

Shree Warana Vibhag Shikshan Mandal's

**WARANA UNIVERSITY,
WARANANAGAR**

(A State Public University established under Section 3 (6) of MPUA, 2016)



Established:2025

**Structure & Syllabus For
Bachelor of Science (B.Sc.) in Zoology
UNDER
Faculty of Science & Technology
B.Sc. Part –II (Semester- III and IV)**

As Per National Education Policy - 2020

With Effect from Academic Year 2026-27 Onwards

Sr. No.	CONTENT	Page No
1	PREAMBLE	3
2	PROGRAMME LEARNING OUTCOMES(POs)	4
3	PROGRAMME SPECIFIC OUTCOMES (PSOs)	5
4	DURATION	6
5	ELIGIBILITY	7,8
6	MEDIUM	9
7	EXAMINATION PATTERN	10
8	STRUCTURE OF PROGRAMME	11
9	SYLLABUS	12-24

Abbreviations:

POs	Program Outcomes
PSOs	Program Specific Outcomes
COs	Course Outcomes
DSC	Discipline Specific Core
DSE	Discipline Specific Elective
GE	Generic Elective
OE	Open Elective
VSC	Vocational Skill Course
SEC	Skill Enhancement Course
IKS	Indian Knowledge System
AEC	Ability Enhancement Course
VEC	Value Education Course
OJT	On Job Training (Internship)
FP	Field project
CEP	Community engagement project
CC	Co-curricular Courses
RM	Research Methodology
RP	Research Project
MJ	Major Course
MN	Minor Course

Preamble – B.Sc. Zoology Program

The Bachelor of Science (B.Sc.) in Zoology is an undergraduate program designed to provide students with a comprehensive understanding of animal biology, biodiversity, and the fundamental principles governing the life processes of animals. Rooted in both classical and modern biological sciences, the program integrates theoretical knowledge with practical and research-based learning to explore the vast diversity of animal life, from molecular and cellular levels to the ecological and evolutionary dynamics of populations and ecosystems.

Zoology is a dynamic and evolving field that intersects with disciplines such as genetics, ecology, physiology, biotechnology, environmental science, and conservation biology. The B.Sc. Zoology program aims to cultivate scientific thinking, analytical skills, and a spirit of inquiry among students, preparing them to contribute meaningfully to scientific research, environmental management, public health, and education.

In an era of rapid environmental change, habitat loss, and biodiversity threats, the study of Zoology is more relevant than ever. This program fosters awareness and responsibility towards wildlife conservation, sustainable development, and the ethical treatment of animals. Graduates will be well-equipped for careers in academia, research institutions, environmental agencies, biotechnology industries, and various governmental and non-governmental organizations, as well as for pursuing higher education in specialized areas of life sciences.

General Objectives of the Zoology

1. To Understand Animal Diversity

Recognize the wide variety of animal life, including classification, taxonomy, and evolutionary relationships among different groups.

2. To Learn Animal Structure and Function

Study the anatomy (structure) and physiology (function) of animals, from single-celled organisms to complex vertebrates.

3. To Explore Evolutionary Relationships

Understand how animals have evolved over time and how natural selection, adaptation, and speciation have shaped life on Earth.

4. To Study Animal Behavior and Ecology

Examine how animals interact with each other and their environment, including behavioral patterns, ecological roles, and life cycles.

5. To Understand Developmental Biology

Learn how animals develop from fertilized egg to adult, including embryology and reproductive strategies.

6. To Gain Skills in Scientific Inquiry and Research

Develop the ability to observe, analyze, and interpret biological data through laboratory experiments and field studies.

7. To Appreciate the Role of Animals in Ecosystems and Human Life

Understand the ecological, economic, and cultural importance of animals, and the impact of human activity on animal life.

8. To Promote Conservation Awareness

Learn the significance of biodiversity conservation and sustainable management of animal resources.

9. To Prepare for Careers in Biological Sciences

Provide foundational knowledge and skills necessary for careers or advanced study in medicine, veterinary science, wildlife biology, research, and more.

10. To Foster Critical Thinking and Problem Solving

Encourage analytical thinking to address biological questions and environmental challenges.

Programme Outcomes (POs)

1. Core Knowledge of Zoology

Acquire comprehensive knowledge of animal biology including structure, function, development, evolution, ecology, and behavior of animals.

2. Scientific Temper and Critical Thinking

Develop scientific temper, logical reasoning, and analytical skills to assess biological phenomena and solve problems in zoological contexts.

3. Laboratory Skills and Techniques

Gain hands-on experience in laboratory and field-based experiments using modern tools and techniques in zoology.

4. Ecological and Environmental Awareness

Understand biodiversity, ecological interactions, conservation strategies, and the impact of human activity on ecosystems.

5. Research Aptitude

Develop the ability to design experiments, collect and analyze data, and present scientific findings in zoological research.

6. Ethics and Animal Welfare

Understand and apply ethical standards in research and practices involving animals; promote animal welfare and biodiversity conservation.

7. Communication Skills

Enhance ability to communicate effectively using scientific terminology in written and oral forms for both academic and general audiences.

8. Teamwork and Leadership

Develop interpersonal skills to work collaboratively in multidisciplinary teams and show leadership qualities in academic or professional settings.

9. Application of Modern Tools

Use modern ICT tools, bioinformatics, and statistical methods for analyzing biological data and solving problems in zoology.

10. Sustainability and Social Responsibility

Apply zoological knowledge in addressing societal and environmental challenges and contribute to sustainable development.

11. Entrepreneurship and Employability

Gain foundational knowledge useful for careers in education, research, environmental management, animal husbandry, pest control, medical labs, and related sectors.

12. Lifelong Learning

Recognize the need for self-directed and life-long learning in the broader context of scientific and technological advancement.

Program Specific Outcomes (PSOs) – B.Sc.Zoology

PSO 1: The students will learn about animal diversity, cell biology, genetics, ecology, ethology, evolution, and entomology.

PSO 2: The students will understand various basic concepts and be able to describe them.

PSO 3: The students can apply their knowledge to classify, distribute, and organize the animals.

PSO 4: The students can solve the problems related to patterns of heredity, pedigree analysis, etc.

PSO 5: The students will acquire skills like sketching the diagrams, karyotype analysis, dissection, and other practical skills.

ELIGIBILITY FOR ADMISSION

As per guidelines obtained from Warana University, Warananagar by following rules and regarding reservations by Govt. of Maharashtra

DURATION

The course shall be a fulltime course. Second Year, Semester III and IV.

MEDIUM OF INSTRUCTION

The medium of instruction shall be English

MEME Instructions:

In alignment with the National Education Policy (NEP) 2020, the Bachelor of Science (B.Sc.) program adopts the Multiple Entry and Multiple Exit (ME-ME) framework. This flexible structure is designed to provide students with academic mobility, skill development, and lifelong learning opportunities. Through ME-ME framework, the program enables students to enter and exit at different stages with appropriate certifications. Information regarding different entry and exit options available to students and respective mandatory number of credits to be earned by the students are provided in the table below.

Year	Stage of exit	Type of Award	Mandatory Credits to be earned	Minimum credits to be earned
1	After successful completion of One Year	Undergraduate Certificate in Science	44	40
2	After successful completion of Two Year	Undergraduate Diploma in Science	88	80
3	After successful completion of Three Year	Bachelor of Science Degree	132	120

Re-entry provision:

Students leaving after a undergraduate certificate or undergraduate diploma may re-enter the program within 5 years by earning required credits through Academic Bank of Credits.

SCHEME OF TEACHING AND EXAMINATION: [The scheme of teaching and examination should be given as applicable to the course/paper concerned.]

B.Sc. Programme Structure for Level 4.5 of B.Sc.-II Semester III														
Teaching Scheme						Examination Scheme								
Sr. No.	Theory (TH) & Practical (P)					Semester-end Examination (SEE)			Internal Assessment (IA)			Practical		
	Course Type	No. of Lectures	Practical	Hours	Credits	Paper Hours	Max	Min	Internal	Max	Min	Paper Hours	Max	Min
1.	DSC-I	4	1	4+4	6	1	30	12	Assignment	20	8	2	50	20
2.	DSC-I	4	1	4+4	6	1	30	12		20	8	2	50	20
3.	DSC-I	4	1	4+4	6	1	30	12		20	8	2	50	20
4.	OE -I	-	1	4	2	-	-	-		-	-	2	50	20
5.	VEC	-	-	-	-	-	-	-		-	-	-	-	-
6.	IKS (Generic)	2	-	2	2	2	50	20		-	-	-	-	-
Total					22	[DSC (60 X 3) + IKS 50] Total SEE = 230			DSC (40X3) Total IA = 120			Practical. = 50X4 Total Practical. = 200		
						Total Semester –I = 550								

B.Sc. Programme Structure for Level 4.5 of B.Sc.-II Semester IV														
Teaching Scheme						Examination Scheme								
Sr. No.	Theory (TH) & Practical (P)					Semester-end Examination (SEE)			Internal Assessment (IA)			Practical		
	Course Type	No. of Lectures	Practical	Hours	Credits	Paper Hours	Max	Min	Internal	Max	Min	Paper Hours	Max	Min
1.	DSC-II	4	1	4+4	6	1	30	12	Assignment	20	8	2	50	20
2.	DSC-II	4	1	4+4	6	1	30	12		20	8	2	50	20
3.	DSC-II	4	1	4+4	6	1	30	12		20	8	2	50	20
4.	OE -II	-	1	4	2	-	-	-		-	-	2	50	20
5.	VEC-I	2	-	2	2	2	50	20		-	-	-	-	-
6.	IKS (Generic)	-	-	-	-	-	-	-		-	-	-	-	-
Total					22	[DSC (60 X 3) + VEC 50] Total SEE = 230			DSC (40X3) Total IA = 120			Practical. = 50X4 Total Practical. = 200		
Total Semester –I = 550														

General Guidelines for the selection of subjects

COURSE CATEGORY	ABBREVIATION (Only 2 Letters)	DESCRIPTION	Sem.I Credit	Sem.II Credit
--------------------	----------------------------------	-------------	-----------------	------------------

1. In first year, student has to choose three DSC subjects from the basket for faculty of Science.
(The DSC Basket for faculty of Science includes Mathematics, Physics, Chemistry, Botany, Zoology, Biochemistry, Industrial Microbiology and Computer Science)
2. At the start of second year, out of these 3 DSC subjects, he/she has to opt one subject as Major subject and one as Minor subject. The remaining DSC subject will be dropped.
3. Student cannot select a subject as major or minor other than the subjects taken in first year.
4. OE is to be chosen compulsorily from faculty other than that of the major. (B.Sc. students needs to select OE from faculty of Arts or Faculty of Commerce)
5. VSC is to be selected from the basket of Skill courses approved by the university. 6. IKS (Generic) will be provided by the university separately.

Credit Distribution Structure for B.Sc.II in Zoology with Multiple Entry and Exit Options.

DSC	DSC(DS)	Discipline Specific Course	6x3=18	6x3=18
OE	OE(OE)	Open Elective	2x1=02	2x1=02
SEC	SEC(SE)	Skill Enhancement Course	-----	-----
AEC/IKS/VEC	AEC(AE)	Ability Enhancement Course	-----	-----
	IKS(IK)	Indian Knowledge System (Generic)	2x1=02	-----
	VEC(VE)	Value Education Course	-----	2x1=02
CC/CEP	CC(CC)	Co-curricular Course	2x1=02	-----
	CEP(CE)	Community Engagement Project	-----	-----
			22	22
			Total	--- 44

4: COURSE OUTCOMES (COs)

Semester III

Zoology Major

1. Fundamental of Chordates

COURSE OUTCOMES (COs):

- CO1. Understand the Morphology and anatomy of Chordate.
- CO2. Enable the students to identify the similarities and differences among the animals in different classes of Chordate animals.
- CO3. Apply their knowledge to study the functioning of different organs and systems of chordates.
- CO4. Enable the students to identify venomous and non-venomous snakes.

2. Biochemistry

Course Outcomes

- CO-1: Enable the students to understand the structure, types and classification of proteins, carbohydrates and fats.
- CO-2: Enable the students to understand enzymes and enzyme action.
- CO-3: Metabolic pathways of various bio-molecules and their functional significance.
- CO-4: Enable the students to acquire the skills of biochemical tests and estimations.

Zoology Minor

1. Fundamentals of Non-Chordates

Course Outcomes (COs)

- CO1: Understand structure and functions of Protozoa (Paramecium)
- CO2: Analyze the anatomical and physiological systems in Annelida (Earthworm)
- CO3: Compare and contrast functional adaptations in diverse invertebrate groups
- CO4: Explore behavioral and structural specializations in minor invertebrates

CO5: Recognize the medical and economic significance of invertebrates

2. Biodiversity, Wild life management and Toxicology

Course Outcomes (COs)

CO1: Understand the Concept and Importance of Biodiversity

CO2: Demonstrate Knowledge of Wildlife Management Principles

CO3: Describe Key Features of National Parks and Sanctuaries in India

CO4: Understand Basic Principles of Toxicology

CO5: Develop Awareness of Environmental and Wildlife Conservation Challenges

3. OE - Aquarium Construction and Maintenance:

Course Outcomes

CO1. Acquire knowledge of ornamental fishes which is highly professional and attractive avenues for youth.

CO2. Enable to acquire skills of aquarium setup and aquarium fish keeping.

CO3. Enable to acquire skills of Fish transportation and management.

4. VSC – I Domestic and Pet Animal Feed Preparation:

Course Outcomes (COs)

CO1. Understand the student the dietary needs of animals

CO2. Enables the students to design the feed for the animals according to their physiological conditions.

CO3. Acquire the skill of feed preparation of animals.

CO4. To develop entrepreneurship qualities in the field of animal feed production

5. SEC - Poultry Farming

Course Outcome (COs)

CO1. To understand different breeds and techniques in poultry farming.

CO2. To acquire the skills of poultry management.

CO3. Students gain confidence to pursue entrepreneurship in farming and assess the economics of a farm.

Semester IV

Zoology Major

1. Reproductive Biology

Course Outcome

CO1: Understand the structure, organization, and functions of male and female reproductive systems in animals.

CO2: Enable to explain the hormonal regulation of reproduction and its role in gametogenesis, ovulation, and spermatogenesis.

CO3: Analyze the mechanisms of reproductive cycles, including estrous and menstrual cycles, and their physiological significance.

CO4: Understand the principles and applications of assisted reproductive technologies (ART) such as IVF, ICSI, and surrogacy.

CO5: Explore the causes and treatments of infertility in males and females, along with emerging diagnostic tools.

CO6: Learn about reproductive health, contraceptive methods, and their societal implications.

2. Applied Entomology

Course Outcome

CO1. Acquire the knowledge of non-beneficial insects.

CO2. Understand the interaction of insect vectors with humans and spread of diseases.

CO3. Aware the managements and control of vector and vector borne diseases.

Zoology Minor

1. Physiology, Endocrinology and Histology

Course Outcomes (COs):

CO1: Understand fundamental principles of animal physiology

CO2: Explain the mechanisms of respiration in vertebrates

CO3: Understand circulatory system functions and blood physiology

CO4: Comprehend excretory physiology and osmoregulatory mechanisms

CO5: Identify sources, roles, and deficiency symptoms of vitamins

CO6: Understand the endocrine system and hormonal regulation

CO7: Identify and describe the histological structure of mammalian digestive organs

CO8: Apply knowledge of physiology, endocrinology, and histology to understand health and disease

2. Economic Zoology and Parasitology

Course Outcomes (COs)

CO1: Describe the economic importance of major fin fishes such as Rohu, Catla, Mrigal, and Tilapia, and explain their role in aquaculture and nutrition.

CO2: Identify commercially important shellfishes like lobster, prawn, crab, mussel, and sepia, and explain their significance in the seafood industry.

CO3: Illustrate the process of fish farming, including the construction and maintenance of fish farms, and evaluate various fishing crafts and gears used in the industry.

CO4: Recognize different breeds of goats, and demonstrate knowledge of their feeding, housing, and economic value in rural and commercial farming systems.

CO5: Understand basic principles of dairy science, including the production and processing of milk and various milk products.

CO6: Define and classify parasites based on their nature and host interaction.

CO7: Describe the morphology, anatomy, life cycle, and reproductive features of Ascaris, and understand its pathogenicity and control measures.

CO8: Analyze the structural and physiological adaptations of parasites, particularly Ascaris, for their survival within the host.

3. OE - Apiculture

CO1. Understand honey bees life cycle, their social organization, and the importance of different species

CO2.Acquire skills of handling basic tools, equipment's, and management of beehives

CO3. To understand the importance and economy of products and by-products of beekeeping.

CO4. To develop entrepreneurial skills for self-employment in beekeeping

CO5.Acquire the skills for scientific management of honey bee colonies

4. SEC - Dairy Farming

CO1. Students gain knowledge of different breeds and their selection in dairy farming.

CO2. Acquire the skills of Dairy farm management

CO3. Acquire the skills of shed construction and maintenance

CO4. Students gain self-confidence to become dairy entrepreneurs.

5: OBJECTIVES OF THE PROGRAMME

- To provide quality education in a branch of Biological sciences i.e. Zoology with different specializations.
- To provide quality education offering skill based programs and motivate the students for self-employment in applied branches of Zoology
- To conduct field visits for experiential learning.
- To facilitate Higher education & research in zoology.

6: DURATION OF THE COURSE: ONE YEAR (SEMESTER III AND IV)

TEACHING HOURS: All courses under the B. Sc. II will be of 2 credits each. The theory courses will be taught for 30 hours and practical courses for 60 hours. All the major and minor subjects will have Practical Courses. In addition VSC, OE and SEC have practical modules.

7: MEDIUM OF INSTRUCTIONS: The medium of instructions shall be English/Marathi (for OE).

8: ELIGIBILITY FOR ADMISSION:

Eligibility requirements for admission to B. Sc. Part-II (Level 5.0):

- i) The students passing or ATKT the B. Sc. Part-I (or Undergraduate Certificate in Science) shall be allowed to enter upon the B. Sc. Part-II (or Undergraduate Diploma in Science).

OR

- ii) An Examination of any other Statutory University or an examining Body recognized as equivalent there to.

OR

- iii) Completed 3-year diploma course with subjects allied / related to the subject at B.Sc. Part I

OR

- iv) Completed first year of B.E./B. Tech. with subjects allied / related to the subject at B.Sc. Part I

9: SCHEME OF TEACHING AND EXAMINATION PATTERN (THEORY / PRACTICAL / INTERNAL):

SCHEME OF TEACHING:

TEACHING HOURS: All courses under the B. Sc. II will be of 2 credits each. The theory courses will be taught for 30 hours and Practical courses for 60 hours. All the major and minor subjects will have Practical Courses. In addition VSC, OE and SEC have practical modules.

EXAMINATION PATTERN (THEORY / PRACTICAL / INTERNAL):

Scheme of Examination: Total marks shall be 50 for 2 credit course.

1. The university exam question paper in each semester end examination for each theory course (paper) for B.Sc. (all Semesters) shall be of 40 marks. Total marks for each course shall be based on continuous assessments and semester-end examination. The division of internal assessment and semester-end examination for B.Sc. will be as follows:

Particulars	2 Credit	Course Duration
1. Semester-end Examination	40 Marks	1.5 hrs.
2. Internal Assessment	10 Marks	1.0 hrs.
Total marks for each course	50 Marks	—

2. The Examination for practical course will be of 50 marks at end of each semester. The rule for practical examination shall be as per the circular/ letter issued by respective board of studies.

3. The examination pattern for Co-Curricular Activities (CC), Field Project (FP), On Job Training (OJT), Community Engagement Program (CEP) and Research Project (RP) as per the University guidelines.

Internal Assessment Process shall be as follows:

(a) The internal assessment should be conducted after completing 50% of syllabus of the course/s.

(b) In case a student has failed to attend internal assessment on scheduled date, it shall be deemed that the student has dropped the test. However, in case of student who could not take the test on scheduled date due to genuine reasons, such a candidate may appeal to the Programme coordinator /Principal /Head of the Department. The Programme coordinator /Principal /Head of the Department in consultation with the concerned teacher shall decide about the genuineness of the case and decide to conduct special test to such candidate on the date fixed by the concerned teacher but before commencement of the concerned semester-end examination.

The outline for continuous internal assessment activities shall be as under:

Outline for continuous internal assessment activities:

Level	Semester	Activities Per Semester	Marks
4.5	Semester–I	Assignment	10 marks
	Semester–II	Unit test	10 marks
5.0	Semester–III	Unit test	10 marks
	Semester–IV	Oral examination/ Group discussion	10 marks
5.5	Semester– V	Seminar/ Group discussion/ Field Work	10 marks
	Semester– VI	Study tour / Field Work / Project Work / Seminar	10 marks
6.0	Semester– VII	Case Study /Field Work/ Project Work	10 marks
	Semester– VIII	Case Study/ Field Work/ Project Work	10 marks

10: EQUIVALANCE OF THE PAPER

Equivalence of papers and chances for the students in previous-Semester pattern: Two additional chances in subsequent semesters shall be provided for the repeater students of old three-year B.Sc. program. In such case the scores obtained by the students in NEP 1.0/CBCS scheme should be converted into equivalent credits in NEP 2.0. After that the students concerned shall have to appear for the examination as per this revised pattern. If a student fails in two consecutive chances he/she has to take admission for the respective course in NEP 2.0. In such cases his previous performance of incomplete academic years (B. Sc. I, B. Sc. II or B. Sc. III) will be cancelled.

11: STRUCTUTE OF PROGRAM:

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDIT
B. Sc. -II	III	MJ-V	Fundamentals of Chordates	2
		MJ-VI	Biochemistry	2
		MJ-P III (MJ –V and VI)	Semester 3 Practical (Based on Major Discipline Specific Course)	2
		MN-V	Fundamentals of Non-Chordates	2
		MN-VI	Biodiversity, Wildlife Management & Toxicology	2
		MN-P III	Semester 3 Practical (Based on Minor Discipline Specific Course)	2
		OE – III P	Fish Aquarium Construction and Maintenance	2
		VSC - I	Domestic and Pet Animal Feed Preparation	2
		SEC - I	Poultry Farming	2
	IV	MJ-VII	Human Reproductive Physiology	2
		MJ-VIII	Applied Entomology	2
		MJ-P IV	Semester 4 Practical (Based on Major Discipline Specific Course)	2
		MN-VII	Physiology, Endocrinology & Histology	2
		MN-VIII	Economic Zoology and Parasitology	2
		MN-P IV	Semester 4 Practical	2

			(Based on Minor Discipline Specific Course)	
		OE – IV P	Apiculture	2
		SEC - II	Dairy Farming	2

12: STANDARD OF PASSING AND DETERMINATION OF SGPA/CGPA, GRADING AND DECLARATION OF RESULT

STANDARD OF PASSING:

The standard of passing shall be as per shown in the following table:

	Semester End Exam	Internal Assessment	Course Exam (Total
Maximum Marks	40	10	50
Minimum Marks required for passing	14	04	18

DETERMINATION OF SGPA/CGPA:

1. Semester Grade Point Average (SGPA)

$$SGPA = \frac{\sum(\text{Course credits} \times \text{Grade points obtained}) \text{ of a semester}}{\sum(\text{Course credits}) \text{ of respective semester}}$$

2. Cumulative Grade Point Average (CGPA)

$$CGPA = \frac{\sum(\text{Total credits of a semester} \times \text{SGPA of respective semester}) \text{ of all semesters}}{\sum(\text{Total course credits}) \text{ of all semesters}}$$

Gradation Chart:

% of Marks Obtained	Numerical Grade (Grade Point)	CGPA	Letter Grade
Absent	-	-	-
- 0 – 34	0	0.0 – 4.99	F (Fail)
35 – 44	5	5.00 – 5.49	C
45 – 54	6	5.50 – 6.49	B
55 – 64	7	6.50 – 7.49	B+
65 – 74	8	7.50 – 8.49	A
75 – 84	9	8.50 – 9.49	A+
85 – 100	10	9.50 – 10.0	O (Outstanding)

DECLARATION OF RESULT:

The result of each semester shall be declared as Pass or Fail with grade/grade points. However, ATKT rules will be followed as per University guidelines.

Revised Rules - These revised rules shall be gradually implemented with effect from the academic year 2025-26 for B.Sc. Degree Programme. However, the existing (i.e. pre-revised) rules shall remain in force for the students of old semester pattern during the transition period.

13: NATURE OF QUESTION PAPER, DURATION AND SCHEME OF MARKING

NATURE OF QUESTION PAPER

Nature of Question Paper for B.Sc. Part – II (40 + 10 Pattern) according to Revised Structure as Per NEP – 2020 to be implemented from academic year 2025-26 Maximum Marks: 40 Duration: 1.5 hrs.

Choose the correct alternative from the following and rewrite the sentence [8]

1 to 8 MCQ one mark each with four options

- a)
- b)
- c)
- d)

Attempt any TWO of the following [16]

- a)
- b)
- c)

Attempt any FOUR of the following [16]

- a)
- b)
- c)
- d)
- e)
- f)

14: SYLLABUS: For Semester III

B. Sc. PART – II SEMESTER – III (NEP 2.0)

MAJOR ZOOLOGY PAPER - V

FUNDAMENTALS OF CHORDATES

THEORY: 30 Hrs. MARKS-50 (CREDITS: 02)

Unit 1

5 hrs

Type Study: Amphioxus (*Branchiostoma lanceolatum*)

- A. Systematic position, Habit and Habitat,
- B. Morphological Characters
- C. Digestive system
- D. Circulatory system

Unit II

15 hrs

Type Study: Rat (*Rattus rattus*) (Physiology is not expected)

- A. Systematic position, Habit and Habitat
- B. Morphological Characters
- C. Digestive System
- D. Respiratory System
- E. Circulatory System (Composition of Blood, Structure of Heart)
- F. Excretory System
- G. Reproductive System
- H. Brain of Rat
- I. Sense organs – (Eye and Ear)

Unit III –

10 hrs

Study of the following general topics

I. Study of Venomous and Non-Venomous Snakes

- A. Identifying characters of Venomous, Mild venomous and non-venomous snakes
- B. Poison Apparatus
- C. Biting mechanism
- D. Venom types and its effects,
- E. Antivenom/Antiserum
- F. First Aid Treatment

II. Aerial Adaptations in birds

III. Dentition in Mammals

Suggested Readings:

- Biology of Vertebrates Walter & Sayles ;(Mc Millan).
- Chordate Zoology, P.S. Dhami & J. K. Dhami - R. Chand & Co., New Delhi.
- Modern Text book of Zoology, R.L. Kotpal, Rastogi Publications, Meerut.
- The Life of Vertebrates, 3rd Edition, 1993, J. Z. Young E. L. B.S. Oxford.
- Chordate Zoology - E.L. Jordan, S. Chand & Co., New Delhi.
- The Phylum Chordata - 1987, H.H. Newman, Distributor Satish Book Enterprise, Agra.
- Comparative Anatomy of the Vertebrates G. C. Kent.
- Pough H. (2008). Vertebrate life, 8th Edition, Pearson International.
- Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
- The Protochordates – by S. H. Bhamrah and Kavita Juneja – Anmol Publications, New Delhi
- Introduction to Protochordata – S. H. Bhamrah and Kavita Juneja – Anmol Publications, New Delhi
- 8) Chordate Zoology – S. Chand Company, New Delhi
- Text Book of Zoology – Vertebrates, Vol. II – T. J. Parker and W. A. Haswell Edited by Marshall and Williams, CBS Publications and Distributors, New Delhi.
- E. L. Jordan – Chordate Zoology, S. Chand and Company, New Delhi.
- A Text Book of Chordates – A. Thangamani, L. M. Narayan, S. Prasannakumar, N. Arumugam
- R. L. Kotpal – Modern Text Book of Zoology, Vertebrates

B. Sc. PART – II SEMESTER – III (NEP 2.0)

MAJOR ZOOLOGY PAPER - VI

BIOCHEMISTRY

THEORY: 30 Hrs. MARKS-50 (CREDITS: 02)

Unit I: Carbohydrate Metabolism (without chemical structure)

14 hrs

- 1) Classification and biological significance of carbohydrates
- 2) Glycolysis
- 3) Krebs Cycle
- 4) Electron Transport Chain
- 5) Gluconeogenesis
- 6) Glycogenesis
- 7) Glycogenolysis
- 8) Pentose Phosphate Pathway

Unit II:

08 hrs

1. Lipid Metabolism:

- 1) Classification and biological significance of lipids
- 2) β oxidation of fatty acids

2. Protein metabolism:

- 1) Structure, Classification and biological significance of proteins
- 2) Transamination
- 3) Deamination
- 4) Urea Cycle/ Ornithine cycle

Unit III:

08 hrs

1. Enzymes:

- 1) Introduction, Classification and Nomenclature
- 2) Mechanism of enzyme action
- 3) Isoenzymes, Co-enzymes and Co-factors.

2. Vitamins:

Study of following vitamins with reference to source, role and deficiency

1. Water soluble Vitamins (B and C)
2. Fat soluble Vitamins (A, D , E and K)

Suggested Readings:

- Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
- Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. IV Edition. W.H. Freeman and Co.
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). Harper's Illustrated Biochemistry. XXVIII Edition. Lange Medical Books/Mc Graw3Hill.

B. Sc. PART – II SEMESTER – III (NEP 2.0)
MAJOR ZOOLOGY PRACTICAL - III
(Based on Fundamentals of Chordates and Biochemistry)
PRACTICAL: 60 Hrs. MARKS-50 (CREDITS: 02)

Unit I (Fundamentals of Chordates)

1. Amphioxus:

1. Systemic Position and Morphology
2. Transverse sections passing through
 - a. Oral Hood
 - b. Pharynx
 - c. Intestine
 - d. Tail

2. Rat: (only demonstration)

1. Systemic Position and Morphology
2. Digestive System
3. Respiratory System
4. Excretory System
5. Male and Female Reproductive System
6. Heart
7. Brain

3. Study of Venomous and Non-Venomous Snakes:

- A. Identifying Characters of venomous and non-venomous snakes
- B. Study of venomous snakes:
 - a. Russell's viper
 - b. Saw scaled viper
 - c. Common krait
 - d. Indian Cobra
 - e. Sea Snake
- C. Mild venomous snakes
 - a. Cat snake
 - b. Green vine snake
- D. Study of non- venomous Snakes:
 - a. Python
 - b. Rat snake
 - c. Checkered keel back
 - d. Sand boa

E. First aid treatments (Simulation)

4. Dentition in Mammals: Rat, Sheep, Dog, Man.

5. Aerial adaptations in birds- Morphological and Anatomical.

Unit – II (Biochemistry)

1. Biochemical tests:

A. Monosaccharaides - Glucose, Fructose,

B. Disaccharides - Sucrose, Lactose

C. Polysaccharides – Starch

D. Lipid

E. Protein

2. Estimation of total protein by Lowry's method.

3. Estimation of casein from milk

4. Study of activity of salivary amylase under optimum conditions.

5. Effect of Temperature on activity of salivary amylase.

6. Effect of pH on activity of salivary amylase.

7. Detection of abnormal urine constituents.

8. Determination of Ascorbic acid/Vitamin C from given sample.

9. Separation of Amino acids by paper chromatography.

B. Sc. PART – II SEMESTER – III (NEP 2.0)

MINOR ZOOLOGY PAPER - V

FUNDAMENTALS OF NON-CHORDATES

THEORY: 30 Hrs. MARKS-50 (CREDITS: 02)

Unit – I	7 hrs
-----------------	--------------

1. Type study: *Paramecium*
 - a) Systematic Position
 - b) Locomotion
 - c) Nutrition
 - d) Osmoregulation
 - e) Reproduction

Unit – II	15 hrs
------------------	---------------

2. Type study: Earthworm
 - a) Systematic Position
 - b) Morphology
 - c) Coelom
 - d) Digestive System
 - e) Circulatory System
 - f) Excretory System
 - g) Nervous System
 - h) Reproductive System (Copulation and Cocoon formation)

Unit – III	8 hrs
-------------------	--------------

3. Type study following General Topics
 - a) Foot in Mollusca – Chiton, Pila, Mytilus, Unio and Sepa.
 - b) Pedicelaria in Echinodermata
 - c) Affinities of Hemichordata
 - d) Stridulation in Cicada and Cricket
 - e) Salient Features of Minor Phyla : Bugula, Sagitta and Lingula
 - f) Invertebrates in Medicine :
 - a. Leech (*Hirudo medicinalis*) – Leech Therapy
 - b. Honey Bees – Apitherapy

Suggested Readings:

1. Modern Textbook of Zoology: Invertebrates – R.L. Kotpal
2. Invertebrate Zoology – E.L. Jordan & P.S. Verma
3. A Manual of Zoology Volume 1 (Invertebrates) – Ekambaranatha Ayyar and T.N. Ananthakrishnan
4. Invertebrates – Ruppert, Fox, and Barnes
5. General Zoology – S.K. Singh & N.C. Nair

B. Sc. PART – II SEMESTER – III (NEP 2.0)
MINOR ZOOLOGY PAPER - VI
BIODIVERSITY, WILD LIFE MANAGEMENT AND TOXICOLOGY
THEORY: 30 Hrs. MARKS-50 (CREDITS: 02)

Unit – I: Biodiversity

7 hrs

- a) Definition and types of Biodiversity
- b) Scope and characterisation
- c) Genetic, Species, and Ecosystem diversity
- d) Levels of Biodiversity: Alpha, Beta, Gamma diversity
- e) Importance of Biodiversity: Ecological, economic, and ethical values
- f) Conservation Strategies

Unit – II: A] Wildlife Management

6 hrs

- a) Definition of wildlife and wildlife management
- b) Scope and significance of wildlife management
- c) Categories of wildlife: rare, endangered, vulnerable, endemic
- d) Factors affecting wildlife: natural and anthropogenic

B] National Parks and Sanctuaries

09 hrs

- a) Malvan Marine Wildlife Sanctuary
 - b) Kaziranga National Park
 - c) Gir National Park
 - d) Bharatpur wildlife sanctuary
 - e) Tadoba- Andhari National Park
 - f) Radhanagari wildlife sanctuary
- (Brief idea about locality, history, target animals, threats)

Unit – III: Toxicology

8 hrs

- a) Definition and classification of toxicology
- b) Toxic agents and mode of action
 - i. Pesticides- Synthetic insecticides (Organophosphate, Organochlorine, Carbamate- one each)
 - ii. Metal toxicity: Lead, Mercury and Cadmium
- c) Mycotoxins-
- d) Applications

Suggested Readings:

1. Wildlife Ecology and Management – Eric G. Bolen & William L. Robinson
2. Wildlife Conservation and Management – S. K. Singh
3. Essentials of Wildlife Ecology and Conservation – G. C. Waugh

4. Wildlife of India – V. B. Saharia
5. Principles of Wildlife Management – R. B. Singh
6. Indian Wildlife Protection Laws – B. B. Hosetti
7. Principles of Toxicology – Stumph & Guthrie
8. Toxicology – K. C. Gupta
9. Essentials of Toxicology – Klaassen & Watkins
10. Elements of Toxicology – P. D. Sharma

B. Sc. PART – II SEMESTER – III (NEP 2.0)
MINOR ZOOLOGY PRACTICAL - III
(Based on Fundamentals of Non-Chordates, Biodiversity,
Wild life management and Toxicology)
PRACTICAL: 60 Hrs. MARKS-50 (CREDITS: 02)

Unit – I *Paramecium*

- A. Systematic position
- B. Morphological characters
- C. Study of locomotion in *Paramecium* (through prepared video/animation)
- D. Reproduction: Asexual (Binary fission), Sexual (Conjugation)

Unit – II Earthworm

- A. Systematic position
- B. Morphological characters
- C. Dissections,
 - a. Digestive system: Alimentary canal
 - b. Circulatory system: Longitudinal blood vessels, hearts and loops
 - c. Nervous System: Central nervous system
 - d. Reproductive System: Male and female reproductive organs
- D. Temporary Preparations,
 - a. Gizzard
 - b. Septal Nephridia
 - c. Spermatheca
 - d. Setae

Unit – III

- A. Foot in Mollusca – Chiton, Pila, Mytilus, Unio and Sepa.
- B. Pedicellaria in Echinodermata
- C. Salient Features of Minor Phyla : Bugula, Sagitta and Lingula
- D. Invertebrates in Medicine :
 - 1) Leech (*Hirudo medicinalis*) – Leech Therapy
 - 2) Honey Bees – Apitherapy

Unit – IV Biodiversity and Wildlife Management

- A. Study of Alpha, Beta and Gamma Diversity (from Forest and Grassland Habitats)
- B. Study of species richness, evenness and abundance using samples
- C. Estimation of biodiversity by Simpson's Diversity Index using sample data.
- D. Study of biodiversity conservation methods.
- E. Study of identification of common Indian wild animals through indirect evidence (e.g. casts, pugmarks, scats, pellets, etc.)

- F. Study of any one nearby national park or wildlife sanctuary
- G. Study of the effects of insecticides on human health (endosulfan effect)
- H. Study of heavy metals toxicity on human health:
 - Pb- (Plumbism)
 - Hg- (Minamata),
 - Cd. (Itai-itai)

Suggested Readings:

1. Practical Zoology: Invertebrates” – S.S. Lal
2. Manual of Practical Zoology – Invertebrates” – P.S. Verma & B.S. Tyagi
3. Manual of Practical Zoology – Invertebrates” – P.S. Verma & B.S. Tyagi
4. Practical Zoology Manual” – A.C. Dutta
5. Methods in Ecology and Environmental Science” – H.S. Sharma
6. India’s National Parks and Wildlife Sanctuaries” – Pradeep Sachdeva
7. Essentials of Toxicology” – M. Asha & P. Ramaswamy
8. A Textbook of Toxicology” – Pandey & Shukla

B. Sc. PART – II SEMESTER – III (NEP 2.0)
OPEN ELECTIVE PRACTICAL COURSE (OE) - III
AQUARIUM CONSTRUCTION AND MAINTENANCE
PRACTICAL: 60 Hrs. MARKS-50 (CREDITS: 02)

I. Importance and history of aquarium fish keeping.

II. Design and construction of aquaria:

1. Aquarium fabrication- shape, size, volume, type of glass tank, cutting of glass, preparation of glass tank,
2. Strengthening and supporting of the tank,
3. Fitting of tanks into room settings.

III. Aquarium floor setting

4. Type and size of pebbles, gravels, granites used for bed construction
5. Aquarium Accessories: Aerator, Filters, Aquarium plants,

IV. Water Quality Management

6. pH and Temperature
7. Turbidity
8. Dissolved oxygen,
9. Free CO₂
10. Total hardness
11. Ammonia

V. Fish Transport

12. Transferring the fish for changing water and cleaning of aquarium
13. Fish transport protocol for short and long distance

VI. Aquarium maintenance

14. Food and feeding,
15. Control of algal growth,
16. Control of snails and other predators

VII. Study of ornamental fish varieties

17. Indigenous and Exotic (five species each)
18. Study of Common diseases (Viral, Bacterial, Protozoans and Fungal- one disease each)

VIII Field Visit: Visit to an ornamental fish center/hatchery (submit a report during practical examination)

B. Sc. भाग – II सेमेस्टर – III (NEP 2.0)

ओपन इलेक्टिव प्रॅक्टिकल कोर्स (OE) - III

अक्वेरियम बांधणी आणि देखभाल

प्रॅक्टिकल: 60 तास. गुण-50 (क्रेडिट्स: 02)

I: अक्वेरियम फिश ठेवण्याचे महत्त्व आणि इतिहास

II: अक्वेरियम डिझाईन आणि बांधणी:

1. अक्वेरियम तयार करणे - आकार, प्रकार, काचेच्या टाकीचे प्रकार, काच कापणे, काचेची टाकी तयार करणे.
2. टाकीला बळकटी देणे आणि समर्थन करणे.
3. टाकी, खोलीच्या सजावटीत बसविणे.

III: अक्वेरियम फ्लोअर सेटिंग

4. तळ तयार करण्यासाठी वापरण्यात येणाऱ्या गोटे, खडी, ग्रॅनाइटचे प्रकार आणि आकार.
5. अक्वेरियम ॲक्सेसरीज: एअरिएटर, फिल्टर्स, अक्वेरियम वनस्पती.

IV: पाण्याच्या गुणवत्तेचे व्यवस्थापन

6. pH आणि तापमान
7. गढूळपणा
8. विरघळलेला ऑक्सिजन
9. मुक्त CO₂
10. एकूण कठोरता
11. अमोनिया

V: माशांची वाहतूक

12. पाणी बदलण्यासाठी आणि अक्वेरियम साफ करण्यासाठी मासे हलविणे.
13. अल्प आणि दीर्घ अंतरासाठी मासे वाहतूक प्रोटोकॉल.

VI: अक्वेरियम देखभाल

14. अन्न आणि खाणे
15. शेवाळ नियंत्रण
16. गोगलगायी आणि इतर भक्षक नियंत्रित करणे

VII: शोषित माशांच्या जातींचा अभ्यास

17. स्वदेशी (इंडिजिनस), परदेशी (एक्झॉटिक) (प्रत्येकी पाच)

18. सामान्य आजारांचा अभ्यास

(व्हायरल, बॅक्टेरियल, प्रोटोजोअन आणि फंगल).(प्रत्येकी एक)

क्षेत्रभेट (फील्ड विजिट)

शोभिवंत मासे मत्स्यपालन केंद्र/ मत्स्य प्रजनन केंद्र भेट देणे (प्रॅक्टिकल परीक्षेच्या वेळी अहवाल सादर करणे).

References

- Aquarium Making: Fish-keeping and Maintenance by Mundy Obilor Jim. JimArts 2019
- A Complete Guide to Setting up and Maintenance of an Aquarium by Pawar Prabhakar. Lambert Academic Publishing 2013
- A Textbook of Pisciculture & Aquarium Keeping Book by H. S. Jagtap, S. N. Mukherjee, V. K. Garad. Daya Publishing House 2009
- 500 Freshwater Aquarium Fish: A Visual Reference to the Most Popular Species
By Greg Jennings. Firefly Books Ltd 2018
- Setting up a Tropical Aquarium: Week by Week Stuart Thraves. Firefly Books Ltd 2015
- Aquarium Food by Mills D. Kingfisher Books 1981
- Manual of tank busters by Sanford G, Crow R. Salamander 1991
- Popular aquarium plants by Thabrow De WV. Thornbill press 1981
- Breeding aquarium fish by Axelrod TFH publications 1978
- Practical Guide to tropical aquarium fish by Crow and Keeley. Tiger Book Int London 1992.

B. Sc. PART – II SEMESTER – III (NEP 2.0)
VOCATIONAL SKILL COURSE (VSC) – I (MAJOR SPECIFIC)

Domestic and Pet Animal Feed Preparation

PRACTICAL: 60 HRS. MARKS-50 (CREDITS: 02)

Practical's:

1. Components of animal feed
2. Designing a Balanced Diet for Lactating Cow/ buffalo
3. Preparation of feed for Pregnant cow/ buffalo
4. Designing a Balanced Diet for Pregnant Cow/ buffalo
5. Preparation of feed for lactating cow/ buffalo
6. Preparation of feed for Goat
7. Preparation of Feed for Layer poultry fowl
8. Preparation of feed for Broiler poultry fowl
9. Preparation of feed for ornamental fishes
10. Preparation of feed for cultured fishes (Anyone fish)
11. Preparation of feed for pet dogs
12. Preparation of feed for pet cats
13. Preparation of feed for laboratory animals (Mice/rats)
14. Test for microbial contamination in animal feed
15. Methods of storage of animal feed
16. Visit to Animal feed formulation center and submission of report at the time of examination.

References:

- D. N. Pandey & Amita Bajpai (2020) animal nutrition & feed technology for livestock, pets & laboratory animal
- Dr. Vir Singh, Ashoka Kumar (2011) Animal Feeding and Production in India
- Dr. Leonard Charles Nwaogu (2022) Feed formulation poultry: a - z professional guide for chicken, turkey. Duck, geese, guinea fowl, quail, fish, breeders stock, and all stages of life
- Athithan (2014) practical book on fish nutrition & feed technology
- Amlan Patra and Rita Payan-Carreira (2022) Animal feed science and nutrition - production, health and environment

B. Sc. PART – II SEMESTER – III (NEP 2.0)
SKILL ENHANCEMENT COURSE (SEC) – I (MAJOR SPECIFIC)
POULTRY FARMING
PRACTICAL: 60 Hrs. MARKS-50 (CREDITS: 02)

Practical's :

I. Morphology of Poultry Birds

II. Poultry Breeds

- a. Indian
- b. Exotic

III. Types of Poultry Breeds

- a. Layers
- b. Broiler
- c. Dual Purpose Breeds

IV. Poultry Housing Systems

- a. Extensive/Open Yard System
- b. Semi-Intensive System
- c. Intensive System
 - 1. Deep Litter System
 - 2. Cage System
 - 3. Slat System

V. Feeding and Nutrition

- a. Nutritional requirements
- b. Feeding ingredients for poultry birds

VI. Poultry Breed Management

- a. Management of Hatchery and Chicks - Chick care and management
- b. Management of Layer Birds -Housing, feeding and care
- a. Management of Broiler Birds - Housing, feeding and care

VII. Poultry Farming Equipment

- a. Types of Poultry Feeder and Waterer
- b. Other essential poultry Equipment

VIII. Health Care in Poultry

- a. Common Diseases
- b. Vaccination
- c. Cleaning and Disinfection

IX. Study of the followings

- a. Nutritional Value of Poultry Meat and Eggs
- b. By products of Poultry Farming
- c. Economic Importance of Poultry Farming

Field visit and submission of report.

B. Sc. PART – II SEMESTER – IV (NEP 2.0)

MAJOR ZOOLOGY PAPER - VII

REPRODUCTIVE BIOLOGY

THEORY: 30 Hrs. MARKS-50 (CREDITS: 02)

Unit I: Structure and hormones of Pituitary gland. (3 Hrs)

Unit II: Functional Anatomy of Human Female Reproductive system: (12 Hrs)

1. Anatomy and Histology of Female Reproductive system
 - a) Ovary
 - b) Fallopian tube
 - c) Uterus
 - d) Cervix
 - e) Vagina.
2. Female Sex Hormones
3. Reproductive cycle
 - a) Menstrual cycle and hormonal regulation
 - b) Structure of Graafian follicle
4. Transport of Ovum and Sperm in female genital tract
5. Process of fertilization, implantation and placentation (In Short).
6. Diagnostic features of Pregnancy and hormonal regulation
7. Mechanism and Hormonal regulation of Parturition and Lactation

Unit III: Functional Anatomy of Human Male Reproductive system: (8 Hrs.)

1. Anatomy and Histology of Male Reproductive system
 - a) Testis
 - b) Epididymis
 - c) Seminal vesicle
 - d) Prostate gland
 - e) Cowper's gland
 - f) Penis
2. Male Sex Hormones
3. Process of Spermatogenesis and Structure of Sperm
4. Sperm maturation in epididymis
5. Sperm transport in Male genital tract and composition of semen
6. Hormonal Control of Testicular activities

Unit IV: Reproductive Health: (4 Hrs.)

1. Infertility in Male: Causes, Diagnosis and Management
2. Infertility in Female: Causes, Diagnosis and Management
3. Assisted Reproductive Technology:
 - A. Sperm bank
 - B. Frozen embryo

- C. Intrauterine Transfer (IUT)
- D. Zygote Intra-fallopian Tube Transfer (ZIFT)
- E. Gamete Intra-fallopian Transfer (GIFT)
- F. Intra-cytoplasmic Sperm injection (ICSI)
- G. In Vitro Fertilization (IVF)
 - a) Ovarian Stimulation
 - b) Egg retrieval
 - c) Sperm retrieval
 - d) Fertilization
 - e) Embryo Transfer

Unit V: Contraceptives:

(3 Hrs.)

1. Natural Methods
2. Mechanical Methods
3. Chemical Methods
4. Intra Uterine Devices (IUDs)
5. Sterilization operations
 - a) Female Sterilization operations - Tubectomy
 - b) Male Sterilization operations - Vasectomy

Reference Books:

- A Textbook of Medical Physiology, Guyton and Hall, Elsevier Publication.
- Human Reproductive Biology by Kristin H. Lopez and Richard E. Jones
- Reproductive Biology by Saroj Kumar Mishra, Manoj Kumar Mohanty and Subodh Chandra Praharaj (Kalyani Publications).
- Endocrinology and Reproductive Biology by K. V. Sastry (Rastogi Publications).

B. Sc. PART – II SEMESTER – IV (NEP 2.0)

MAJOR ZOOLOGY PAPER - VIII

APPLIED ENTOMOLOGY

THEORY: 30 Hrs. MARKS-50 (CREDITS: 02)

Unit I Medical Entomology

(14hrs)

1. Types of vectors
 - a) Mechanical vectors (Meaning with examples)
 - b) Biological vectors (Meaning with examples)
2. Morphology and life cycle of –
 - a) Mosquito (*Anopheles* and *Aedes*)
 - b) House fly (*Musca domestica*)
3. Study of mosquito borne diseases –
 - a) Malaria
 - b) Dengue
 - c) Control measures of Mosquitoes
4. Study of house fly transmitted disease
 - a) Typhoid
 - b) Dysentery
 - c) Control measures of house fly

Unit II: Agricultural Entomology

(8hrs)

1. Concept of insect pest
2. Biology, damage caused and Control measures of
 - A. Gram pod borer, *Helicoverpa armigera*
 - B. Sugarcane leafhopper, *Pyrilla perpusilla*
 - C. Lemon Butterfly, *Papilio demoleus*
 - D. Pulse Beetle, *Callosobruchus chinensis*
 - E. Rice Weevil, *Sitophilus oryzae*
 - F. Red Flour beetle, *Tribolium castaneum*

Unit III: Forensic Entomology:

(8 hrs)

1. Introduction to forensic Entomology
2. Insects involved in the forensic investigations
(Morphological Characteristics of adults and maggots)
 - A. Blow fly, *Calliphora vicina*
 - B. Common flesh fly, *Sarcophaga carnaria*
 - C. Head louse *Pediculus humanus capitis*
3. Postmortem Interval (PMI) and its estimation process
4. Applications and limitations of Forensic Entomology

Suggested Readings for Paper VIII:

- Tembhare D. B. (1997) Modern Entomology. Himalaya Publishing House, New Delhi.
- Atwal, A. S.(1986).Agricultural Pests of India and South East Asia, Kalyani
- Chapman,R.F.(1998).The Insects: Structure and Function. IV Edition, Cambridge University Press, UK.
- Dennis, H.(2009).Agricultural Entomology.Timber Press (OR).
- Pedigo L. P. (2002). Entomology and Pest Management
- Ganga,G. and Chetty,S.J.(1997):An Introduction to Sericulture,2nd Edition, Oxford and IBH Publishing Co. Ltd. New Delhi.
- Mohan Rao M.M.(1988):A textbook of Sericulture BSP Publications, Sultan Bazar, Hyderabad.
- Hisao, Aruga:Principles of Sericulture.Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- Catts EP, Goff ML. Forensic entomology in criminal investigations. Annu Rev Entomol 1992;37:253-72.
- Amendt J, Krettek R, Zehner R. Forensic entomology. Naturewissenschaften 2004;91:51-65. 3.
- Sukontason K, Narongchai P, Kanchai C, Vichairat K, Sribanditmongkol P, Bhoopat T, et al. Forensic entomology cases in Thailand: a review of cases from 2000 to 2006. Parasitol Res 2007;101:1417-23.

B. Sc. PART – II SEMESTER – IV (NEP 2.0)

MAJOR ZOOLOGY PRACTICAL - IV

(Based on Reproductive Biology and Applied Entomology)

PRACTICAL: 60 Hrs. MARKS-50 (CREDITS: 02)

Unit I: Reproductive biology

1. Study of Animal house:
 - a) Set up and maintenance of animal house
 - b) Breeding techniques
 - c) Care of normal and experimental animals with the help of model/photographs
2. Stages/phases of menstrual cycle.
3. Surgical techniques: Principles of surgery in endocrinology in rats through Demonstration or Video
 - a) Ovariectomy
 - b) Tubectomy
 - c) Hysterectomy
 - d) Orchiectomy
 - e) Vasectomy
4. Examination of histological sections from photomicrographs/permanent slides of Rat /Rabbit
 - a) Testis
 - b) Epididymis
 - c) Ovary
 - d) Fallopian tube
 - e) Uterus (proliferative and secretory phases),
 - f) Cervix
 - g) Vagina
5. Structure of human sperm and ovum
6. Composition of Semen
7. Detection of pregnancy by using kit.
8. Study of contraceptive devices by photographs or models.

Unit II: Applied Zoology:

9. Study of arthropod vectors associated with human diseases:

- a) *Anopheles* Mosquito
- b) *Aedes* mosquito
- c) *Musca* Housefly

10. Study of mosquito borne diseases –

- d) Malaria
- e) Dengue

11. Study of house fly transmitted disease

- a) Typhoid
- b) Dysentery

12. Study of insect pests through damaged products/photographs.

A. Crop Pests:

- a) Gram pod borer (*Helicoverpa armigera*)
- b) Sugarcane leaf hopper (*Pyrilla perpusilla*)
- c) Lemon Butterfly (*Papilio demoleus*)

B. Stored grains pests

- a) Pulse Beetle (*Callosobruchus chinensis*)
- b) Rice Weevil (*Sitophilus oryzae*)
- c) Red Flour beetle (*Tribolium castaneum*)

13. Study of Insects involved in the forensic investigations

- a) Blow fly, *Calliphora* spp.
- b) Common flesh fly, *Sarcophaga* spp.
- c) Head louse *Pediculus humanus capitis*

14. Study tour: visit to any one sea shore or national park, sanctuary or zoo to study animal diversity. Submission of report during the practical examination. Duration for study tour may be of 2 to 7 days.

Suggested Reading

1. Arthropod Vectors (*Anopheles*, *Aedes*, Housefly): Volume I, Pages 60–80
2. Mosquito-Borne Diseases (Malaria, Dengue): Volume I, Pages 90–110
3. Crop Pests (*Helicoverpa armigera*, *Pyrilla perpusilla*): Volume II, Pages 200–220
4. Stored Grain Pests (*Callosobruchus chinensis*, *Sitophilus oryzae*): Volume II, Pages 230–240
5. Diseases Caused by Houseflies (Myiasis): Chapter 6, Pages 140–160
6. Mosquito Biology and Disease Transmission: Chapter 8, Pages 180–200
7. Forensic Entomology (*Calliphora vicina*, *Sarcophaga carnaria*): Chapter 10, Pages 300–320
8. Identification of Crop and Stored Grain Pests: Pages 50–70
9. Models and Photographs of Arthropod Vectors: Pages 100–110

B. Sc. PART – II SEMESTER – IV (NEP 2.0)

MINOR ZOOLOGY PAPER - VII

Physiology, Endocrinology and Histology

THEORY: 30 Hrs. MARKS-50 (CREDITS: 02)

Unit – I: Physiology

16 hrs

1: Introduction to Animal Physiology

- Definition, scope and importance
- Levels of physiological regulation
- Homeostasis and feedback mechanisms

2: Respiration

- Types of respiration: aerobic and anaerobic
- Respiratory organs and Mechanism of Breathing (in rat and *Scoliodon*)

3: Circulation

- Composition and functions of blood
- Blood groups and coagulation
- Structure and mechanism of working of heart in mammals

4: Excretion and Osmoregulation

- Structure and function of nephron
- Mechanism of urine formation

5: Vitamins (with reference to source role and deficiency)

- Water soluble vitamins: B complex and C
- Fat soluble vitamins: A, D, E and K

Unit – II: Endocrinology

7 hrs

1: Introduction to Endocrinology

- Definition
- General properties of hormones

2: Study of Endocrine organs with respect to structure and functions

- Pituitary gland
- Adrenal Gland
- Thyroid Gland
- Pancreatic gland

Unit – III: Histology of mammalian organs

7 hrs

1: Alimentary canal

- Oesophagus
- Stomach

- Small intestine
- Large intestine

2: Digestive glands

- Liver
- Pancreas

Suggested Readings:

- 1) Animal Physiology and Biochemistry – R. Rastogi
- 2) Animal Physiology – A.K. Berry
- 3) Animal Physiology – P.S. Verma, V.K. Agarwal (S. Chand & Co.)
- 4) Essentials of Animal Physiology – S.C. Rastogi
- 5) Animal Physiology and Anatomy – K. V. Sastry
- 6) Textbook of Endocrinology – Mac E. Hadley
- 7) Endocrinology – S. Vinay Kumar & Ramesh Gupta
- 8) Animal Physiology & Endocrinology – R.L. Kotpal
- 9) Vertebrate Endocrinology – Norris & Carr
- 10) Essentials of Animal Histology – G.P. Pal
- 11) A Textbook of Histology – Ham & Cormack
- 12) Animal Histology – Dr. M. A. Suvarna (Vidya Books, Kolhapur)
- 13) Histology and Histotechnology – M.A. Subramanian

B. Sc. PART – II SEMESTER – IV (NEP 2.0)

MINOR ZOOLOGY PAPER - VIII

Economic Zoology and Parasitology

Unit – I: Fisheries

11 hrs

1. Economic importance of fin fishes
 - a) Rohu (*Labeo rohita*)
 - a) Catla (*Catla catla*)
 - b) Mrigal (*Cirrhinus mrigala*)
 - c) Tilapia (*Oreochromis mossambicus*)
2. Economic importance of shell fishes
 - a) Lobster
 - b) Prawn
 - c) Crab
 - d) Mussel
 - e) *Sepia*
3. Fish Farming
 - a) Construction and Maintenance of a fish farm
 - b) Fishing Crafts and gears

Unit – II: Goat farming and Dairy science

08 hrs

1. Goat Farming
 - a) Breeds of Goat
 - b) Feeding
 - c) Housing
 - d) Economic Importance
2. Dairy Science
 - a) Milk and milk products

Unit – III: Parasitology

11 hrs

1. Definition and types of parasites
2. Type study: *Ascaris*
 - a) Systematic Position
 - b) Habit and Habitat
 - c) Morphology
 - d) Digestive System
 - e) Reproductive system
 - f) Life Cycle
 - g) Pathogenicity
 - h) Parasitic adaptations
 - i) Prevention and control

Suggested Readings:

1. Economic Zoology – Shukla & Upadhyay

2. Applied Zoology – *S.K. Gupta*
3. Economic Zoology – *Vasanth Kumar*
4. Manual of Economic Zoology – *Jagdish Prasad*
5. Textbook of Applied Zoology – *R.L. Kotpal*
6. Introduction to Economic Zoology – *S.K. Sharma*
7. Parasitology – *K.D. Chatterjee*
8. Medical Parasitology – *R.L. Kotpal*
9. Textbook of Parasitology – *S.C. Parija*

B. Sc. PART – II SEMESTER – IV (NEP 2.0)

MINOR ZOOLOGY PRACTICAL - IV

(Based on Physiology, Endocrinology, Histology, Economic Zoology and Parasitology)

Unit I: Physiology and Endocrinology

- A. Estimation of Haemoglobin percentage using Sahli's Hemoglobinometer.
- B. Determination of Bleeding time (own or provided blood sample)
- C. Determination of Coagulation time (own or provided blood sample)
- D. Microscopic Examination of Blood Smear
- E. Peak expiratory flow rate
- F. Study of vitamins: Water and fat soluble
- G. Study of Endocrine Glands (Slides/Charts/Models)
 - Pituitary gland
 - Thyroid gland
 - Adrenal gland
 - Pancreas (Islets of Langerhans)

Unit II: Histology

- A. Study of following Permanent Slide
 - Oesophagus
 - Stomach
 - Small intestine
 - Large intestine
 - Liver
 - Pancreas

Unit III: Fisheries

- A. Study of Economically Important Fishes
(Using preserved specimens/charts/models)
 - Rohu (*Labeo rohita*)
 - Catla (*Catla catla*)
 - Mrigal (*Cirrhinus mrigala*)
 - Tilapia (*Oreochromis mossambicus*)
- B. Study of Economic importance of followings
(using preserved specimens/charts/models)
 - Prawn
 - Lobster
 - Crab
 - *Sepia*
 - Mussel
- C. Study of Fish Farm Design (Chart/Model)
 - Structure and layout of fish pond:
 - Hatchery, nursery, grow-out pond
 - Water inlet/outlet, bunds, aerators

- D. Fishing Crafts:
Gill net, cast net, trawl net, long lines, Seine net, Drift net, Purse seines,

Unit IV: Goat Farming and Dairy Science

- A. Study of Goat Breeds:
Sirohi, Jamunapari, Osmanabadi, Boer, Beetal, Saanen
- B. Study dairy products:
Milk, curd, ghee, paneer, cheese, khoa

Unit V: Parasitology

- A. Ascaris:
- Morphology (Male, Female, Sexual dimorphism)
 - Life cycle
 - Parasitic adaptations

Study tour: visit to any one sea shore or national park, sanctuary or zoo to study animal diversity. Submission of report during the practical examination. Duration for study tour may be of 2 to 7 days.

Suggested Readings:

1. Practical Zoology – Vertebrates” – S.S. Lal
2. Practical Zoology: Vertebrate” – P.S. Verma & B.S. Tyagi
3. Human Histology” – Inderbir Singh
4. Fish Biology and Fisheries” – J.S. Datta Munshi & H. Srivastava
5. A Handbook of Animal Husbandry” – ICAR Publication
6. Goat Farming” – K. Pradhan
7. Dairy Technology” – Sukumar De

B. Sc. PART – II SEMESTER – IV (NEP 2.0)

OPEN ELECTIVE COURSE (OE)

Title: Apiculture – Practical

Practical:

1. Study of morphology of Honey bee.
2. Study of different species of honey bees (*Apis dorsata*, *A. florea*, *A. cerana indica*, and *A. mellifera*)
3. Study of different castes of honey bees.
4. Study of life cycle of the honey bee.
5. Study of natural and artificial bee hive.
6. Study of equipment required for bee keeping.
7. Study of techniques of rearing of honey bees.
8. Study of extraction of honey
9. Study of Processing of honey.
10. Study of extraction methods of bee-wax, royal jelly, propolis and bee venom.
11. Study of communication in bees.
12. Study of swarming in Honeybees (for Colony shifting and Nuptial flight)
13. Study of enemies, pests of honey bees
14. Study of diseases of honey bees
15. Analysis of adulteration of honey.

Institute Visit to Apiary / Bee Research Centre and submission of report at the time of Examination.

Suggested Readings:

- Roger A. Morse, Kim Flottum, 1998. Honey Bee Pests, Predators and Diseases. WicwasPr; 3rd edition.
- Alethea Morrison (Author), Mars Vilaubi (Photographer), 2013. Homegrown Honey Bees: An Absolute Beginner's Guide to Beekeeping Your First Year, from Hiving to Honey Harvest. Storey Publishing, LLC; 1edition.
- Hunt, G.J., 2000. Using honey bees in pollination Purdue University.
- aidlaw, H.H., 1997. Contemporary queen rearing. Published by Dadantand Sons. R. A. Morse, Rearing queen honey bees. Wicwas press, NY.
- Alison Benjamin, By (author) Brian McCallum, 2008. Keeping Bees and Making Honey. David & Charles, Newton Abbot.
- Kim Pezza, 2013. Backyard Farming: Keeping Honey Bees: From Hive Management to Honey Harvesting and More. Hatherleigh Press, U.S
- Kim Flottum, 2014. The Backyard Beekeeper: An Absolute Beginner's Guide to Keeping Bees in Your Yard and Garden. Quarry Boo

पाठ्यक्रमाचे उद्दिष्टे:

1. मधमाशीपालनासाठी लागणारे साधनसामग्री, उपकरणे आणि मधमाशांचे पोळे व्यवस्थापित करण्याचे मूलभूत ज्ञान मिळवणे.
2. मधमाशांच्या जीवनचक्राबद्दल तसेच मधमाशीपालनासाठी लागणाऱ्या उपकरणांचे प्राथमिक ज्ञान मिळवणे.
3. मधमाशांच्या पोळ्यांचे व्यवस्थापन, मध उत्पादन, व परागीभवनासाठी आवश्यक कौशल्ये शिकणे.
4. विद्यार्थ्यांना स्वयंरोजगाराच्या दृष्टीने या कोर्सचा उपयोग होईल.
5. मधमाशीपालनामुळे वनस्पतींच्या परागीभवनासाठी उपयोग होतो.
6. विविध मधमाशी उत्पादनांच्या विक्री व बाजारपेठेचे ज्ञान मिळवणे.

प्रात्यक्षिक अभ्यास

1. मधमाशांच्या शरीररचनेचा अभ्यास.
2. भारतीय मधमाशांच्या विविध प्रजातींचा अभ्यास (*Apis dorsata*, *A. florea*, *A. cerana indica*, आणि *A. mellifera*).
3. मधमाशांच्या विविध जातींचा अभ्यास.
4. मधमाशांच्या जीवनचक्राच्या विविध टप्प्यांचा अभ्यास.
5. नैसर्गिक मधमाशांच्या पोळ्यांचा अभ्यास.
6. कृत्रिम मधमाशांच्या पोळ्यांच्या विविध प्रकारांचा अभ्यास.
7. मधमाशा पालनासाठी लागणाऱ्या विविध साधनांचा अभ्यास.
8. मधमाशा पाळण्याच्या विविध तंत्रांचा अभ्यास.
9. मध संकलन प्रक्रियेचा अभ्यास.
10. मध प्रक्रियेचा अभ्यास.
11. मेण, रॉयल जेली, प्रोपोलिस, आणि मधमाशांच्या विषाच्या काढणीच्या पद्धतींचा अभ्यास.
12. मधमाशांमधील संवादाचा अभ्यास.
13. मधमाशांमधील गटगिरी (स्वार्मिंग) चा अभ्यास.
14. मधमाशांचे शत्रू आणि रोग यांचा अभ्यास.
15. मधाच्या भेसळीचे विश्लेषण.
मधमाशांच्या पालन केंद्र व संशोधन संस्थेला भेट.

Suggested Readings:

- Roger A. Morse, Kim Flottum, 1998. Honey Bee Pests, Predators and Diseases. WicwasPr; 3rd edition.

- Alethea Morrison (Author), Mars Vilaubi (Photographer), 2013. Homegrown Honey Bees: An Absolute Beginner's Guide to Beekeeping Your First Year, from Hiving to Honey Harvest. Storey Publishing, LLC; 1edition.
- Hunt, G.J., 2000. Using honey bees in pollination Purdue University.
- Aidlaw, H.H., 1997. Contemporary queen rearing. Published by Dadant and Sons. R. A. Morse, Rearing queen honey bees. Wicwas press, NY.
- Alison Benjamin, By (author) Brian McCallum, 2008. Keeping Bees and Making Honey. David & Charles, Newton Abbot.
- Kim Pezza, 2013. Backyard Farming: Keeping Honey Bees: From Hive Management to Honey Harvesting and More. Hatherleigh Press, U.S
- Kim Flottum, 2014. The Backyard Beekeeper: An Absolute Beginner's Guide to Keeping Bees in Your Yard and Garden. Quarry Boo

B. Sc. PART – II SEMESTER – IV (NEP 2.0)
SKILL ENHANCEMENT COURSE (SEC) IN ZOOLOGY
Introduction to Dairy Science and Management
PRACTICAL: 60 Hrs. MARKS-50 (CREDITS: 02)

I. Introduction to Common Dairy Animals

1. Study of dairy animals
2. Breeds and their characteristics of – Breeds of cow (Indigenous and Exotic) and Buffalo (Murrha)
3. Selection of the breeds for specific climates and purposes

II. Techniques of Dairy Management

4. Study of Housing and Maintenance
5. Feeding practices: Nutritional needs and formulation of feed
6. Milking techniques: Hand milking and machine milking
7. Record-keeping for milk yield, breeding, and health

III. Milk and Milk Products

8. Study of Composition and properties of milk
9. Study of Processing techniques: Pasteurization, homogenization, and sterilization
10. Study of Common milk products: Curd, Paneer , Butter ,Cheese ,Ice Cream , Yoghurt and Ghee
11. Testing of Fat in Milk.

IV. Diseases of Dairy Animals

12. Study of common diseases in dairy animals with reference to Bovine Mastitis, Foot-and-Mouth disease (FMD), Brucellosis, Bovine viral diarrhea (BVD).
13. Study of Recognizing signs of illness in dairy animals
14. Study of Basic Treatment and first-aid
15. Prevention and control measures of diseases : Vaccination, biosecurity, and hygiene

Visit to Dairy farm / industry and submission of report.

Suggested Readings:

1. Handbook of Animal Husbandry: Indian Council of Agricultural Research (ICAR)
2. Cattle and Buffalo Production Systems: J. W. Rendel

3. Livestock Production and Management: N. S. R. Sastry, C. K. Thomas, and R. A. Singh
4. Dairy Management: Principles and Practices: G. A. Khan
5. Feeds and Feeding Practices in Dairy Animals: Ranjan Kumar
6. Milking and Milk Handling: M. N. Mathur
7. Dairy Microbiology Handbook: Richard K. Robinson
8. Technology of Milk Processing and Dairy Products: N. P. Agrawal
9. Principles of Dairy Chemistry: Jenness R. and Patton S.
10. Dairy Processing Handbook: Tetra Pak International
11. A Textbook of the Diseases of Cattle, Sheep, Goats, Pigs, and Horses, Otto Radostits et al.
12. Manual of Veterinary Therapeutics: Douglass S. K.
13. Dairy Herd Health: Martin Green
14. Practical Guide to Cattle Diseases and Their Control: Clive Brown

B. Sc. PART – II SEMESTER – III (NEP 2.0)
SKILL ENHANCEMENT COURSE (SEC) – I
(MAJOR SPECIFIC)

AI in Zoology

Credits: 02

30 Hours

Course Objectives:

1. Students should aware AI and their use in Zoology.
2. Students should know advanced Applications and Conservation Technologies through AI

Unit I: Basics of Data Science in Zoology

10 Hours

Types of biological data (image, sound, GPS, genomic data), Big data in biodiversity studies, Data collection methods (camera traps, satellite tracking)

A) AI in Wildlife Monitoring

Image recognition for species identification, Camera trap data analysis, Population estimation models

B) AI in Animal Behaviour Studies

Movement tracking using GPS, Migration pattern analysis, Behavioral pattern recognition

C) Bioacoustics and AI

Sound pattern recognition, Bird call and whale song analysis, AI-based biodiversity monitoring

UNIT II: Advanced Applications and Conservation Technologies

20 Hours

D) AI in Conservation Biology

Endangered species prediction, Habitat suitability modeling, Climate change impact modelling

E) AI in Anti-Poaching and Wildlife Protection

Drone surveillance systems, Predictive modelling of poaching hotspots, Smart monitoring systems

F) AI in Veterinary and Animal Health

Disease detection using AI, Livestock monitoring systems

G) AI in Genomics and Evolutionary Biology

DNA sequence analysis, Phylogenetic tree construction, Species classification using AI

Course Outcomes: After completion, students are able to

1. understand the AI applications in Zoology
2. understand Monitoring of animals, detection of diseased animals and anti-pouching activities helps to save the ecosystem.
3. understand the various statistical application use in zoology.
4. understand correlation and regression among two or more items

Practical Based on AI in Zoology and Biostatistics

1. Set up a camera trap image classifier.
2. Analyze GPS tracking data for migratory patterns.
3. Build a bird call classifier using AI.
4. Predict endangered species risk using habitat data.