Dissection: Afferent branchial arterial system and IX and Xth Cranial nerves of carp
7. Submission of Laboratory Note Book

Distribution of Marks**Examination Pattern:****Full marks: 15**

- | | |
|---|------------|
| 1. Identification with reasons (any three;) | 6 (2+2+2)* |
| 2. Mounting and staining | 2 |
| 3. Dissection | 5 [3+1+1]* |
| 4. Submission of laboratory note book: | 2 |

Zoology Minor

**Semester- I****Paper I : Non chordate (Theory)****3 Credits****Unit 1: Introduction**

Coelom: Types, Evolution and significance

Unit 2: Basics of Animal Classification

1. Definitions: Classification, Systematics and Taxonomy: Taxonomic Hierarchy, Taxonomic types
2. Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy; Six kingdom concept of classification (Carl Woese)

Unit 3: Protista

1. Protozoa:

General characteristics and classification up to phylum (Levine et. al., 1981)

Locomotion in Protozoa with special reference to *Euglena*, *Paramecium* and *Amoeba*; Conjugation in *Paramecium*.

Unit 4: Porifera

1. General characteristics and classification up to Classes (Hyman 1940)
2. Canal system and spicules in sponges

Unit 5: Cnidaria

1. General characteristics and classification up to classes
2. Metagenesis in *Obelia*
3. Corals and coral reef diversity, function & conservation

Unit 6: Platyhelminthes

1. General characteristics and classification up to classes

Unit 7: Nematoda

1. General characteristics and classification up to classes
2. Parasitic adaptations in helminthes

Unit 8: Annelida

1. General characteristics and classification up to classes
2. Reproduction in earthworm.

Unit 9: Arthropoda

1. General characteristics and classification up to classes
2. Social life in termite
3. Insect Metamorphosis

Unit 10: Onychophora

General characteristics and Evolutionary significance of *Peripatus*

Unit 11: Mollusca

1. General characteristics and Classification up to classes
2. Nervous system and torsion in Gastropoda

Unit 12: Echinodermata

1. General characteristics and Classification up to classes
2. Water-vascular system in *Asterias*

Unit 13: Hemichordata

1. General characteristics of phylum Hemichordata.
2. Evolutionary significance of Hemichordates

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

Reference Books

Barnes, R. D. & Ruppert, E. E., (1994). Invertebrate Zoology. 6thEd. Brooks Cole



- Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4th Ed. Sinauer Associates
Mandal FB (2015), Human Parasitology 2nd Edition, PHI Learning
Kapoor, V. C. (2008). Theory and practice of animal taxonomy. 6th Ed. Oxford & IBH Pub
Mayr, E. (1969). Principles of Systematic Zoology. Tata McGraw-Hill.
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
Pechenik, J. A. (1998). Biology of the Invertebrates, 4th Ed. McGraw Hill
Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
Sinha, K. S., Adhikari, S., & Ganguly, B. B. Biology of Animals. Vol. I. New Central Book Agency. Kolkata

Paper I : Non chordate (Practical)**1 Credit****Practicals**

1. Identification of following specimen
Amoeba, Euglena, Paramecium, Sycon, Fasciola, Ascaris Physalia, Aurelia, Gorgonia, Metridium, Pennatula, Fungia, Aphrodite, Pheretima, Hirudinaria, Balanus, Eupagurus, Scolopendra, Peripatus. Chiton, Pinctada, Octopus, Nautilus, Asterias, Balanoglossus
2. Identification of T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm
3. Dissection of digestive system and nervous system of earthworm
4. Dissection of reproductive system of earthworm
5. Dissection: digestive system and nervous system of Cockroach
6. a. Mounting of mouth parts of Cockroach
b. Staining and mounting of any protozoa/helminth from gut of cockroach.
7. Submission of Laboratory Note Book

Distribution of Marks**Examination Pattern:**

	Full marks: 15
1. Identification with reasons (any three):	3x2= 6 *
2. Dissection (any one) (From Item no. 3, 4 and 5)	3 [2+1]
3. Staining/ Mounting (any one) (From Item no. 6):	4 [2+1+1]
4. Laboratory Note book	2

***Note:**

Q1. For Item (1), Sc. name:0.5 mark, Systematic Position 0.5 and Reasons: 1 marks.

For Item (2) 1 mark is allotted for both identification and characters.

Suggested readings:

- Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
Poddar T. K., S. Mukherjee & S. K. Das (2002) An Advanced Laboratory Manual of Zoology, Laxmi Publications
Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015) Advanced Practical Zoology

Zoology Minor

**Semester -II****Paper II : Chordate and Comparative Anatomy (Theory)****3 Credits****Group A****Unit 1: Introduction to Chordates**

Origin of Chordate (Dipleurula concept and the Echinoderm theory)

Unit 2: Urochordata and Cephalochordata

3. General characteristics and classification of Urochordata and Cephalochordata up to Classes.
4. Retrogressive metamorphosis in *Ascidia*.

Unit 3: Agnatha

General characteristics and classification of cyclostomes up to order

Unit 4: Pisces

4. General characteristics and classification of Chondrichthyes and Osteichthyes up to Subclasses
5. Migration in fishes
6. Structure and function of Swim bladder

Unit 5: Amphibia

3. General characteristics and classification up to living Orders.
4. Parental care in Amphibia

Unit 6: Reptilia

3. General characteristics and classification up to living Orders.
4. Poison apparatus and biting mechanism in snakes

Unit 7: Aves

4. General characteristics and classification up to Sub-Classes
5. Migration in birds
6. Aerodynamics of flight

Unit 8: Mammals

4. General characters and classification up to living orders
5. Affinities and phylogeny of Monotremata
6. Echolocation in micro chiropterans

GROUP B**Unit 9: Integumentary System**

Structure, function and derivatives of integument in amphibian, birds and mammals

Unit 10:

General idea of Axial and appendicular Skeleton

Unit 11: Digestive System

Ruminating stomach; dentition in mammals

Unit 12: Respiratory System

Respiratory organs in fish, amphibian, and birds

Unit 13: Circulatory System

Comparative account of heart and aortic arches

Unit 14: Urinogenital System

Archinephros, Pronephros, Mesonephros and Metanephros Evolution of urinogenital ducts,

Unit 15: Nervous System

Comparative account of brain, Cranial nerves in mammals

**Unit 16: Sense Organs**

Classification of receptors

Note: Classifications for Protochordata, Agnatha, Reptilia, Aves and Mammalia to be followed from Young (1981), for Pisces to be followed from Romer (1959), for Amphibia to be followed from Nobel (1924).

Reference Books

- Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.
 Futuyama, D. (1997). Evolutionary Biology. 3rd Ed. Sinauer Associates, INC.
 Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
 Jordan, E.L. & Verma, P.S. (2003). Chordate Zoology. S. Chand & Company Ltd. New Delhi.
 Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
 Kent, G. C. & Carr, R. K. (2001). Comparative anatomy of the Vertebrates. 9th Ed. McGraw Hill.
 Mandal FB (2013) Vertebrate Zoology, Oxford and IBH Co Pvt Ltd, New Delhi
 Nelson, J.S., (2006): Fishes of the World, 4th Edn., Wiley.
 Parker, T. J. & Haswell, W. (1972). Text Book of Zoology, Volume II: Marshall and Wiliam (Eds.) 7th Ed. Macmillan Press, London.
 Pough H. Vertebrate life, VIII Edition, Pearson International.
 Romer, A. S. & Parsons, T. S. (1986). The vertebrate body. 6th Ed. Saunders College Publishing.
 Sinha, K. S., Adhikari, S., Ganguly, B. B. & Bharati Goswami, B. D. (2001). Biology of Animals. Vol. II. New Central Book Agency (p) Ltd.
 Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
 Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education
 Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies
 Hilderbrand, M (1988) . Analysis of Vertebrate Structure. 3rd Edition, John Wiley and Sons
 Saxena, R.K. & Saxena, S.C. (2008): Comparative Anatomy of Vertebrates, Viva Books Pvt. Ltd.

Paper II : Chordate and Comparative Anatomy (Practical)**1 Credits****Practicals**

1. Identification of following specimen
Branchiostoma, Petromyzon, Scoliodon, Torpedo, Heteropneustes, Exocoetus, Hippocampus, Necturus, Bufo, Tylototriton, Chelone, Chamaeleon, Draco, Vipera, Naja, Alcedo, Psittacula. Pteropus, Funambulus,
2. Identification of disarticulated skeleton of Pigeon and Guinea pig [Skull, Vertebrae (Atlas, Axis) and Pectoral girdle, Pelvic girdle],
3. Mounting of Pecten from Fowl head
4. Staining and mounting of Placoid, Cycloid and Ctenoid scales
5. Dissect out brain of carp
6. Dissection: Afferent branchial arterial system and IX and Xth cranial nerves of carp
7. Submission of Laboratory Note Book

Distribution of Marks**Examination Pattern:**

3. Identification with reasons (any three);
4. Mounting and staining
5. Dissection
6. Submission of laboratory note book:

Full marks: 15

- 6 (2+2+2)*
 2
 5 [3+1+1]*
 2

**Sericulture****(Theory)****3 Credits****Unit 1: Introduction**

Sericulture: Definition, history and present status: Silk route

Types of silkworms, Distribution and Races

Exotic and indigenous races

Mulberry and non-mulberry Sericulture

Unit 2: Biology of Silkworm

Life cycle of *Bombyx mori*

Structure of silk gland and secretion of silk

Unit 3: Rearing of Silkworms

Selection of mulberry variety and establishment of mulberry garden]

Rearing house and rearing appliances.

Disinfectants: Formalin, bleaching powder,

Silkworm rearing technology: Early age and Late age rearing

Types of mountages

Spinning, harvesting and storage of cocoons

Unit 4: Pests and Diseases

Pests of silkworm: Uzi fly, dermestid beetles and vertebrates

Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial

Control and prevention of pests and diseases

Unit 5: Entrepreneurship in Sericulture

Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture

Visit to any sericulture centre.

Reference Books

Manual on Sericulture; Food and Agriculture Organisation, Rome 1976

Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore

Silkworm Rearing and Disease of Silkworm, 1956, Ptd. By Director of Ptg., Stn. & Pub. Govt. Press, Bangalore

Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.

Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan 1972.

Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988.

Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.

A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989.

Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986



Aquarium Fish Management (Theory)

3 Credits

Unit 1: Introduction to Aquarium Fish Keeping

The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes, Setting of freshwater aquarium

Unit 2: Biology of Aquarium Fishes

Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angelfish, Blue morph, Anemone fish and Butterfly fish

Unit 3: Food and feeding of Aquarium fishes

Use of live fish feed organisms. Preparation and composition of formulated fish feeds, Aquarium fish as larval predator

Unit 4: Fish Transportation

Live fish transport - Fish handling, packing and forwarding techniques.

Unit 5: Maintenance of Aquarium

General Aquarium maintenance - budget for setting up an Aquarium Fish Farm as a Cottage Industry



Zoology Multidisciplinary Paper-1

Sericulture and Silk Production Technology (Theory)

3 Credits**Unit 1: Introduction**

Sericulture: Definition, history and present status: Silk route
Types of silkworms,
Mulberry and non-mulberry Sericulture

Unit 2: Biology of Silkworm

Life cycle of *Bombyx mori*
Structure of silk gland, Composition of Silk and secretion of silk

Unit 3: Rearing of Silkworms

Selection of mulberry variety and establishment of mulberry garden
Rearing house and rearing appliances.
Disinfectants: Formalin, bleaching powder,
Types of mountages
Spinning, harvesting and storage of cocoons

Unit 4: Pests and Diseases

Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial

Unit 5: Entrepreneurship in Sericulture

Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture

Reference Books

- Manual on Sericulture; Food and Agriculture Organisation, Rome 1976
Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
Silkworm Rearing and Disease of Silkworm, 1956, Ptd. By Director of Ptg., Stn. & Pub. Govt. Press, Bangalore
Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan 1972.
Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988.
Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.
A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989.
Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986



Zoology Multidisciplinary Paper-II

Environment and Public Health Management (Theory)

3 Credits

Unit 1: Introduction

Sources of Environmental hazards,

Unit 2: Climate Change

Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health

Unit 3: Pollution

Air, water, noise pollution: sources, effects and control,

Unit 4: Waste Management Technologies

Sources of waste, types and characteristics, Solid waste disposal, Biomedical waste handling and disposal, e-waste management, 3 R principle of waste management

Unit 5: Diseases

Causes, symptoms and control of tuberculosis, Cholera, Minamata disease,

Causes, symptoms and control of mosquito borne diseases – Malaria and Dengue

Control of Mosquitoes

Reference Books

Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.

Joseph F Louvar and B Diane Louver Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey 1997.

Kasperson, J.X. and Kasperson, R.E. and Kasperson, R.E., Global Environmental Risks, V.N. University Press, New York, 2003.

Kofi Asante Duah "Risk Assessment in Environmental management", John Wiley and sons, Singapore, 1998.

Kolluru Rao, Bartell Steven, Pitblado R and Stricoff "Risk Assessment and Management Handbook", McGraw Hill Inc., New York, 1996.

UKImms, A.D. (1977). A General Text Book of Entomology. Chapman & Hall, UK

Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell

Mosquito (2000) Chandra G, Sribhumi Publication Co. Kolkata Medical Entomology, Hati A. K Allied Book Agency, Kolkata

