



Savitribai Phule Pune University, Pune
(Formerly University of Pune)

4 Year Bachelor Degree Program in Zoology
(Faculty of Science & Technology)

Revised Syllabus for B. Sc. Zoology

As per National Education Policy (2020) for
S. Y. B. Sc. Zoology (Semester III & IV)

To be implemented from Academic Year 2025 - 2026
(For Colleges Affiliated to Savitribai Phule Pune
University, Pune)

Framed by

BOARD OF STUDIES IN ZOOLOGY

Savitribai Phule Pune University,
Ganeshkhind, Pune – 411 007

❖ Aims and Objectives :

- Focus is on building concepts in biological sciences and enabling them to apply their experimental knowledge in various sectors of life sciences specifically in animal biology.
- Specifically, this programme aims at enhancing the professional competencies and skills.
- Analyze complex interactions among various animals of different phyla, their distribution and their relationship with the environment.
- Helps to understand the physiological, biochemical, molecular and genetic principles of animals and their surroundings.
- Empower learners by enabling them with communication, professional and life skills.
- This course provides an advanced knowledge of modern biology and help to develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.

❖ Program outcomes (POs):

The curriculum is designed after a long thinking and interacting process with various components of the stakeholders. After successful completion of B. Sc. Zoology Major program students will be able to gain the basic, applied and research-based knowledge pertaining to the various branches of Animal sciences.

1. Knowledge and skills on the topic :

- i. In-depth knowledge of the major concepts, theoretical principles and experimental skills of zoology and its various fields, including biodiversity, anatomy, physiology, biochemistry, bio-nanotechnology, ecology, evolutionary biology, cell biology, molecular biology, immunology, genetics, as well as some other areas of applied research such as wildlife conservation and management, beekeeping, sericulture, vermiculture, neuroscience, aquatic biology, fisheries science, animal breeding, bioinformatics and research methodology, etc.
- ii. Interdisciplinary knowledge of life sciences, environmental sciences, and related biochemical sciences.
- iii. Learn about the various techniques, tools, and computer software used to analyze the forms and functions of animals.

2. Skillful communication : Ability to communicate complex zoological information effectively and efficiently.

- 3. Critical thinking and problem-solving skills :** The ability to rationally analyze and solve animal science issues without relying on hypotheses and guesswork.
- 4. Logical thinking and reasoning :** Ability to search for solutions and solve them logically by experimenting and processing the data manually or by using software.
- 5. Team spirit and leadership qualities :** Ability to identify and mobilize the resources required for the project and management of the project responsibly while adhering to ethical scientific concern and bio-safety protocols.
- 6. Digital efficiency :** Ability to use computers and other tools for biological simulations, calculations, appropriate bio-statistical software, and research tools to locate, retrieve, and evaluate zoology-related data.
- 7. Ethical awareness and reasoning :** Avoid unethical behaviour such as data falsification, forgery or deception, plagiarism and value environmental and sustainability issues.
- 8. Lifelong learning :** Capable of independent, self-directed learning with the aim of personal and social development.
- 9. Entrepreneurship qualities :** Develop entrepreneurship qualities as this course contains almost all branches of applied zoology. One can establish a start-up project by learning various courses.
- 10. Advanced education :** Students will be able to develop their mind with some advanced and superior knowledge, research outcomes and also the new as well as easy system of education. This will make them more reliable and capable in the world to lead the nation.

❖ **Program Specific Outcomes (PSOs) :**

- PSO 1 :** After completion of this course students will be able to contribute as policy makers in biodiversity conservation, animal preservation and environment protection.
- PSO 2 :** Equip with the knowledge of animal classification and diversity, ecology and economic importance of animals.
- PSO 3 :** Acquire the advanced concepts in insect rearing and various animal breedings for the food security of human beings.
- PSO 4 :** Inculcate the traditional knowledge of using various animal based products in human healthcare system.
- PSO 5 :** Adapt scientific research techniques in various applied branches of Zoology for sustainable development.
- PSO 6 :** Perform procedures as per laboratory standards in the areas of Taxonomy,

Physiology, Ecology, Cell biology, Genetics, Applied Zoology, Toxicology, Entomology, Sericulture, Biochemistry, Fish biology, Animal breeding and Clinical Pathology.

PSO 7 : Zoology course also provides a knowledge of applied subjects to develop various skills to make a career and become an entrepreneur in the field of aquatic biology, sericulture, apiculture, vermiculture, prawn culture, dairy management, animal breeding and management, wildlife conservation and management, wildlife photography etc.

PSO 8 : Analyze the relationships among animals, plants, and microbes.

PSO 9 : Understand and analyze the ecological and evolutionary significance of different taxa of animals.

PSO 10 : Analyze the mechanisms involved in life processes up to the molecular level.

PSO 11 : Gains knowledge about research methodologies, effective communication and skills of problem-solving methods.

PSO 12 : Contributes the knowledge for Nation building.

❖ **Course Title :**

- B. Sc. Zoology Major (03 years) / B. Sc. Honours in Zoology (04 years) / B. Sc. Honours in Zoology with Research (04 years).
- Revised syllabus as per the National Education Policy (NEP), 2020 for the Colleges Affiliated to Savitribai Phule Pune University, Pune.

❖ **Faculty : Science and Technology**

❖ **Program Duration and Exit Options :**

- The UG Program is of four years divided in eight semesters. Student may leave the program after third year if, they prefer to receive a three-year graduate degree.
- If the student decides to exit after first year, they will receive a UG Certificate, if they decide to exit after Second year; they will receive a UG Diploma. This will also depend on the total required credits they had earned.
- Re-entry within three years to finish the degree program is allowed for those who had left with a UG Certificate or UG Diploma.
- A student must earn minimum 22 credits and a maximum 26 credits in each semester.

- The minimum number of credits required to be earned for award of Undergraduate Certificate / Undergraduate Diploma / Bachelor Degree / Bachelor's Degree with Honors in Zoology / Bachelor's Degree with Honors in Zoology with Research are as follows –

Sr. No.	Type of Award	Exit Stage	Mandatory Credits to be obtained
1.	Undergraduate Certificate in Zoology	After successful completion of First year i. e. Semester I & II	44
2.	Undergraduate Diploma in Zoology	After successful completion of Second year i. e. Semester III & IV	88
3.	Bachelor of Science in Zoology Major	After successful completion of Third year i. e. Semester V & VI	132
4.	Bachelor of Science in Zoology (Honors)	After successful completion of Fourth year i. e. Semester VII & VIII	176
5.	Bachelor of Science in Zoology (Honors) with Research	After successful completion of Fourth year i. e. Semester VII & VIII	176

❖ Eligibility Criteria :

- The criteria for S. Y. B. Sc. Zoology admission will be completion of at least 50% credits at F. Y. B. Sc. level.
- Other conditions will be as prescribed by Savitribai Phule Pune University, Pune / Government of Maharashtra.

❖ Fee Structure :

As per the norms laid down by Savitribai Phule Pune University, Pune.

❖ Course Implementation criteria :

Each semester consisting of 15 weeks = 12 weeks for Actual Teaching + 3 weeks for Continuous Internal Evaluation.

I. Two Credits of the Theory = 30 Clock hours (Actual Teaching of 2 hours per week + 3 hours for continuous internal evaluation which may consists of short questions, class

tests, field visits, tutorials, problem solving sessions, practice, group discussion, assignments, unit tests, seminars, quiz, M. C. Q., project work etc.

II. Two Credits of Practical = 60 Clock hours.

❖ Examination Pattern :

➤ Theory Paper of 02 Credits –

- Internal Exam (15 Marks) + University Theory Exam (35 Marks) = 50 Marks.
- Duration : For Internal exam = 40 Minutes and For University Exam = 02 hours.

➤ Practical Paper of 2 Credits –

- Internal Exam (15 Marks) + University Practical Exam (35 Marks) = 50 Marks.
- Duration : For Internal exam = 40 Minutes and For University Exam = More than 04 hours.

❖ Assessment Method (For each Semester) :

The examinations will be conducted after completion of each semester, both for Theory as well as Practical courses. Total marks for 2 credit course examination will be 50.

❖ Award of Class / Grade and A. T. K. T. Rules :

As per the norms and conditions laid down by SPPU, Pune.

❖ Important Instructions :

- There should be at least a short (1 day) and a Distant (2-3 days) Study tour / Field visit / Industrial visit / Institutional visit per year.
- Tours are the part of curriculum and are mandatory to each student, failing which they will not be considered eligible to claim the marks assigned in the practical examination.
- The student has to submit the followings at the time of practical examination :
Certified Journal, Certified Study tour report / Field visit report and Any other prescribed for the course.

❖ Question paper pattern for Theory (2 Credit courses) :

The students will have to solve the question paper of 35 marks. Including optional questions, The paper setter should set the paper on entire syllabus for total 61 marks.

N. B. : All questions are compulsory.

Max. Time : 2 Hours.

Q. 1) Answer any five of the followings in one sentence - 05 Marks

- Attempt any five from six questions.

Q. 2 (a) Attempt any one of the following - 06 Marks

- Attempt any one from the two questions.

Q. 2 (b) Attempt any one of the following - 04 Marks

- Attempt any one from the two questions.

Q. 3 (a) Solve any one of the following - 06 Marks

- Solve any one from the two questions.

Q. 3 (b) Solve any one of the following - 04 Marks

- Solve any one from the two questions.

Q. 4) Write notes on (Any four) - 10 Marks

- Attempt any four from six questions.

Equivalence of Previous Syllabus :

Semester III

Old Course (2019 Pattern)	NEP - 2020 (2025 Pattern)
ZO - 231 : Animal Diversity III	ZOO - 202 - MJ : Invertebrate Zoology – I (T) ZOO - 242 - MN : Amazing world of Invertebrates-I (T)
ZO - 232 : Applied Zoology I	OE - 201 - ZOO - T : (Sericulture Practices and Management) (T) रेशीम उद्योग आणि व्यवस्थापन (T) OE - 202 - ZOO – T : (Pearl Culture and Management) (T) मोती निर्माण आणि व्यवस्थापन (T)
ZO - 233 : Zoology Practical Paper	ZOO - 203 - MJP : Practicals in Public Health and Hygiene and Invertebrate Zoology – I (P) ZOO - 222 - MJP : Practicals in Pearl Culture (P)
EVS 231 : Environment Awareness	-----
LA 231 : English/Marathi	AEC - 201 - ENG : English
	ZOO - 201 - MJ : Public Health and Hygiene (T) ZOO - 241 - MN : Modern Zoological Techniques and Instrumentation – I (T) ZOO - 243 - MNPP : Practicals in Modern Zoological Techniques and Instrumentation – I (P) ZOO - 221 - MJP : Practicals in Medical Laboratory Techniques – I (P) ZOO - 231 - FP : Field Project ZOO - 200 - IKS: Treasures of Animal Kingdom (T)

Semester IV

Old Course (2019 Pattern)	NEP - 2020 (2025 Pattern)
ZO - 241 : Animal Diversity IV	ZOO - 252 - MJ : Invertebrate Zoology – II (T) ZOO – 292 - MN : Amazing world of Invertebrates – II (T)
ZO - 242 : Applied Zoology II	ZOO - 271 - MJP : Practicals in Crab Culture (P) OE - 251 – ZOO - P : Practicals in Advanced Sericulture Technology (P) आधुनिक रेशीम लघु उद्योग (P) OE - 252 – ZOO - P : (Crab Culture and Management) (P) खेकडे पालन आणि व्यवस्थापन (P) SEC - 251 - ZOO : Practicals in Sericulture (P) SEC - 252 - ZOO : Practicals in Aquarium Management (P)
ZO - 243 : Zoology Practical Paper	ZOO - 253 - MJP : Practicals in Ecology and Invertebrate Zoology – II (P) ZOO - 294 - MNP : Practicals in Amazing world of Invertebrates – II (P)
EVS 241 : Environment Awareness	-----
LA 241 : English/Marathi	AEC - 251 - ENG : English
	ZOO - 251 - MJ : Ecology (T) ZOO - 291 - MN : Modern Zoological Techniques & Instrumentation – II (T) ZOO - 292 - MNP : Practicals in Modern Zoological Techniques and Instrumentation – II (P) ZOO - 271 - MJP : Medical Laboratory Techniques – II (P) ZOO - 281 - CEP : Community Engagement Program

Savitribai Phule Pune University, Pune

Credit Framework for Under Graduate (UG) (2024 - 25) (3 Subject) for

Faculty of Science and Technology

Level / Difficulty	Sem.	Subject-1	Subject - 2	Subject - 3	GE/OE	SEC	IKS	AEC	VEC	CC	Total
4.5 / 100	I	2(T) + 2(P)	2 (T) + 2 (P)	2 (T) + 2 (P)	2(T)	2(T/P)	2 (T) (Generic)	2(T)	2	--	22
	II	2(T) + 2(P)	2 (T) + 2 (P)	2 (T) + 2 (P)	2(P)	2(T/P)	--	2(T)	2	2	22

Exit option: Award of UG Certificate in Major with 44 credits and an additional 4 credits core NSQF course / Internship OR Continue with Major and Minor

Continue option: Student will select one subject among the (subject1, subject 2 and subject 3) as major and another as minor and third subject will be dropped.

Level / Difficulty	Sem.	Credits Related to Major				Minor		GE/OE	SEC	IKS	AEC	VEC	CC	Total
		Major Core	Major Elective	VSC	FP/OJT/ CEP									
5.0 / 200	III	4(T) + 2(P)	--	2(T/P)	2 (FP)	2(T) + 2(P)	--	2(T)	--	2 (T) (Major Subject Specific)	2(T)	--	2	22
	IV	4(T) + 2(P)	--	2(T/P)	2 (CEP)	2(T) + 2(P)	--	2(P)	2(T/P)	--	2(T)	--	2	22

Exit option : Award of UG Diploma in Major and Minor with 88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor

5.5 / 300	V	8(T) + 4(P)	2 (T) + 2 (P)	2(T/P)	2(FP/CEP)	2(T)	--	--	--	--	--	--	--	22
	VI	8(T) + 4(P)	2 (T) + 2 (P)	2(T/P)	4 OJT	--	--	--	--	--	--	--	--	22
Total 3 Years		44	8	8	10	18	8	8	6	4	8	4	6	132

Exit option: Award of UG Degree in Major with 132 credits OR Continue with Major and Minor

6.0 / 400	VI I	6(T) + 4(P)	2(T) + 2(T/P)	--	4 (RP)	4(RM) (T)	--	--	--	--	--	--	--	22
	VI II	6(T) + 4(P)	2(T) + 2(T/P)	--	8 (RP)	0	--	0	0	0	0	0	0	22
Total 4 Years		64	16	8	22	22	8	8	6	4	8	4	6	176

Four Year UG Honours with Research Degree in Major and Minor with 176 credits OR

6.0 / 400	VI I	10(T) + 4(P)	2(T) + 2(T/P)	0	0	4(RM) (T)	--	0	0	0	0	0	0	22
	VI II	10(T) + 4(P)	2(T) + 2(T/P)	0	4 (OJT)	0	--	0	0	0	0	0	0	22
Total 4 Years		72	16	8	14	22	8	8	6	4	8	4	6	176

Four Year UG Honours Degree in Major and Minor with 176 credits

Notes:

Abbreviation: VSC: Vocational Skill Course, IKS: Indian Knowledge System, FP: Field Project, OJT: On Job Training, CEP: Community Engagement and Service, GE/OE: Generic Elective / Open Elective, SEC: Skill Enhancement Course, AEC: Ability Enhancement Course, VEC: Value Education Course, CC: Cocurricular Courses, T—Theory, P— Practical

1. VSC, FP/OJT/CEP should be related to the Major subject
2. OE is to be chosen compulsorily from faculty other than that of the Major.
3. SEC to be selected from the basket of Skill Courses approved by college.
4. Student has to choose three subjects from the same faculty in First Year and at the start of Second year he has to opt one subject as Major subject and one another subject as Minor subject and the last one subject will be dropped by the student. Therefore, the student after completion of the three years will be awarded degree in Major and Minor subject.
5. Student cannot select a subject as major or minor other than the subjects taken in first year
6. Frame each course having given number of credits such as 2 or 4 credits.
7. This UG credit structure is applicable for all the programme across all faculties, except the programmes required approval from apex bodies like AICTE, PCI, BCI, COA, NCTE, etc.

Credit Structure for S. Y. B. Sc. Zoology, Semester – III, (Level 5.0 / 200)

Semester III			
Courses	Course Code	Course Title	Credits
Major 4 (T) Paper 1 (T)	ZOO - 201 - MJ	Public Health and Hygiene (T)	2
Paper 2 (T)	ZOO - 202 - MJ	Invertebrate Zoology - I (T)	2
Major 2 (P) Paper 3 (P)	ZOO - 203 - MJP	Practicals in Public Health and Hygiene and Invertebrate Zoology - I (P)	2
Minor 2 (T) (Any One from the Basket)	ZOO - 241 -MN	Modern Zoological Techniques and Instrumentation - I (T)	2
	ZOO - 242 -MN	Amazing world of Invertebrates – I (T)	2
Minor 2 (P) (Any One from the Basket)	ZOO - 243 - MNP	Practicals in Modern Zoological Techniques and Instrumentation - I (P)	2
	ZOO - 244 - MNP	Practicals in Amazing world of Invertebrates – I (P)	2
VSC 2 (T/ P) (Any One from the Basket)	ZOO - 221 - MJP	Practicals in Medical Laboratory Techniques - I (P)	2
	ZOO - 222 - MJP	Practicals in Pearl Culture (P)	2
FP/OJT/CEP	ZOO - 231 - FP	FP	2
GE / OE -2 (Generic / Open Elective) (Any One from the Basket)	OE - 201 - ZOO -T	Sericulture Practices and Management (T) रेशीम उद्योग आणि व्यवस्थापन (T)/	2
	OE - 202 - ZOO -T	Pearl Culture and Management (T) (मोती निर्माण आणि व्यवस्थापन) (T)	2
SEC-Major 2 (T/P) (Skill Enhancement Courses)	-----	-----	--
IKS – 2 (T) (Indian Knowledge System)	ZOO - 200 - IKS	Treasures of Animal Kingdom (T)	2
AEC- 2 (T) (Ability Enhancement Courses)	AEC - 201 – ENG / MAR / HIN	M. I. L. - English / Marathi / Hindi (T)	2
VEC (Value Education Course)	-----	-----	---
CC-2 (Cocurricular Courses)	2 Credits	-----	2
Total			22

Credit Structure for S. Y. B. Sc. Zoology, Semester – IV, (Level 5.0 / 200)

Semester IV			
Courses	Course Code	Course Title	Credits
Major 4 (T) Paper 1 (T)	ZOO - 251 - MJ	Ecology (T)	2
Paper 2 (T)	ZOO - 252 - MJ	Invertebrate Zoology - II (T)	2
Major 2 (P) Paper 3 (P)	ZOO - 253 - MJP	Practicals in Ecology and Invertebrate Zoology - II (P)	2
Minor - 2 (T) (Any One from the Basket)	ZOO - 291 - MN	Modern Zoological Techniques and Instrumentation - II (T)	2
	ZOO - 292 - MN	Amazing world of Invertebrates – II (T)	2
Minor - 2 (P) (Any One from the Basket)	ZOO - 293 - MNP	Practicals in Modern Zoological Techniques and Instrumentation - II (P)	2
	ZOO - 294 - MNP	Practicals in Amazing world of Invertebrates - I (P)	2
VSC 2 (T/ P) (Any One from the Basket)	ZOO - 271 - MJP	Practicals in Medical Laboratory Techniques - II (P)	2
	ZOO - 272 - MJP	Practicals in Crab Culture (P)	2
FP/OJT/CEP	ZOO - 281 - CEP	Community Engagement Program	2
GE / OE- 2 (P) (Generic / Open elective) (Any One from the Basket)	OE - 251 - ZOO -P	Practicals in Advanced Sericulture Technology (P) आधुनिक रेशीम लघु उद्योग (P)	2
	OE - 252 - ZOO -P	Practicals in Crab Culture and Management (P) खेकडे पालन आणि व्यवस्थापन (P)	2
SEC - Major 2 (T / P) (Skill Enhancement Courses) (Any one from the Basket)	SEC - 251 - ZOO	Practicals in Sericulture (P)	2
	SEC - 252 - ZOO	Practicals in Aquarium Management (P)	2
IKS (Indian Knowledge System)	-----	-----	
AEC - 2 (T) (Ability Enhancement Courses)	AEC - 251 - ENG / MAR / HIN	M. I. L. - English / Marathi / Hindi (T)	2
VEC (Value Education Course)	-----	-----	--
CC (Co-Curricular Courses)	2 Credits	-----	2
Total			22

SEMESTER - III

ZOO - 201 - MJ : Public Health and Hygiene (T)						
Year: II				Semester: III		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Lectures per week	Internal Assessment	Semester End Exam	Total
Major Paper - 1	02	30	02	15	35	50

Course Outcomes:

After the completion of the course, students should be able to:

CO1: Understand the fundamental definitions, scope, principles and determinants of public health, and the concept of the Right to be healthy.

CO2: Identify the causes, symptoms, and preventive strategies for major communicable diseases such as malaria, STDs, and rabies.

CO3: Explain the risk factors, symptoms, and prevention methods for common non-communicable diseases like heart disease, asthma, diabetes, cancer, and mental health disorders.

CO4: Apply the principles and methods of health education in addressing population growth, family health, mental health in children, and substance abuse.

CO5: Evaluate the impact of lifestyle choices such as junk food, digital device overuse, and substance consumption on individual and community health.

CO6: Demonstrate knowledge of various types of hygiene including personal, food, and community hygiene and their role in disease prevention.

CO7: Analyze the relationship between hygiene practices and public health, including the role of sanitation, school hygiene programs, and national cleanliness campaigns.

CO8: Understand the structure and functioning of health administration at different levels and critically assess national and global health initiatives, with special emphasis on the COVID - 19 pandemic responses.

Detailed Syllabus :

Sr. No.	Name of the Topic	Lectures Allotted
1.	Introduction to public health : 1.1 Definition and scope. 1.2 Principles and key concepts of public health. 1.3 Determinants of health (biological, environmental, socio-economic). 1.4 Right to be healthy.	03
2.	Communicable and non-communicable diseases : 2.1 Communicable diseases: Causes, symptoms and preventive measures of Malaria, sexually transmitted diseases, Rabies. 2.2 Non-communicable diseases: Heart Attack and Strokes, Asthma, Diabetes, Hypotension, Hypertension. 2.3 Introduction to Cancer, Depression, Anxiety, Arthritis.	08
3.	Health Education : 3.1 Definition, principle and methods of health education. 3.2 Managing population growth and promoting family health, mental health challenges in children. 3.3 Harmful effects of junk food and street food, tobacco, alcohol and drugs on health. 3.4 Unhealthy lifestyle habits: Overusing digital devices (computer & mobile phones) and their impacts on health. 3.5 Role of health education in environment improvement and prevention of diseases, national health programs and policies.	06
4.	Hygiene : 4.1 Definition, principle and importance of hygiene. 4.2 Kinds of hygiene: Personal hygiene - regular hand washing, dental care, body odour, proper grooming, good sleep habits, menstrual health. 4.3 Community hygiene: Keeping surroundings, public spaces and shared facilities clean to stop the spread of diseases and standard hygiene practices. 4.4 Food hygiene: Safe handling, preparation, and storage of food to prevent food borne illness.	04

5.	Public health & hygiene : 5.1 Common hygiene-related diseases: Food poisoning, giardiasis, diarrhea. 5.2 Importance of community hygiene and public sanitation. 5.3 Hygiene practices in schools and hostels. 5.4 Role of government and NGOs in promoting hygiene (Clean India Campaign, swachh bharat abhiyan, clean village campaigns).	04
6.	Health administration : 6.1 Structure and management of health services from national to local levels. 6.2 National health policies and government health initiatives in India, health communication methods for spreading awareness. 6.3 WHO Programme - Government and voluntary organizations and their health services. 6.4 Case study: Covid -19 pandemic, significant changes and adaptation: testing and diagnosis (swab and RT - PCR), vaccine development and preventive measures.	05

Suggested Readings:

1. Park, K. (2023). Park's textbook of preventive and social medicine (27th ed.). Banarsidas Bhanot.
2. Taneja, D. K. (2022). Foundations of community medicine (3rd ed.). CBS Publishers & Distributors Pvt Ltd.
3. Battle, C. U. (2009). Essentials of public health biology: A guide for the study of pathophysiology. Jones & Bartlett Learning.
4. Sharma, S. K. (2015). Health education: Theory and practice. Khel Sahitya Kendra.
5. Lal, S., & Adarsh, P. (2020). Textbook of community medicine: Preventive and social medicine (5th ed.). CBS Publishers.
6. Aggarwal, A. C. (2010). Textbook of hygiene and health education. S. Chand Publishing.

Websites:

1. Ministry of Health and Family Welfare. (n.d.). Ministry of Health and Family Welfare, Government of India. <https://www.mohfw.gov.in/>

2. National Health Portal of India. (n.d.). National Health Portal. <https://www.nhp.gov.in/>
3. World Health Organization. (n.d.). World Health Organization. <https://www.who.int/>
4. National Institute of Health and Family Welfare. (n.d.). NIHFw. <http://www.nihfw.org/>
5. Centers for Disease Control and Prevention. (n.d.). CDC. <https://www.cdc.gov/>
6. Ministry of Housing and Urban Affairs. (n.d.). Swachh Bharat Mission – Grameen. <https://swachhbharatmission.gov.in/>
7. Indian Council of Medical Research. (n.d.). ICMR. <https://www.icmr.gov.in/>
8. UNICEF India. (n.d.). UNICEF India – Child health and hygiene. <https://www.unicef.org/india/>

ZOO - 202 - MJ : Invertebrate Zoology - I (T)						
Year: II				Semester: III		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Lectures per week	Internal Assessment	Semester End Exam	Total
Major Paper - 2	02	30	02	15	35	50

Course Outcomes:

After the completion of the course, students should be able to:

CO1: Classify and describe the anatomical, physiological and reproductive features of Protozoa, Porifera, Cnidaria.

CO2: Classify and describe the anatomical, physiological and reproductive features of Platyhelminthes, Aschelminths, and Annelida.

CO3: Understand use of nanoparticles in protozoan infection treatment, use of marine natural products from sponges for anticancer and antimicrobial drugs,

CO4: Learn about recent advances in venom studies, bioluminescence, potential in regenerative medicine.

CO5: Analyze life cycles and adaptations of parasitic species (e.g., *Plasmodium*, *Taenia*, *Wuchereria*) and connect this knowledge to current health challenges.

CO6: Interpret current scientific literature on invertebrate research (regeneration in *Hydra* and *Planaria*, genetic studies in *C. elegans*).

Detailed Syllabus:

Sr. No.	Name of the Topic	Lectures Allotted
1.	Introduction of Animal Kingdom : 1.1 Overview of animal kingdom: Principles of classification of invertebrates' animal kingdom, taxonomy and systematics. 1.2 Importance of Invertebrate Classification: Evolutionary relationships, Ecological roles (pollination, decomposition, parasitism), Applications in research, medicine, and biotechnology.	02
2.	Phylum Protozoa : 2.1 General features of phylum Protozoa, habitat diversity and adaptive features, environmental and ecological significance. 2.2 Classification up to class level and e. g. (names only) – 2.2.1 Class Rhizopoda - <i>Entamoeba histolytica</i> , <i>Arcella</i> . 2.2.2 Class Mastigophora - <i>Euglena viridis</i> , <i>Trypanosoma gambiense</i> . 2.2.3 Class Ciliata - <i>Paramecium caudatum</i> , <i>Opalina ranarum</i> . 2.2.4 Class Sporozoa - <i>Plasmodium vivax</i> , <i>Toxoplasma gondii</i> . 2.3 Economic importance of Protozoa - three harmful and one useful protozoan. 2.4 Recent advances: Use of nanoparticles in protozoa infection treatment.	07
3.	Origin of Metazoa 3.1 Introduction, origin and importance of Metazoa.	01
4.	Phylum Porifera: 4.1 General features of phylum Porifera, role in marine ecosystems and sponge microbiomes. 4.2 Classification up to class level and e. g. (names only) – 4.2.1 Class Calcarea - <i>Leucosolenia</i> , <i>Sycon</i> (<i>Scypha</i>). 4.2.2 Class Hexactinellida - <i>Euplectella</i> (venus flower basket), <i>Hyalonema</i> (glass sponge). 4.2.3 Class Demospongiae - <i>Chalina</i> (Mermaid's gloves), <i>Spongilla</i> (fresh water sponge). 4.3 Recent Advances: Marine natural products from sponges for anticancer and antimicrobial drugs.	07

5.	Phylum Cnidaria : 5.1 General features of phylum Cnidaria: General features, polymorphism, symbiosis (example with zooxanthellae). 5.2 Classification up to class level and e. g. (names only) – 5.2.1 Class Hydrozoa - <i>Hydra</i> , <i>Physalia</i> (Portuguese man of war). 5.2.2 Class Scyphozoa - <i>Aurelia</i> (Jelly fish), <i>Leucernaria</i> (trumpet shaped Jellyfish). 5.2.3 Class Anthozoa - <i>Metridium</i> (Common Sea anemone). 5.3 Recent Advances: Venom studies, bioluminescence, potential in regenerative medicine.	07
6.	Phylum Platyhelminthes : 6.1 General features of phylum Platyhelminthes, parasitic adaptations, regeneration. 6.2 Classification up to class level and e. g. (names only) – 6.2.1 Class: Turbellaria - <i>Dugesia</i> , <i>Bipallium</i> . 6.2.2 Class: Trematoda - <i>Fasciola hepatica</i> , <i>Schistosoma haematobium</i> . 6.2.3 Class Cestoda: <i>Taenia solium</i> (pork tape worm), <i>Echinococcus granulosus</i> (dog tapeworm). 6.2.4 Recent Advances: Introduction to stem cell and regeneration research in Planaria, Trematode control strategies in <i>Fasciola hepatica</i> .	06

Suggested Readings:

1. Modern Text book of Zoology, Invertebrates, R. L. Kotpal, 12th Edition, Rastogi Publication, Meerut.
2. Invertebrate Zoology: E.L. Jordan, P.S. Verma, 15th Edition, S. Chand Publication, New Delhi.
3. Text books of Zoology, Vol-I, T.J. Parker and W.A. Haswell, 7th Edition by Marshall and Williams, McMillan Press Ltd.
4. Invertebrate Zoology, N. Arumugam, N.C Nair, S. Leelavathy N. Sundara Pandian, 5th Edition, Saras Publication.
5. Invertebrate Zoology: Ruppert, Fox & Barnes.
6. Biology of Invertebrates: Jan Pechenik.
7. Molecular and Cell Biology of Parasitic Protozoa: H.P. Hildreth.

8. Stem Cells in Regenerative Medicine: Kursad Turksen.
9. Recent Advances in CRISPR/Cas9 Technology” (Springer or Elsevier collections).
10. Hyman, L. H. (1940). The invertebrates: Vol. I. Protozoa through Ctenophora. McGraw-Hill.

ZOO - 203 - MJP : Practicals in Public Health and Hygiene and Invertebrate Zoology - I (P)						
Year: II				Semester: III		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Practicals per week	Internal Assessment	Semester End Exam	Total
Major Paper - 3	02	60	01	15	35	50

Course Outcomes:

After the completion of the course, students should be able to:

CO1: Learn hygiene practices like personal, menstrual, oral and hand hygiene.

CO2: Gain the knowledge of medically important organisms as transmission vectors for infectious disease.

CO3: Qualitative analysis of carbohydrates, proteins and lipids.

CO4: Identify and classify various invertebrate specimens under study.

CO5: Identify various parasitic invertebrates and study their life cycle.

CO6: Understand the detailed study of life cycle of earthworm.

Detailed Syllabus:

Fifteen Practicals should be conducted from the following list (At least 8 Practical's from Public Health and Hygiene and 7 practicals from Invertebrate Zoology - I inclusive of the compulsory practicals).

Sr. No.	Title of the Practical	Practical Allotted
Public Health and Hygiene		
1.	To study various hygiene practices like personal, hand hygiene, oral and menstrual, etc. (D)	1P
2.	To study medically important organisms' as transmission vectors for infectious diseases - mosquito, house fly, cockroach and rats. (D) (Compulsory)	1P

3.	To carry out physical examination of spoiled / contaminated food sample. (D) (Compulsory)	1P
4.	Estimation of Carbohydrates by Anthrone method. (E) (Compulsory)	1P
5.	Estimation of Proteins by Lowry <i>et. al.</i> , method. (E) (Compulsory)	1P
6.	Screening for obesity and diabetes risk using body mass index. (D)	1P
7.	To prepare diet plan for healthy and malnourished persons. (D) (Compulsory)	2P
8.	Case study on recent disease outbreak : Guillain-Barré syndrome (GBS) / COVID 19. (D)	1P
9.	Field visit to nearby health care centre to collect the data on the rate of a particular disease over past few months or years. (E)	2P
Invertebrate Zoology - I		
10.	Museum Study of Phylum Protozoa: <i>Euglena</i> , <i>Paramecium</i> , <i>Amoeba</i> , <i>Plasmodium sp.</i> (D)	1P
11.	Museum study of Phylum Porifera: <i>Sycon</i> , <i>Euplectella</i> , <i>Chalina</i> , <i>Spongilla</i> . (D)	2P
12.	Museum study of Phylum Cnidaria: <i>Hydra</i> , <i>Physalia</i> , <i>Aurelia</i> , <i>Metridium</i> . (D)	1P
13.	Museum Study of Phylum Platyhelminthes: <i>Planaria</i> , <i>Fasciola hepatica</i> , <i>Taenia solium</i> . (D)	1P
14.	Study of <i>Paramecium</i> : External morphology, binary fission and conjugation. (D) (Compulsory)	1P
15.	Study of preparation of <i>Paramecium</i> Culture. (D)	1P
16.	Study of permanent slides: Spicules and Gemmules in sponges, T.S. of <i>Hydra</i> , <i>Taenia solium</i> : Scolex and Gravid proglottid. (D)	1P
17.	Identification of any three-museum specimen with the help of taxonomic identification key. (D) (Compulsory)	2P
18.	Compulsory visit to Zoological Survey of India / Museum / Wildlife Sanctuary / National Park and submission of report. (E)	3P

Suggested Readings:

1. A text book of preventive and social medicine. Park and Park.
2. Preventive and social medicine in India: Dr. B. K. Mahajan.
3. A Manual of Practical Zoology Invertebrates. P. S. Verma, S. Chand Publication, New Delhi.

4. Practical Zoology Invertebrates. S. S. Lal, 12th Edition, Rastogi Publication.
5. Invertebrate Zoology: A Functional Evolutionary Approach: R. D. Barnes.
6. Manual of Zoology: Invertebrates: Ekambaranatha Ayyar and T. N. Ananthakrishnan.
7. Laboratory Manual of Invertebrate Zoology: P. S. Verma.
8. Zoology Practical Manual for B.Sc. Students. Dr. Veer Bala Rastogi.
9. Text book of Invertebrate Practical Zoology: R. L. Kotpal.

ZOO - 241 - MN : Modern Zoological Techniques and Instrumentation - I (T)						
Year: II				Semester: III		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Lectures per week	Internal Assessment	Semester End Exam	Total
Minor	02	30	02	15	35	50

Course Outcomes :

After the completion of the course, students should be able to :

CO1: Describe Zoological laboratory safety protocols, biosafety levels, and biological waste disposal methods.

CO2: Explain the principles and significance of good laboratory practices (GLP) in Zoological dissection and research.

CO3: Demonstrate the use of laboratory instruments such as balances, pipettes, microscopes, and prepare Zoological solutions including buffers and fixatives.

CO4: Calculate concentration units (molarity, normality) and apply them to prepare reagents for Zoological applications.

CO5: Perform colorimetric estimation of biological compounds like hemoglobin and proteins, and interpret their relevance in nutritional and veterinary contexts.

CO6: Carry out simple paper chromatography to separate pigments or amino acids and analyze their applications in forensic and Zoology related toxicology.

Detailed Syllabus :

Sr. No.	Name of the Topic	Lectures Allotted
1.	Safety & Good Laboratory Practices : 1.1 Zoology-specific lab rules: dealing with live / dead animals.	05

	1.2 Biosafety levels in animal handling. 1.3 Disposal of biological waste and animal remains. 1.4 Importance of good laboratory practices in dissection and Zoology research labs.	
2.	Basic Laboratory Tools and Measurements : 2.1 Measuring weight and volume : Balance, pipettes. 2.2 Solution preparation: Saline, fixatives, buffers (Zoology relevance). 2.3 Concept of molarity and normality for animal tissue preservation.	06
3.	Microscopy Techniques : 3.1 Principle and Applications of Light microscopy, Fluorescence microscopy, Electron microscopy (SEM, TEM), Confocal microscopy. 3.2 Mounting of animal parts: scales, feathers, antennae, wings. 3.3 Imaging Techniques: Digital imaging, image analysis software and applications in biological research.	07
4.	Spectroscopy and Colorimetry : Introduction to - 4.1 Colorimetric analysis and Beer-Lambert Law. 4.2 Principle & applications of UV-Vis spectroscopy, Fluorescence spectroscopy. 4.3 Mass spectrometry, Nuclear Magnetic Resonance (NMR), Fluorimetry and Atomic Absorption Spectroscopy (AAS).	06
5.	Chromatographic and Electrophoretic Techniques : 5.1 Principle and introduction to types of chromatography: Paper chromatography, Thin Layer chromatography (TLC), Gas chromatography (GC), High Pressure Liquid chromatography (HPLC). 5.2 Electrophoresis: Agarose and SDS-PAGE, Native PAGE. 5.3 Western blotting, DNA fingerprinting. 5.4 Applications in biological research.	06

Suggested Readings:

1. Balami, S. B. (2018). Good Laboratory Practices: Training Manual for Health and Environmental Science Students. Lambert Academic Publishing.

2. Plummer, D. T. (1987). An Introduction to Practical Biochemistry (3rd Edition). McGraw Hill.
3. Rastogi, S. C. (2005). Experimental Zoology. New Age International Publishers.
4. Nigam, G. L. (1996). Laboratory Manual in Biochemistry. Tata McGraw-Hill.
5. Bhatia, K. N. (2004). Textbook of Chromatography. CBS Publishers & Distributors.
6. Humason, G. L. (1979). Animal Tissue Techniques (4th Edition). W.H. Freeman. WCB/McGraw-Hill.
7. Wilson, K., & Walker, J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
8. Boyer, R. (2012). Modern Experimental Biochemistry. Pearson Education.
9. Freifelder, D. (2005). Physical Biochemistry. W.H. Freeman.
10. Malhotra, V.K. (2013). Biochemistry for Students. Jaypee Brothers Medical Publishers.
11. Sharma, B.K. (2000). Instrumental Methods of Chemical Analysis. Goel Publishing.

ZOO - 242 - MN : Amazing World of Invertebrates – I (T)						
Year: II				Semester: III		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Lectures per week	Internal Assessment	Semester End Exam	Total
Minor	02	30	02	15	35	50

Course Outcomes:

After the completion of the course, students should be able to:

CO1: Explain key concepts and levels of taxonomy and systematics, including various modern approaches such as Alpha, Beta, and Gamma taxonomy.

CO2: Apply principles of binomial nomenclature and taxonomic hierarchy to classify organisms accurately up to species level.

CO3: Differentiate between the characteristics of unicellular and multicellular animals, highlighting the evolutionary significance of Metazoa.

CO4: Describe structural and functional adaptations in Protozoans, with emphasis on locomotion, reproduction, and economic importance.

CO5: Classify and compare the major classes of lower invertebrate phyla such as Porifera, Cnidaria, and Platyhelminthes based on morphology and anatomy.

CO6: Interpret polymorphism in Cnidarians and its ecological role in coral reef formation and marine biodiversity.

CO7: Analyze parasitic adaptations in flatworms and discuss their impact on human and animal health.

CO8: Develop skills in identifying and describing key diagnostic features of lower invertebrates using morphological characteristics and classification keys.

Detailed Syllabus:

Sr. No.	Name of the Topic	Lectures Allotted
1.	Introduction to Taxonomy : 1.1 Basic terminology and scope: Alpha, Beta, and Gamma taxonomy. 1.2 Introduction to systematics and its role in evolutionary biology. 1.3 Linnaean hierarchy and concept of taxonomic ranks. 1.4 Binomial nomenclature: rules and conventions. 1.5 Overview of five-kingdom classification.	06
2.	Phylum Protozoa : 2.1 Introduction to Kingdom Protista and Phylum Protozoa. 2.2 General characters and classification (with e. g. – names only): Class Rhizopoda – <i>Entamoeba</i> , <i>Arcella</i> , Class Mastigophora – <i>Euglena</i> , <i>Trypanosoma</i> , Class Ciliata – <i>Paramecium</i> , <i>Opalina</i> , Class Sporozoa – <i>Plasmodium</i> , <i>Toxoplasma</i> . 2.4 Protozoan locomotion: Pseudopodia, Flagella, and Cilia (with examples). 2.5 <i>Paramecium caudatum</i> – structure, feeding, excretion, and reproduction – binary fission and conjugation. 2.6 Economic roles of Protozoa: Pathogenic: <i>Plasmodium</i> , <i>Entamoeba</i> . Beneficial: <i>Trichonympha</i> .	07
3.	Phylum Porifera : 3.1 General characters and classification (with e. g. – names only): Calcarea – <i>Leucosolenia</i> , <i>Sycon</i> , Hexactinellida – <i>Euplectella</i> , <i>Hyalonema</i> , Demospongiae – <i>Spongilla</i> , <i>Chalina</i> . 3.3 Types of canal systems: Asconoid, Syconoid, Leuconoid. 3.4 Sponge skeleton: spicules (microscleres & mMegasccleres) and spongin	07

	fibers. 3.5 Regeneration in sponges and their ecological importance.	
4.	Phylum Cnidaria : 4.1 General characters and classification (with e. g. – names only): Hydrozoa – <i>Hydra</i> , <i>Physalia</i> , Scyphozoa – <i>Aurelia</i> , <i>Leucernaria</i> , Anthozoa – <i>Metridium</i> . 4.2 Polymorphism and colony organization in Hydrozoans. 4.3 Coral reefs: Formation, types and ecological significance.	04
5.	Phylum Platyhelminthes (Flatworms) : 5.1 General characters and classification (with e. g. – names only): Turbellaria – <i>Dugesia</i> , <i>Bipallium</i> , Trematoda – <i>Fasciola</i> , <i>Schistosoma</i> , Cestoda – <i>Taenia</i> , <i>Echinococcus</i> . 5.2 Adaptations of parasitic flatworms: Morphological and physiological. 5.3 Human and veterinary importance of flatworms.	06

Suggested Readings:

1. Barnes, R. D. (1987). Invertebrate zoology (5th ed.). Philadelphia, PA: Saunders College Publishing.
2. Jordan, E. L., & Verma, P. S. (2014). Invertebrate zoology (14th ed.). Meerut, India: S. Chand & Company Ltd.
3. Ruppert, E. E., Fox, R. S., & Barnes, R. D. (2004). Invertebrate zoology: A functional evolutionary approach (7th ed.). Belmont, CA: Brooks/Cole.
4. Mayr, E., & Ashlock, P. D. (1991). Principles of systematic zoology (2nd ed.). New York, NY: McGraw-Hill.
5. Hickman, C. P., Roberts, L. S., Keen, S. L., Larson, A., Eisenhour, D. J., & I'Anson, H. (2017). Integrated principles of zoology (17th ed.). New York, NY: McGraw-Hill Education.
6. Kotpal, R. L. (2021). Modern textbook of zoology: Invertebrates (Revised ed.). New Delhi, India: Rastogi Publications.
7. Margulis, L., & Chapman, M. J. (2009). Kingdoms and domains: An illustrated guide to the phyla of life on Earth (4th ed.). Burlington, MA: Academic Press.

ZOO - 243 - MNP : Practicals in Modern Zoological Techniques and Instrumentation - I (P)						
Year: II				Semester: III		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Practicals per week	Internal Assessment	Semester End Exam	Total
Minor	02	60	01	15	35	50

Course Outcomes :

After the completion of the course, students should be able to:

CO1: Recall and explain laboratory safety symbols and demonstrate safe practices while handling Zoological equipment and biological specimens.

CO2: Prepare normal saline, tissue fixatives like Bouin's fluid, and other essential reagents used in dissection and histology work.

CO3: Demonstrate proficiency in handling, calibrating, and using laboratory instruments such as weighing balances, graduated cylinders, and microscopes for biological observations.

CO4: Analyze and measure microscopic specimens like protozoans, rotifers, insect antennae etc. using micrometry and microscopy techniques, enhancing their observations and data recording skills.

CO5: Perform basic biochemical and physiological estimations, including protein estimation and hemoglobin measurement using colorimetry, and interpret their results.

CO6: Develop skills in pigment and amino acid separation techniques using chromatography, and document and report their findings systematically, including reporting from a lab visit.

Detailed Syllabus:

Sr. No.	Title of the Practical	Practical Allotted
1.	Maintenance and cleaning of microscopes. (D) (Compulsory)	1P
2.	Use of light microscope to observe and record cellular structures. - Barr Bodies from Cheek epithelial cells, Mitochondria by Janus Green Stain. (D) (Compulsory)	2P
3.	Study of calibration and handling of pH meter & weighing balance. (E)	1P

4.	To study mounting of feathers, scale, hair (permanent / temporary). (E) (Compulsory)	1P
5.	To study the measurement of rotifers / insect antenna / any suitable biological material by using micrometry. (E) (Compulsory)	1P
6.	To study the use of digital cameras or software to capture and process images. (D)	2P
7.	To study the separation and analysis of biological molecules using Paper Chromatography / Thin Layer Chromatography Techniques. (E) (Compulsory)	2P
8.	To study the use of online tools or software for analyzing genomic data. (D)	2P
9.	Zoological specimen labeling and preservation practice - Digitization of Zoological Lab specimen / Instruments - any five. (D)	2P
10.	Preparation and use of Animal tissue fixatives - e. g. Bouin's fluid. (E)	1P
11.	Compulsory visit to Zoology research lab / Central Instrumentation Facility / National Laboratory / National research centre / ZSI / and report submission. (E)	3P

Suggested Readings:

1. Verma, P.S. & Agarwal, V.K. (2020). A Textbook of Practical Zoology. New Delhi: S. Chand Publishing
2. Lal, S.S. (2019). Practical Zoology: Invertebrate & Vertebrate. Meerut: Rastogi Publications.
3. Plummer, D.T. (2005). An Introduction to Practical Biochemistry (3rd ed.). New Delhi: Tata McGraw-Hill.
4. Wilson, K. & Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology (8th ed.). Cambridge: Cambridge University Press.
5. Kumar, P. & Mina, U. (2016). Biological Instrumentation and Techniques. New Delhi: Pathfinder Publications.
6. Miller, J.M. (2005). Chromatography: Concepts and Contrasts (2nd ed.). Hoboken: Wiley-Interscience.

ZOO - 244 - MNP : Practicals in Amazing world of Invertebrates - I (P)						
Year: II				Semester: III		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Practicals per week	Internal Assessment	Semester End Exam	Total
Minor	02	60	01	15	35	50

Course Outcomes:

After the completion of the course, students should be able to:

CO1: Identify and describe key diagnostic features of protozoans such as *Amoeba*, *Paramecium*, *Euglena*, *Trypanosoma*, and *Plasmodium* using temporary or permanent slides.

CO2: Demonstrate an understanding of locomotion in protozoans by observing and differentiating between flagella, cilia, and pseudopodia.

CO3: Analyze and label the anatomical features of *Paramecium caudatum*, including food vacuoles, contractile vacuoles, and oral groove through slides or models.

CO4: Prepare and examine temporary mounts of sponge spicules and interpret the canal systems (ascon, sycon, leucon) using charts or models.

CO5: Classify and compare selected sponges (*Sycon*, *Spongilla*, *Euplectella*, *Hyalonema*) up to class level based on morphological features.

CO6: Explain polymorphism in cnidarians through identification of zooid types (gastrozooids, gonozooids, dactylozooids) using diagrams or models.

CO7: Evaluate the structure, types, and ecological significance of corals and coral reefs through specimens, images, or models.

CO8: Examine parasitic flatworms (*Fasciola*, *Taenia*, *Echinococcus*) and describe their adaptations and life cycles using preserved specimens and life cycle charts, understand biodiversity through visits to Zoological institutions.

Detailed Syllabus:

Sr. No.	Name of the Practical	Practical Allotted
1.	To study temporary or permanent slides: <i>Amoeba</i> , <i>Paramecium</i> , <i>Euglena</i> , <i>Trypanosoma</i> , <i>Plasmodium</i> . (D) (Compulsory)	2P

2.	Study of locomotory structures in Protozoa - Flagella, cilia, and pseudopodia observed in <i>Euglena</i> , <i>Paramecium</i> , and <i>Amoeba</i> (by slides or digital resources). (D)	1P
3.	To study classification up to class level of <i>Sycon</i> , <i>Spongilla</i> , <i>Euplectella</i> , <i>Hyalonema</i> . (D) (Compulsory)	1P
4.	To study temporary mounts of sponge spicules - microscleeres and megascleres and diagrams/models showing ascon, sycon, leucon types. (E)	1P
5.	Identification and labelling of external structures, food vacuoles, contractile vacuoles, oral groove (by slides or models) of <i>Paramecium caudatum</i> . (D)	2P
6.	To study Cnidarian polymorphism through diagram or model-based observation of polyps and medusae, including gastrozooids, gonozooids, and dactylozooids. (D)	1P
7.	To study types of corals (hard/soft), reef types (barrier, fringing, atoll) & their importance in marine ecosystems. (D)	2P
8.	To study the life cycle of <i>Fasciola hepatica</i> & <i>Taenia solium</i> . (D)	2P
9.	Study of parasitic adaptations in flatworms: morphological and reproductive adaptations of trematodes and cestodes. (D)	1P
10.	Compulsory visit to Zoological Survey of India / Museum / National Park/ Wildlife Sanctuary & submission of report. (E)	3P

Suggested Readings:

1. Brusca, R. C., & Brusca, G. J. (2003). Invertebrates (2nd ed.). Sinauer Associates.
2. Chatterjee, K. D. (2017). Parasitology: Protozoology and Helminthology (13th ed.). CBS Publishers & Distributors.
3. Ekambaranatha Ayyar, M., & Ananthakrishnan, T. N. (n.d.). Manual of Zoology: Invertebrata. S. Viswanathan Pvt. Ltd.
4. Jordan, E. L., & Verma, P. S. (n.d.). Invertebrate Zoology. S. Chand Publishing.
5. Kotpal, R. L. (n.d.). Coelenterata. Rastogi Publications.
6. Kotpal, R. L. (n.d.). Porifera. Rastogi Publications.
7. Kotpal, R. L. (n.d.). Protozoa: Diversity and Adaptations. Rastogi Publications.
8. Kudo, R. R. (1966). Protozoology (5th ed.). Charles C. Thomas.

9. Pandey, B. N., & Singh, A. K. (n.d.). Practical Zoology: Invertebrate. Viva Books.
10. Pati, U. C., & Pradhan, D. (n.d.). Zoology Practical Manual: BSc I Year (Semester I). Kalyani Publishers.
11. Ruppert, E. E., Fox, R. S., & Barnes, R. D. (2004). Invertebrate Zoology (7th ed.). Cengage Learning.
12. Sharma, P. D. (n.d.). Protozoology. Rastogi Publications.
13. Sharma, P. D. (n.d.). Zoology for Degree Students: B.Sc. First Year. Rastogi Publications.
14. Arora, D. R., & Arora, B. (2022). Medical Parasitology (5th ed.). CBS Publishers & Distributors.

ZOO - 221 - MJP : Practicals in Medical Laboratory Techniques - I (P)						
Year: II				Semester: III		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Practicals per week	Internal Assessment	Semester End Exam	Total
VSC	02	60	01	15	35	50

Course Outcomes :

After the completion of the course, students should be able to :

CO1: Perform routine urine analysis using dipstick methods to detect glucose, proteins, and ketones, and interpret findings relevant to metabolic and renal health.

CO2: Understand and apply protocols for blood compatibility testing, safe blood storage, labelling, and the use of anticoagulants in transfusion practices.

CO3: Prepare and examine KOH mounts for detection of fungal infections in skin, hair, or nails, identifying dermatophytes under the microscope.

CO4: Determine bleeding time and clotting time to assess basic haemostatic function and understand their clinical implications.

CO5: Accurately measure ESR, haemoglobin levels, pulse rate, and respiratory rate, and relate these parameters to general health conditions.

CO6: Prepare and stain peripheral blood smears to identify blood cell morphology and perform basic haematological evaluations.

CO7: Use and interpret results from diagnostic tools such as ECG, rapid diagnostic kits (malaria, HIV), and ELISA to evaluate infectious and non-infectious diseases.

CO8: Develop observational and reporting skills through a mandatory visit to a diagnostic / pathology / blood bank / hospital laboratory and submit a detailed report.

Detailed Syllabus:

Sr. No.	Title of the Practical	Practical Allotted
1.	Test urine sample for glucose, protein, and ketones using dipstick tests. (E)	2P
2.	To study Compatibility testing and blood storage protocols - Blood bag labeling, anticoagulants, temperature maintenance. (D) (Compulsory)	1P
3.	To prepare KOH mount for fungal infections of skin, hair, or nail scrapings to detect dermatophytes. (E)	2P
4.	To determine bleeding time and clotting time. (E) (Compulsory)	1P
5.	To measure erythrocyte sedimentation rate (ESR). (E)	1P
6.	To interpret an ECG and understand cardiac activity. (E)	1P
7.	To measure pulse rate and respiratory rate. (E)	1P
8.	To study the use of rapid diagnostic tests to detect infectious diseases – e. g. malaria, HIV. (D)	1P
9.	Measurement of hemoglobin level using hemoglobinometer. (E) (Compulsory)	1P
10.	Prepare and stain blood smear to observe blood cell morphology. (D) (Compulsory)	1P
11.	To test blood for urea and glucose level. (E)	1P
12.	Perform a simple ELISA to detect antibodies or antigens. (E)	1P
13.	To study the life cycle of malarial and leishmania parasites. (D)	1P
14.	Compulsory visit to Diagnostic Centre / Pathology Lab / Blood Bank / Hospital Laboratory and Report submission. (E)	3P

Suggested Readings:

1. Verma, P.S. & Agarwal, V.K. (2020). A Textbook of Practical Zoology. New Delhi: S. Chand Publishing
2. Lal, S.S. (2019). Practical Zoology: Invertebrate & Vertebrate. Meerut: Rastogi Publications.

3. Plummer, D.T. (2005). An Introduction to Practical Biochemistry (3rd ed.). New Delhi: Tata McGraw-Hill.
4. Wilson, K. & Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology (8th ed.). Cambridge: Cambridge University Press.
5. Kumar, P. & Mina, U. (2016). Biological Instrumentation and Techniques. New Delhi: Pathfinder Publications.
6. Miller, J.M. (2005). Chromatography: Concepts and Contrasts (2nd ed.). Hoboken: Wiley-Interscience.

ZOO - 222 - MJP: Practicals in Pearl Culture (P)						
Year: II				Semester: III		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Practicals per week	Internal Assessment	Semester End Exam	Total
VSC	02	60	01	15	35	50

Course Outcomes:

After the completion of the course, students should be able to:

CO1: Compare and describe the morphology and anatomy, particularly the pallial complex, of *Lamellidens marginalis* (fresh water) and *Pinctada fucata* (marine), highlighting adaptations for pearl formation.

CO2: Analyze water quality parameters such as pH, temperature, and salinity, and evaluate their impact on pearl mussel health and pearl production in culture systems.

CO3: Explain the life cycle stages of *Lamellidens marginalis* and *Pinctada fucata*, and understand their significance in selecting suitable stages for pearl implantation.

CO4: Demonstrate skills in establishing and maintaining a freshwater pearl culture unit, including feeding, cleaning, and regular monitoring of the system.

CO5: Perform the procedure of MBBE (bead) implantation into pearl mussels and observe the biological response during the pearl formation process.

CO6: Identify and differentiate between natural and cultured pearls, and evaluate pearl quality based on size, shape, color, luster, and chemical composition.

CO7: Diagnose common diseases and identify predators of pearl mussels and propose management strategies for effective culture maintenance.

CO8: Assess the economic potential of pearl culture through market-oriented strategies and practical exposure via compulsory visits to pearl farms or natural habitats.

Detailed Syllabus:

Sr. No.	Title of the Practical	Practical Allotted
1.	Study of morphology and anatomy - Pallial complex of freshwater pearl mussel - <i>Lamellidens marginalis</i> . (D)	1P
2.	Study of morphology and anatomy - Pallial complex of marine water pearl oyster - <i>Pinctada fucata</i> . (D)	1P
3.	Analyze water quality parameters - pH, temperature, salinity in pearl culture systems. (E) (Compulsory)	1P
4.	Study of life cycle of <i>Lamellidens marginalis</i> and <i>Pinctada fucata</i> . (D)	2P
5.	Study of common species of freshwater pearl mussel used for pearl formation. (D)	1P
6.	Establishment of freshwater pearl culture unit. (E) (Compulsory)	3P
7.	Embedding beads (MBBE) in suitable mussel for pearl culture. (E)	2P
8.	Study of chemical composition of pearl. (D)	1P
9.	Study of types of pearl - i. Natural pearl ii. Cultured pearl. (D)	1P
10.	Maintenance of freshwater pearl culture unit by feeding, monitoring, the culture systems. (E) (Compulsory)	1P
11.	Study to diagnose diseases in pearl oysters and understand management strategies. (D)	1P
12.	Study of predators of freshwater pearl mussel. (D)	1P
13.	Learn to evaluate pearl quality based on factors like size, shape, colour, and luster. (D)	1P
14.	Study of harvesting, post harvest management, various marketing strategies for pearl and the economic importance of pearl. (D)	1P
15.	Compulsory visit to a pearl farm to observe commercial pearl culture operations or Seashore / waterbody & submission of report. (E)	3P

Suggested Readings:

1. Alagarswami, K. (1991). Marine pearl culture: Status and prospects. Central Marine Fisheries Research Institute (CMFRI) Bulletin No. 44. CMFRI.
2. Ghosh, A., & Mandal, B. (2019). Pearl Culture. ICAR-Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar.
3. James, P. S. B. R. (1991). Pearl oyster resources of India. CMFRI Bulletin No. 42. Central Marine Fisheries Research Institute.
4. Jhingran, V. G. (1991). Fish and fisheries of India (3rd ed.). Hindustan Publishing Corporation.
5. Misra, K. S. (1962). An aid to the identification of the common commercial fishes of India and Pakistan. Records of the Indian Museum, Zoological Survey of India.
6. Paulraj, R., & Edward, D. J. (1998). A manual on freshwater pearl culture. Tamil Nadu Veterinary and Animal Sciences University.
7. Santhana Krishnan, M., & Sanjeeviraj, P. J. (2014). Aquaculture biotechnology. New India Publishing Agency.
8. Sehgal, K. L. (1999). Coldwater fish and fisheries in the Indian Himalayas: Rivers and streams. FAO Fisheries Technical Paper No. 385. Food and Agriculture Organization.
9. Shanmugam, A., & Bhatnagar, R. K. (2002). Pearl oyster farming and pearl production. Daya Publishing House.
10. Tripathi, S. D., & Singh, B. N. (1990). Manual on pearl culture. Training Manual Series, No. 9, Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar.
11. Venkataraman, R., & Chellam, A. (1998). Techniques of pearl oyster spat collection and culture. CMFRI Special Publication.

ZOO - 231 - FP : Field Project (P)						
Year: II				Semester: III		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Practicals per week	Internal Assessment	Semester End Exam	Total
FP / OJT / CEP	2	60	01	15	35	50

The National Education Policy (NEP) 2020 emphasizes experiential learning, skill-based education, interdisciplinary approaches, and local context relevance. Introducing Field Project at the S.Y. B. Sc. Zoology syllabus aligns perfectly with these goals.

1. **Experiential & Hands-on Learning:** Promotes real-world application of Zoological concepts through field observation and data collection.
2. **Promotes Scientific Temper:** Encourages critical thinking, hypothesis formulation, data analysis, and interpretation.
3. **Skill Development:** Enhances practical skills like species identification, ecological survey techniques, mapping, and report writing.
4. **Connection with Local Biodiversity:** Encourages students to explore local fauna and ecological systems, fulfilling NEP's focus on local and regional relevance.
5. **Fosters Research Mindset:** Builds foundation research skills, potentially motivating students towards research-based careers.
6. **Interdisciplinary Exposure:** Integrates Zoology with environmental science, geography, and data analysis tools (e. g. statistics, GIS etc.).
7. **Community & Ecosystem Awareness:** Sensitizes students for conservation, human-wildlife conflict, and sustainable development goals (SDGs).
8. **Continuous Evaluation:** Aligns with NEP's emphasis on formative assessment and continuous evaluation.

Course Outcomes:

After the completion of the course, students should be able to:

CO1: Identify and classify local fauna using standard field techniques and taxonomic keys.

CO2: Develop skills in ecological data collection methods such as quadrat sampling, transect walk, and direct / indirect animal observations.

CO3: Analyze field data using basic statistical tools to draw meaningful biological inferences.

CO4: Prepare and present scientific field reports using standard formats including observations, methodology, and conclusions.

CO5: Demonstrate awareness of biodiversity conservation practices and the ecological importance of local habitats.

CO6: Collaborate effectively in team-based field activities, showing responsibility and ethical behaviour in field work.

CO7: Apply knowledge of animal behaviour, adaptations, and habitat preferences through first hand field observation.

CO8: Utilize digital tools like camera, GPS, field apps and maintain field diaries for documentation and mapping of biodiversity.

Project Report:

All projects should be typed on A4 sheets, Font Times New Roman, Font Size 12, one and a half spacing on executive bond paper. The project report shall have appropriate chapter scheme and be presented with minimum 20 pages.

Project report arrangement :

- 1) Title Page
- 2) Certificate by the department
- 3) Certificate by the Guide
- 4) Student's Declaration
- 5) Acknowledgement
- 6) Index
- 7) Abstract : (200 - 300 words)
- 8) Table of contents :
- 9) Content :
 - Chapter - 1: Introduction
 - Chapter - 2: Literature Review
 - Chapter - 3: Methodology
 - Chapter - 4: Result, Observations and Analysis
 - Chapter - 5: Discussion, Conclusion and Recommendations if any
- 10) References
- 11) Appendices.

Evaluation Pattern :

Evaluation of the FP program involves two key components:

- a) Internal Evaluation (30%) : By the Guide (Marks 15)
- b) External Evaluation (70%) : By Internal and External Examiners (Marks 35).

OE - 201 - ZOO - T : Sericulture Practices and Management (T)						
Year: II				Semester: III		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Lectures per week	Internal Assessment	Semester End Exam	Total
GE / OE	2	30	02	15	35	50

Course Outcomes:

After the completion of the course, students should be able to:

CO1: Identify and differentiate between major silk-producing moths - Mulberry, Tassar, Eri, and Muga, based on their morphology and silk characteristics.

CO2: Interpret sericulture maps of India and the world, and understand regional distribution and climatic suitability for silk production.

CO3: Examine and describe the morphology and developmental stages like egg, larva, pupa, adult moth of the silkworm life cycle through practical observation.

CO4: Diagnose and differentiate common silkworm diseases - protozoan, bacterial, fungal, and viral and recommend basic preventive measures.

CO5: Analyse suitable agro-climatic conditions and cultivation practices for mulberry farming and assess its potential for rural employment and women empowerment.

CO6: Demonstrate practical skills in silkworm rearing including setup of rearing houses, handling of appliances, and care for early and late-age larvae.

CO7: Perform post-harvest techniques such as stiffling, sorting, cooking, and reeling of cocoons and evaluate their role in silk quality enhancement.

CO8: Assess the economic aspects of sericulture, including cocoon and silk marketing, reeling technologies, and the viability of sericulture as a rural industry.

Detailed Syllabus:

Sr. No.	Name of the Topic	Lectures Allotted
1.	Introduction to Sericulture: 1.1 Study of different types of silk moths: Mulberry, Tassar, Eri and Muga. 1.2 Sericulture map of India and the World.	04

2.	Morphology and life cycle of silkworm: Morphology of egg, larva, pupa and adult.	04
3.	Silkworm diseases: Protozoan disease, Bacterial disease, Fungal disease, Viral disease.	02
4.	Cultivation of Mulberry: Agro-climatic conditions, site suitability for mulberry garden, employment generation and role of women in sericulture.	04
5.	Silkworm rearing: Model rearing house, Rearing appliances, Mounting methods, young age worm rearing, late age silkworm rearing.	06
6.	Post-harvest technology: Stifling, sorting, storage, deflossing and riddling, cocoon cooking, reeling and re-reeling, washing and polishing.	06
7.	Sericulture Economics: Silk reeling as a cottage industry, handloom and power loom activities, marketing of cocoon and silk, economics of mulberry cultivation, cocoon production and silk production.	04

Suggested Readings

1. Ganga, G., & Sulochana, C. R. (1997). An introduction to sericulture (2nd ed.). Oxford & IBH Publishing Co. Pvt. Ltd.
2. Kumar, R. U. (2015). Textbook of sericulture. Discovery Publishing House Pvt. Ltd.
3. Babu, R. M. (2013). Comprehensive sericulture. APH Publishing Corporation.
4. Jolly, M. S. (1987). Approaches to sericultural problems. Central Silk Board.
5. Sengupta, K. (1989). Manual on sericulture (Vols. 1–3). Food and Agriculture Organization of the United Nations (FAO).
6. Chakravorty, R., & Neog, K. (2014). Muga silk industry and its prospects. Central Silk Board.
7. Dandin, S. B., Jayaswal, J., & Giridhar, K. (2003). Handbook of sericulture technologies. Central Silk Board.
8. Adhikari, S., & Chatterjee, D. K. (2008). Textbook of Sericulture. Kalyani Publishers.

Websites:

1. Central Silk Board. (n.d.). Central Silk Board, Ministry of Textiles, Government of India. <https://csb.gov.in>
2. International Sericultural Commission. (n.d.). International Sericultural Commission (INSerCo). <https://inserco.org>

OE - 202 - ZOO -T : Pearl Culture and Management (T) मोती निर्माण आणि व्यवस्थापन (T)						
Year: II				Semester: III		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Lectures per week	Internal Assessment	Semester End Exam	Total
GE / OE	02	30	02	15	35	50

Course Outcomes:

After the completion of the course, students should be able to:

CO1: Understand the historical development and significance of pearl culture in both global and Indian contexts.

CO2: Differentiate between natural and cultured pearls, including their formation processes and types.

CO3: Identify and describe various species of pearl oysters, their key morphological and biological characteristics.

CO4: Locate and explain the major pearl farming regions in India, with a focus on the Gulf of Mannar and Gulf of Kutch.

CO5: Explain the chemical composition and physical properties of pearls, including nacre secretion and calcium carbonate formation.

CO6: Understand the detailed process of pearl formation - including the role of the pearl sac, secretion mechanisms, and influencing factors and preparation of MBBE.

CO7: Demonstrate knowledge of pearl implantation techniques, including mussel selection, graft tissue handling, surgical procedures, and post-operative care.

CO8: Analyze the economics of pearl farming, encompassing marketing strategies, price determination, income sources, and recent developments in freshwater pearl culture in India.

Detailed Syllabus:

Sr. No.	Name of the Topic	Lectures Allotted
1.	Introduction to Pearl culture : 1.1 History and importance of pearl culture. 1.2 Types of Pearls: Natural pearls and cultured pearls.	07

	1.3 Pearl farming region in India: Gulf of Mannar and Gulf of Kutch. 1.4 Study of various pearl oyster species for pearl culture.	
2.	Properties of Pearl : 2.1 Chemical composition of pearl. 2.2 Classification of pearls. 2.3 Physical properties of pearl. 2.4 Formation of Pearl: Formation of pearl sac; Secretion of pearl forming nacre and calcium absorption and formation of calcium carbonate; Factors influencing secretion of nacre. 2.5 Uses of pearl.	08
3.	Implantation and harvesting : 3.1 Transportation of oyster species, water quality management of rearing pond. 3.2 Selection of mussel : Surgery of mussel and precautions, Graft tissue. 3.3 MBBE Preparation, Nucleus implantation, and post-surgical care and harvesting of pearl, post harvesting management.	08
4.	Economics of pearl farming : 4.1 Marketing of the pearl. 4.2 Income and expenditure for pearl culture, economics of pearl farming. 4.3 Recent Trends in Freshwater Pearl Farming in India.	07

Suggested Readings:

1. Prasad, B. N. (2011). Pearl culture in India: An overview. Central Marine Fisheries Research Institute.
2. Southgate, P. C., & Lucas, J. S. (2008). The pearl oyster (2nd ed.). Elsevier.
3. Sharma, B. K. (2010). Pearl farming technology. Daya Publishing House.
4. Baldwin, R., & Cirata, M. (2012). Freshwater pearl culture: Biology and farming methods. Fishing News Books.
5. Keshavanath, P., & Mulye, M. N. (2006). Pearl oyster and pearl farming in India. Central Institute of Fisheries Education.

ZOO – 200 - IKS: Treasures of Animal Kingdom (T)						
Year: II				Semester: III		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Lectures per week	Internal Assessment	Semester End Exam	Total
IKS	02	30	02	15	35	50

Course Outcomes:

After completion of the course, students should be able to:

CO1: Understand the historical roots of Indian Zoological traditions by studying the contributions of ancient scholars such as Shalihotra, Palakapya, Bhoja, Paramar, and Hamsadev.

CO2: Trace the evolution of animal conservation ethics from the prehistoric period through the Indus Valley civilization to the Mauryan Dynasty, including references from Vedic texts.

CO3: Critically evaluate human-wildlife interactions through time, with a focus on animal exploitation for sport during the Mughal and colonial periods.

CO4: Identify and describe the major ecological zones of India, including their geographical distribution, key features, and endemic wildlife species.

CO5: Analyze the impact of colonial hunting practices on biodiversity conservation and understand how these practices influenced post-independence conservation policies.

CO6: Appraise the contributions of Indian naturalists such as Dr. Salim Ali and Dr. Sunder Lal Hora, including the significance of the Satpura Hypothesis in Indian biogeography.

CO7: Discuss the roles and research functions of major Indian institutions like the Wildlife Institute of India and Zoological Survey of India, including their organizational structures and regional branches.

CO8: Interpret the provisions of the Wildlife Protection Act, 1972, including the categorization of animals under various schedules, and explain the significance of Indian natural history museums in biodiversity education.

Detailed Syllabus:

Sr. No.	Name of the Topic	Lectures Allotted
1.	Introduction : Natural fauna history of India.	01
2.	Indian authors and sages : Shalihotra, Palakapya, Bhoja, Paramar, Hamsadev.	02
3.	Animals in Indian History : 3.1 Pre-historic to Indus valley civilization of tradition of animal conservation. 3.2 Names and kinds of birds and animals during the Vedic period to Maurya dynasty. 3.3 Animal killing as major sports during mughal and colonial period.	05
4.	Ecosystem of India : 4.1 Trans-Himalaya, Himalaya, Desert, Semi-arid, Western Ghats, Deccan Plateau, Gangetic plains, Coastal India, Islands - Andaman and Nicobar.	10
5.	Colonial Hunting and Indian Conservation Pioneers : 5.1 Environmental and wildlife conservation issues with reference to hunting during colonial India. 5.2 Contribution of - Dr. Salim Ali & Dr. Hora's to Indian Ichthyology, Satpura Hypothesis.	05
6.	Wildlife Governance in India : 6.1 Establishment of Wildlife institute of India, Zoological Survey of India, Its branches and role, responsibility, and present-day research. 6.2 Wildlife Protection Act in India with information on various schedules.	06
7.	Indian Natural History Museums.	01

Suggested Readings:

1. Mandala, V. R. (Ed.). (2018). Shooting a Tiger: Big-game hunting and conservation in colonial India. Oxford University Press.
2. Ramakrishna, Raghunathan, C., & Sivaperuman, C. (2010). Status Survey on *Trochus Niloticus* (Linnaeus, 1767) in Andaman and Nicobar Islands. Zoological Survey of India.

3. Verma, S. P. 1999. Mughal Painter of Flora and Fauna Ustad Mansur. Abhinav Publications.
4. Study and Practice of Wild Life Laws in India: Concepts, Acts, Rules and Notifications (Revised and Updated, 2020 edition).
5. Environmental issues in India: A Reader by Mahesh Rangarajan, Pearson Education India publisher.
6. Science & Conservation of Wildlife Populations by K. Ullas Karanth, Nataraj Publisher.

Web Link:

1. <https://en.wikipedia.org/wiki/Shalihotra>
2. <https://en.wikipedia.org/wiki/Bhoja>
3. https://en.wikipedia.org/wiki/Paramara_dynasty
4. <https://www.wisdomlib.org/definition/hamsadeva>



END OF THE SEMESTER - III

SEMESTER - IV

ZOO - 251 – MJ : Ecology (T)						
Year: II				Semester: IV		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Lectures per week	Internal Assessment	Semester End Exam	Total
Major Paper - 1	02	30	02	15	35	50

Course Outcomes:

After the completion of the course, students should be able to:

CO1: Define ecology, its types, and levels of ecological organization from individual organisms to the biosphere.

CO2: Describe ecosystems, functions of ecosystems, food chains, food webs, energy flow and ecological pyramids.

CO3: Evaluate the role of density-dependent and independent factors in regulating population size.

CO4: Analyze the factors affecting population growth.

CO5: Explain the key characteristics of communities, such as species richness, diversity, and abundance.

CO6: Classify examples of protocoeperation, mutualism, commensalism, parasitism, and predation in natural ecosystems.

Detailed Syllabus:

Sr. No.	Name of the Topic	Lectures Allotted
1.	Introduction to Ecology : 1.1 Definition of Ecology, types of ecology, autecology and synecology. 1.2 Levels of ecological organisation from individual organism to the biosphere. 1.3 Importance of Ecology.	03
2.	Ecosystem : 2.1 Ecosystem - Definition and components - biotic and abiotic. 2.2 Functions of ecosystem. 2.3 Types of ecosystems: Aquatic - Freshwater ecosystem – Lentic and Lotic	08

	and Marine ecosystem, Terrestrial - Forest, Grassland and Desert ecosystem. 2.4 Food chain and food web in ecosystem. 2.5 Energy flow through the ecosystem. 2.6 Ecological pyramids - energy, biomass and number.	
3.	Population Ecology : 3.1 Introduction and concepts of population ecology. 3.2 Population characteristics, population density, population size. 3.4 Population growth, factors affecting population growth, natality, mortality, immigration, emigration. 3.5 Population growth curves, types of growth curves - exponential and logistic. 3.6 Sampling techniques for determining population size and density - quadrat, mark and recapture, camera traps. 3.7 Ecological sampling techniques used to study the distribution and abundance of organisms - Line transect and Belt transect method.	10
4.	Community Ecology : 4.1 Introduction and concepts of community ecology. 4.2 Community characteristics - species richness, dominance, diversity, abundance. 4.3 Ecotone and edge effect. 4.4 Ecological succession, types of succession with example.	04
5.	Population Interactions : 5.1 Concept of interspecific and intraspecific population interactions. 5.2. Protocooperation - Ants and Aphids, Amazonian bees and Scale ants. 5.3 Mutualism – Honey bee and Flowering plants, <i>Acacia</i> and <i>Pseudomyrmex</i> ants. 5.4 Commensalisms - Hermit crabs and gastropod shell, Remora fish on shark. 5.5 Parasitism - Tapeworms and humans, copepods and fish. 5.6 Brood parasitism - Common cuckoo, Honey guide bird. 5.7 Predation - Tiger and deer, eagle and snake. 5.8 Competition - Interspecific and intraspecific with any two examples of each.	05

Suggested Readings:

1. Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole.
2. Krebs, C. J. (2001). Ecology: The Experimental Analysis of Distribution and Abundance, 6th Edition, ©2009, Pearson.
3. Sharma P.D. (2002) Ecology and Environment, Himalaya Publication.
4. Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Press.
5. Colinviaux, P. A. (1993). Introduction to Ecology. II Edition. Wiley, John and Sons, Inc.
6. Robert Leo Smith Ecology and field biology Harper and Row publisher
7. Putnam R (2010) Community ecology. Springer Publications. ISBN: 978-9048140114.
8. Ranta E, Lundberg P, Kaitala V (2006) Ecology of populations. Cambridge University Press.
9. Sudarshan KN, Trivedi KR (2011) Population and Community Ecology. Neha Publishers & Distributors. ISBN: 978-8171692804.
10. Verma & Agarwal (1995). Environmental Biology (Principles of ecology) Chand & Co., New Delhi.

ZOO - 252 - MJ : Invertebrate Zoology - II (T)						
Year: II				Semester: IV		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Lectures per week	Internal Assessment	Semester End Exam	Total
Major Paper-2	02	30	02	15	35	50

Course Outcomes:

After the completion of the course, students should be able to:

- CO1:** Understand the diversity and characteristics of phylum Aschelminths and Annelida.
- CO2:** Classify and explain the structure and function of different groups within phylum Arthropoda.
- CO3:** Gain knowledge about phylum Mollusca and its relevance.
- CO4:** Analyze the features and classification of phylum Echinodermata.
- CO5:** Learn about life cycle of earthworm, cockroach and starfish.
- CO6:** Develop classification and comparative skills across multiple invertebrate phyla.

Detailed Syllabus:

Sr. No.	Name of the Topic	Lectures Allotted
1.	Phylum Aschelminths (Nemathelminths) : 1.1 General characters, body structure, pseudocoelom, parasitism. 1.2 Classification up to classes with examples (names only). 1.3 Class Nematoda: <i>Ascaris lumbricoides</i> – Helminth control programs, <i>Wuchereria bancrofti</i> – Lymphatic filariasis and its control measures, <i>Ancylostoma duodenale</i> – anemia due to hookworm infection. 1.4 Human and plant parasitic nematodes and economic importance of Nematoda. 1.5 Recent Advances: Introduction of <i>Caenorhabditis elegans</i> as model organism in genetics and developmental biology.	06
2.	Phylum Annelida : 2.1 General characters. 2.2 Classification up to classes with examples (names only). 2.2.1 Class Polychaeta - <i>Nereis pelagica</i> , <i>Aphrodite aculeate</i> . 2.2.2 Class Oligochaeta - <i>Pheritima posthuma</i> . 2.2.3 Class Hirudinea - <i>Hirudinaria granulosa</i> . 2.3 Economic importance of annelids with reference to earthworms and leeches. 2.4 Study of Earthworm: External characters, digestive system, reproductive system, excretory system (Nephridia only). 2.5 Recent Advances: Introduction of role of hirudin as a potential anticoagulant in modern medicine, use of Annelids as a model for studying synaptic transmission.	06
3.	Phylum Arthropoda : 3.1 General characters. 3.2. Classification up to classes with examples (names only). 3.2.1 Class: Crustacea: <i>Palaemon</i> (prawn) 3.2.2 Class: Chilopoda: <i>Scolopendra</i> sp. (centipede). 3.2.3 Class: Diplopoda: <i>Julus</i> sp. (millipede). 3.2.4 Class Insecta: <i>Periplaneta americana</i> .	06

	3.2.5 Class: Arachnida - <i>Buthus sp.</i> (scorpion). 3.3 Study of Cockroach: External Morphology, Digestive System, Reproductive System. 3.4 Recent Advances: Introduction of Use of CRISPER-Cas9 in gene editing in <i>Drosophilla melanogaster</i>, Vaccine development using Arthropods salivary proteins, medicinal properties of Arthropods	
4.	Phylum Mollusca: 4.1 General characters. 4.2. Classification up to classes with examples (names only). 4.2.1 Class Gastropoda - <i>Pila globosa</i> (apple snail). 4.2.2 Class Pelecypoda - <i>Lamellidens marginalis</i> (bivalve). 4.2.3 Class Polyplacophora - <i>Chiton</i>. 4.2.4 Class: Cephalopod - <i>Octopus vulgaris</i> (common octopus). 4.3 Recent Advances: Introduction of development of analgesics from toxins of cone snails, use of snail mucous & its medicinal properties, use of molluscan species as bioindicator of aquatic pollution.	06
5	Phylum Echinodermata: 5.1 General characters. 5.2. Classification up to classes with examples (names only). 5.2.1 Class Asteroidea - <i>Asterias rubens</i> (sea stars or starfish). 5.2.2 Class: Holothuroidea - <i>Holothuria sp.</i> (sea cucumbers). 5.2.3 Class: Echinoidea - <i>Echinus esculentis</i> (common sea urchins). 5.2.4 Class: Crinoidea - Sea lilies or feather stars. 5.3 Economic importance of Echinodermata. 5.4 Recent Advances: Limbs and organ regeneration studies in starfish and sea cucumbers, Echinoderms as bioindicators of marine ecosystem health.	06

Suggested Readings:

1. A text book of zoology Invertebrates, vol. I 1992, 7th edition. Parker and Haswell edited by Marshall and William, CBS publishers and distributors, New Delhi.
2. Invertebrate zoology, 1992; E.L. Jordan, S. Chand and Co., New Delhi.
3. Life of invertebrate, 1992; S.N. Prasad, Vikas publishing house, New Delhi.
4. Invertebrate zoology, 1992 4th edition. reprint, P.S. Dhami and J.K. Dhami, R. Chand and Co., New Delhi.

5. Modern text book of zoology, Invertebrates 6th edition. 1992, R.L. Kotpal, Rastogi publ., Meerut.
6. Invertebrates structure and function, 2nd edition. 1992, R.L. Kotpal, Rastogi publication, Meerut.
7. Invertebrate zoology, 1982, R.D. Barnes; Saunder college, Philadelphia.
8. Invertebrate zoology 1987, 5th edition. Barnes R.D. Saunders College Publishing U.S.A.
9. The Invertebrates: Protozoa through Ctenophora Vol. I, 1959, McGraw – Hill Book Co., Inc. New York.
10. A text book of Zoology, Vol. II, 1990, T.J. Parker and W.A. Haswell, Low price publication, Delhi.
11. Modern text book of zoology, 1992, R.L. Kotpal, Rastogi publication Meerut.
12. A text book of zoology, 1984, R.D. Vidyarthi, S. Chand and Co., New Delhi.
13. <https://www.sciencedirect.com/science/article/pii/S2590006424003685>.

ZOO – 253 - MJP: Practicals in Ecology and Invertebrate Zoology - II (P)						
Year: II				Semester: IV		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Practical per week	Internal Assessment	Semester End Exam	Total
Major Paper - 3	02	60	01	15	35	50

Course Outcomes:

After the completion of the course, students should be able to:

CO1: Learn about the estimation of DO, CO₂, water holding capacity of soil through experiments.

CO2: Demonstrate understanding of the ecological roles and social behavior of insects, including bees and termites.

CO3: Develop practical competencies in the observation, documentation, and comparative study of invertebrate diversity.

CO4: Identify and describe key morphological features of Aschelminths, Annelida, Arthropoda, Mollusca and Echinodermata using preserved specimens.

CO5: Acquire skills in rearing and managing earthworms, highlighting their environmental and agricultural importance.

CO6: Illustrate the anatomy and physiology of starfish with a focus on its digestive and water vascular systems.

Detailed Syllabus:

Fifteen Practicals should be conducted from the following list (At least 8 Practicals from Ecology and 7 practicals from Invertebrate Zoology-II inclusive of the compulsory practicals).

Sr. No.	Title of the Practical	Practical Allotted
Ecology		
1.	To estimate dissolved oxygen content of a given water sample using Winkler's method. (E) (Compulsory)	1P
2.	Estimation of free carbon dioxide in a given water sample. (E) (Compulsory)	1P
3.	Identification and classification of primary producers, consumers, decomposers in a selected ecosystem - pond or grassland.	1P
4.	To determine water holding capacity of given soil samples - clay and sandy soil. (E)	1P
5.	To determine density, frequency, abundance of the animal species by quadrat method - in the field or by given hypothetical data on sheet / simulation. (E)	1P
6.	Study of dispersion patterns of population - Random, Clumped, Uniform. (D)	1P
7.	Study of - a. Mutualism species - Honey bee and flowering plants. b. Commensalism species - Hermit crabs and gastropod shell. c. Parasitic species - Tapeworms and humans. (D)	1P
8.	Study of competitive exclusion in <i>Paramoecium</i> species, Brood parasitism in common Cuckoo. (D)	1P
9.	Compulsory field visit to local ecosystem and submission of report. (E)	3P
Invertebrate Zoology - II		
10.	To study characteristics and classification : Phylum Aschelminths - <i>Ascaris</i> , <i>Wuchereria</i> . (D)	1P
11.	To study characteristics and classification : Phylum Annelida - <i>Nereis</i> , Earthworm, Leech. (D)	1P

12.	To study characteristics and classification : Phylum Arthropoda - Prawn, Cockroach, Centipede, Millipede, Crab. (Any four) (D)	1P
13.	To study characteristics and classification : Phylum Mollusca - Pila, Chiton, Bivalve, Octopus. (D)	1P
14.	To study characteristics and classification : Phylum Echinodermata - Sea Star, Sea urchin, Brittle Star, sea cucumber. (D)	1P
15.	Study of permanent slides: Mouth parts of insects - Mandibulate, Piercing and Sucking, Chewing and Lapping. (D)	1P
16.	Study of types of shells in mollusca - Pila, Bivalve, Chiton, Sepia. (D)	1P
17.	Economic importance of honey bees, Lac insect, silk worm, red cotton bug, Anopheles mosquito. (D)	1P
18.	Study of External morphology of earthworm, digestive system, temporary mounting of setae. (E) (Compulsory)	2P
19.	Study of reproductive system of earthworm, temporary mounting of spermatheca & septal nephridia. (E) (Compulsory)	1P
20.	Study of external characters of cockroach, digestive system, temporary mounting of - antenna, and mouth Parts. (E) (Compulsory)	1P

Suggested Readings:

1. Standard methods for examination of water and waste water, American Public Health Association.
2. A comprehensive laboratory manual for Environmental Sciences and Engineering by P.R. Sree Mahadevan Pillai. New Age International Publishers.
3. Chemical and biological methods for water pollution studies by R.K. Trivedi
4. Handbook of water and waste water analysis by S.K. Maiti.
5. Soil and air analysis by S.K. Maiti.
6. Practical Zoology- Invertebrates S.S. Lal.
7. Practical Zoology - Invertebrates P.S. Verma.
8. An Advanced Laboratory Manual of Zoology - T. Poddar and S Mukhopadhyay.
9. A Manual of Practical Zoology Invertebrates- Dr. P.S. Verma.

ZOO - 291 - MN : Modern Zoological Techniques and Instrumentation - II (T)						
Year: II				Semester: IV		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Lectures per week	Internal Assessment	Semester End Exam	Total
Minor	02	30	02	15	35	50

Course Outcomes:

After the completion of the course, students should be able to:

CO1: Explain the processes and significance of blood smear preparation, haemoglobin estimation, and clotting time in animal physiology and health diagnostics.

CO2: Demonstrate the practical use of diagnostic kits such as ELISA, pregnancy tests, and glucose strips for assessing veterinary animal health in the field.

CO3: Analyze environmental parameters using tools like DO / pH meters, and interpret noise and temperature data for evaluating habitat quality and animal welfare.

CO4: Evaluate the suitability and accuracy of wildlife field techniques such as camera traps, scat analysis, and GPS tracking in biodiversity studies and monitoring.

CO5: Design a simple, interdisciplinary Zoological survey or monitoring plan integrating molecular, physiological, and ecological techniques for a given field setting.

CO6: Utilize citizen science platforms (eBird, iNaturalist) and mobile-based biodiversity mapping tools to build employable skills in field Zoology and wildlife research careers.

Detailed Syllabus:

Sr. No.	Name of the Topic	Lectures Allotted
1.	Basics of Molecular Tools in Zoology : 1.1 DNA / RNA role in animal traits and identification. 1.2 Basics of DNA extraction and PCR. 1.3 Use of DNA barcoding in animal taxonomy.	06
2.	Blood Analyzer and Animal Physiology Tools : 2.1 Hematology analyzers, Hemoglobin meter, Glucometer, Blood gas analyzer (portable), Hematocrit centrifuge, Manual blood cell counter. 2.2 Animal physiology tools: Electrocardiography (ECG), Electromyography (EMG), Blood pressure monitors, Respiratory gas Analyzers.	07

3.	Diagnostic Kits and Rapid Testing in Animals : 3.1 ELISA principle - as used in poultry, vet diagnostics. 3.2 Pregnancy tests in animals and glucose strip tests. 3.3 Application of lateral flow assays in animal health. 3.4 Bleeding & clotting time, and their importance.	06
4.	Environmental Monitoring for Zoology Field Work : 4.1 Use of DO & pH meters in fishery / ponds. 4.2 Simple noise / temperature data collection. 4.3 Importance in habitat study and animal welfare.	06
5.	Wildlife Tracking and Field Techniques : 5.1 Camera traps, scat analysis, call recording. 5.2 Use of GPS and mobile apps for biodiversity mapping. 5.3 Application of citizen science and eBird / iNaturalist.	05

Suggested Readings:

1. Primrose, S.B. & Twyman, R.M. (2013). Principles of Gene Manipulation and Genomics (7th Ed.). Wiley-Blackwell.
2. Nelson, D.L., & Cox, M.M. (2017). Lehninger Principles of Biochemistry (7th Ed.). W.H. Freeman and Company.
3. Gupta, R.C. (2018). Veterinary Toxicology: Basic and Clinical Principles (2nd Ed.). Academic Press.
4. Ghai, C.L. (2012). A Textbook of Practical Physiology (8th Ed.). Jaypee Brothers Medical Publishers.
5. Sutherland, W.J., Newton, I., & Green, R.E. (2004). Bird Ecology and Conservation: A Handbook of Techniques. Oxford University Press.
6. Boyd, C.E. (2015). Water Quality: An Introduction (2nd Ed.). Springer.

ZOO - 292 - MN : Amazing World of Invertebrates - II (T)						
Year: II				Semester: IV		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Lectures per week	Internal Assessment	Semester End Exam	Total
Minor	02	30	02	15	35	50

Course Outcomes:

After the completion of the course, students should be able to:

CO1: Describe and classify major invertebrate phyla including Nematoda, Annelida, Arthropoda, Mollusca, and Echinodermata.

CO2: Identify diagnostic features and representative organisms of each phylum.

CO3: Explain ecological roles and economic importance of selected invertebrates.

CO4: Illustrate adaptive features like segmentation, mouthparts, locomotion, and parasitism.

CO5: Analyze life processes such as reproduction, digestion, and locomotion in key invertebrate models.

CO6: Compare morphological and functional characteristics across phyla.

CO7: Interpret structural adaptations in parasitic and free-living invertebrates.

CO8: Demonstrate practical skills in specimen observation, slide identification, and interpretation of biological models.

Detailed Syllabus:

Sr. No.	Name of the Topic	Lectures Allotted
1.	Phylum Aschelminths (Nemathelminths) : 1.1 Diagnostic features of nematodes. 1.2 Classification and examples - <i>Ascaris lumbricoides</i> , & <i>Wuchereria bancrofti</i> . 1.3 Parasitic adaptations and economic relevance.	05
2.	Phylum Annelida : 2.1 Diagnostic features and segmentation. 2.2 Classification and examples: Polychaeta (<i>Nereis</i> , <i>Aphrodite</i>), Oligochaeta (<i>Pheretima posthuma</i>), Hirudinea (<i>Hirudinaria granulosa</i>). 2.3 Functional role of annelids: Vermicomposting and agriculture.	05
3.	Phylum Arthropoda : 3.1 Diagnostic features and body plan. 3.2 Classification and examples: Crustacea (<i>Palaemon</i> , Crab spp.), Chilopoda (<i>Scolopendra</i>), Diplopoda (<i>Julus</i>), Insecta (<i>Periplanata</i> , <i>Anopheles</i>), Arachnida (Spiders, <i>Buthus</i>). 3.3 Comparative study of insect mouthparts: Biting & chewing (Cockroach), Piercing & sucking (<i>Anopheles</i>), Chewing & lapping (Honey	10

	bee). 3.4 Applied entomology: Beneficial insects – Honey bee, lac insect, silk worm; Pest and vector insects - mosquito, red cotton bug, rice weevil.	
4.	Phylum Mollusca : 4.1 Diagnostic features and shell variations 4.2 Classification and examples: Gastropoda (<i>Pila globosa</i>), Bivalvia (<i>Lamellidens marginalis</i>), Polyplacophora (<i>Chiton</i>), Cephalopoda (<i>Octopus vulgaris</i> , <i>Sepia officinalis</i>). 4.3 Economic importance: Food, pearls, biofouling, ornamentals.	05
5.	Phylum Echinodermata : 5.1 Diagnostic features, radial symmetry. 5.2 Classification and examples: Asteroidea (<i>Asterias rubens</i>), Echinoidea (<i>Echinus esculentus</i>), Holothuroidea (<i>Holothuria</i>), Crinoidea (Sea lilies). 5.3 <i>Asterias rubens</i> – Habit, habitat, water vascular system, regeneration. 5.4 Pedicellaria - Types, structure and function. 5.5 Economic and ecological roles of echinoderms.	05

Suggested Readings:

1. Barnes, R. D. (1987). Invertebrate Zoology (5th ed.). Philadelphia, PA: Saunders College Publishing.
2. Ruppert, E. E., Fox, R. S., & Barnes, R. D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach (7th ed.). Brooks/Cole.
3. Kotpal, R. L. (2020). Modern Textbook of Zoology: Invertebrates. Rastogi Publications.
4. Parker, T. J., & Haswell, W. A. (1981). A Textbook of Zoology, Vol. 1: Invertebrates. Macmillan Press Ltd.
5. Jordan, E. L., & Verma, P. S. (2019). Invertebrate Zoology. S. Chand Publishing.
6. Brusca, R. C., & Brusca, G. J. (2002). Invertebrates (2nd ed.). Sinauer Associates.
7. Dhami, P. S., & Dhami, J. K. (2020). Invertebrate Zoology. R. Chand & Co.
8. Shukla, G. S., & Upadhyay, V. B. (2021). Economic Zoology. Rastogi Publications.

ZOO - 293 - MNP: Practicals in Modern Zoological Techniques and Instrumentation - II						
Year: II				Semester: IV		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Practical per week	Internal Assessment	Semester End Exam	Total
Minor	02	60	01	15	35	50

Course Outcomes:

After completion of this course, students should be able to:

CO1: Describe the working principles and importance of diagnostic and field instruments used in Zoological investigations, including ELISA kits, Sahli's apparatus, and pH meters.

CO2: Apply appropriate laboratory and field methods to conduct blood smear preparation, use pregnancy / glucose test strips, and measure physiological and environmental parameters.

CO3: Analyze field data and diagnostic results from camera trap images, mobile identification apps, and DO / pH readings to derive biological or ecological conclusions.

CO4: Evaluate the reliability and significance of various modern techniques in disease diagnosis, biodiversity assessment, and environmental monitoring.

CO5: Develop biodiversity checklists and structured field records through direct observations, specimen collection, and interpretation of field signs.

CO6: Communicate scientific observation effectively in the form of reports from diagnostic lab / wildlife park visits, and work collaboratively during field and lab activities.

Detailed Syllabus:

Sr. No.	Title of the Practical	Practical Allotted
1.	Observation of DNA strands using virtual lab / video.	1P
2.	Simple DNA extraction from fish fin or fat bodies or cheek cells. (D)	2P
3.	Preparation of hemin crystal from hemoglobin in red blood cells. (E) (Compulsory)	1P
4.	Measurement of pulse, temperature, and B.P. (E) (Compulsory)	1P
5.	Detection of HCG by pregnancy strip method (UP). (D)	1P

6.	Detection of Blood sugar by Glucometer. (E)	1P
7.	Estimation of Bleeding and Clotting time from human blood sample. (E) (Compulsory)	1P
8.	ELISA kit demo for poultry disease diagnosis.	1P
9.	Measurement of pond water pH and temperature.	1P
10.	Estimation of dissolved oxygen from given water sample. (E) (Compulsory)	1P
11.	Introduction to camera trap images and their interpretation.	1P
12.	Use of mobile-based bird / butterfly identification apps.	1P
13.	Making a biodiversity check list using local observations.	1P
14.	Compulsory report on a visit to veterinary diagnostic lab or wildlife park & submission of report.	3P
15.	Field collection of animal signs (feathers, scat, etc.) and record keeping.	3P

ZOO - 294 - MNP: Practicals in Amazing World of Invertebrates – II (P)						
Year: II				Semester: IV		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Practical per week	Internal Assessment	Semester End Exam	Total
Minor	02	60	01	15	35	50

Course Outcomes :

After the completion of the course, students should be able to :

CO1: Identify and describe morphological and anatomical features of *Ascaris lumbricoides* and *Wuchereria bancrofti*, recognizing their adaptations for parasitism.

CO2: Demonstrate the ability to observe and label external features of *Pheretima posthuma* using preserved specimens or models.

CO3: Analyze the structure and function of parapodia and setae in *Nereis*, relating them to locomotion and habitat adaptation.

CO4: Compare and contrast different insect mouth parts like biting, piercing, lapping through accurate identification using models or diagrams.

CO5: Identify economically important insects and explain their beneficial or harmful role in agriculture, apiculture, or sericulture.

CO6: Classify and distinguish representative arthropod specimens like *Palaemon*, *Crab*, *Julus*, *Scolopendra*, *Periplaneta*, *Buthus*, *Anopheles* based on key morphological traits.

CO7: Recognize and interpret structural features of molluscan shells and echinoderm systems - *Pila*, *Lamellidens*, *Asterias*, including water vascular system and pedicellariae.

CO8: Prepare and submit a field / museum visit report demonstrating the understanding of non-chordate diversity, taxonomy, and ecological relevance through observational learning.

Detailed Syllabus:

Sr. No.	Name of the Practical	Practical Allotted
1.	To study morphology and parasitic adaptations of <i>Ascaris lumbricoides</i> and <i>Wuchereria bancrofti</i> . (D) (Compulsory)	2P
2.	To study external morphology & digestive system of earthworm <i>Pheretima posthuma</i> . (D) (Compulsory)	1P
3.	Temporary mounting of parapodia and setae in earthworm. (E)	1P
4.	Identification and comparison of insect mouth parts: cockroach (biting), mosquito (piercing), honey bee (lapping). (D)	2P
5.	Study of economically important insects: honey bee, silkworm, lac insect. (D)	2P
6.	Study of general characters of - <i>Palaemon</i> , <i>Crab</i> , <i>Julus</i> , <i>Scolopendra</i> , <i>Periplaneta</i> , <i>Buthus</i> , <i>Anopheles</i> . (D) (Any five)	2P
7.	Study of general characters of <i>Pila</i> , <i>Chiton</i> , <i>Lamellidens</i> , <i>Octopus</i> , <i>Sepia</i> . (Any five)	2P
8.	Study of water vascular system in starfish, <i>Asterias rubens</i> . (D) (Compulsory)	2P
9.	Study of types of pedicellaria. (D)	1P
10.	Compulsory visit to Zoological Survey of India / National Park / Wild Life Sanctuary and submission of report. (E)	3P

Suggested Readings:

1. Barnes, R. D. (1987). Invertebrate Zoology (5th ed.). Philadelphia, PA: Saunders College Publishing.

2. Ruppert, E. E., Fox, R. S., & Barnes, R. D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach (7th ed.). Brooks/Cole.
3. Kotpal, R. L. (2020). Modern Textbook of Zoology: Invertebrates. Rastogi Publications.
4. Parker, T. J., & Haswell, W. A. (1981). A Textbook of Zoology, Vol. 1: Invertebrates. Macmillan Press Ltd.
5. Jordan, E. L., & Verma, P. S. (2019). Invertebrate Zoology. S. Chand Publishing.
6. Brusca, R. C., & Brusca, G. J. (2002). Invertebrates (2nd ed.). Sinauer Associates.
7. Dhami, P. S., & Dhami, J. K. (2020). Invertebrate Zoology. R. Chand & Co.
8. Shukla, G. S., & Upadhyay, V. B. (2021). Economic Zoology. Rastogi Publications.

ZOO - 271 - MJP: Practicals in Medical Laboratory Techniques II (P)						
Year: II				Semester: IV		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Practical per week	Internal Assessment	Semester End Exam	Total
VSC	02	60	01	15	35	50

Course Outcomes :

After completion of this course, students should be able to:

CO1: Understand and identify the cellular and tissue-level characteristics of acute and chronic inflammation through microscopic examination of prepared slides.

CO2: Prepare and apply standard cytological stains such as Eosin, Methylene Blue, Hematoxylin, and Giemsa, and evaluate their effectiveness in diagnostic applications.

CO3: Demonstrate proficiency in tissue processing and microtomy techniques for the preparation of permanent histological slides.

CO4: Perform and interpret essential hematological procedures including blood cross-matching, bleeding time, and clotting time for transfusion compatibility and bleeding disorders.

CO5: Recognize various cytological specimens and understand their diagnostic significance in cytopathology and cancer screening.

CO6: Estimate and analyze clinical biochemistry parameters such as total protein, albumin, globulin, liver enzymes (ALT, AST), bilirubin, cholesterol, and triglycerides using standardized assays.

CO7: Culture and identify bacteria using differential media and biochemical tests, and understand their clinical relevance in diagnostic microbiology.

CO8: Describe the principles and procedures of biopsy and autopsy, including the types, techniques, and importance in disease diagnosis and postmortem studies.

Detailed Syllabus:

Sr. No.	Title of the Practical	Practical Allotted
1.	To study microscopic examination of acute and chronic inflammation. (D)	1P
2.	Preparation of stains used in cytology - eosin, methylene blue, haematoxylin, giemsa. (E) (Compulsory)	1P
3.	Prepare permanent slide of tissues by using microtomy. (E) (Compulsory)	3P
4.	Microscopic examination of stained tissue slides. (E)	1P
5.	To perform bleeding & clotting time from different blood samples. (E) (Compulsory)	1P
6.	To study the different types of cytological specimens used in cytopathology. (D)	1P
7.	Estimation of total proteins by Biuret method and estimation of serum albumin & serum globulin. (E) (Compulsory)	2P
8.	To perform assays for liver enzymes (e. g. ALT, AST) and bilirubin.	2P
9.	Measurement of cholesterol and triglyceride levels. (E)	2P
10.	To culture and identify bacteria using various media and biochemical tests. (E)	2P
11.	To study the types of cancer & common techniques used in cancer cytology. (D)	1P
12.	To study the steps in autopsy. (D)	1P
13.	To study the types and steps of biopsy. (D)	1P

ZOO - 272 - MJP: Practicals in Crab Culture (P)						
Year: II				Semester: IV		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Practical Per week	Internal Assessment	Semester End Exam	Total
VSC	02	60	01	15	35	50

Course Outcomes:

After completion of this course, students should be able to :

CO1: Identify and differentiate key morphological features of commercially important crab species like *Scylla* sp. and perform sex differentiation and grading techniques.

CO2: Demonstrate safe and effective methods for handling and transporting live crabs under aquaculture conditions.

CO3: Apply techniques for brood stock collection, maintenance, and induced breeding in crab hatcheries, including setup and larval rearing operations.

CO4: Compare and implement different grow-out systems (pond, pen, box) for crabs and assess the effectiveness of monoculture vs. polyculture practices.

CO5: Formulate appropriate crab feeds and apply scientifically guided feeding practices for optimal growth and health.

CO6: Identify common crab diseases, describe their symptoms, and apply effective disease prevention and control strategies.

Detailed Syllabus:

Sr. No.	Title of the Practical	Practical Allotted
1.	To study the anatomy and physiology of mud crab, <i>Scylla</i> sp. (D) (Compulsory)	1P
2.	To study the handling and transportation methods of mud crab, <i>Scylla</i> sp. (D) (Compulsory)	1P
3.	Making of a hatchery setup and collection of larvae. (E) (Compulsory)	3P
4.	Rearing of crab larvae in pond / tank. (E)	2P
5.	Determine the nutritional requirements of crabs - growing larva and adult. (D)	2P
6.	Monitoring and management of adult crab health. (E) (Compulsory)	2P
7.	Collection and analysis of crab growth data - survival and water quality. (D)	2P
8.	Monitoring water quality parameters of the crab culture and adjustment - Measure pH, temperature, salinity, and dissolved oxygen levels. (D)	2P
9.	Monitoring and control of crab diseases. (D)	1P
10.	Study of Economic importance of Crab culture. (D)	1P

OE - 251 – ZOO – P : Practicals in Advanced Sericulture Technology (P) आधुनिक रेशीम लघु उद्योग (P)						
Year: II				Semester: IV		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Practical per week	Internal Assessment	Semester End Exam	Total
GE / OE	02	60	01	15	35	50

Course Outcomes:

After completion of this course, students should be able to :

CO1: To learn the rearing technique of silkworms for entrepreneurship.

CO2: To learn the complete life cycle of silkworm in practice.

CO3: To learn different types of diseases and the causes of diseases in silkworms and take measures accordingly.

CO4: To identify different sericulture products and their outcome.

CO5: Identify the enemies and damages caused by them.

CO6: Understand the sericulture industries across the States in India

CO7: Explore the knowledge about appliances in sericulture.

CO8: Experience the silk farming practices.

Detailed Syllabus:

Sr. No.	Title of the Practical	Practical Allotted
1.	Study of external morphology and life cycle of different silkworms. (D)	2P
2.	Study of digestive system and silk gland in silkworm. (D)	2P
3.	Study of silkworm enemies, nature of damage and their control measures. (D)	2P
4.	Study of various diseases of silkworm and their control measures - Grasserie, Flacherie, Muscardine and Pebrine. (D)	2P
5.	Preparation of a map showing distribution of silk moth and rearing / sericulture practices in India. (E)	2P
6.	Study of any five rearing appliances in sericulture. (E) (Compulsory)	2P
7.	Estimation of cocoon quality parameters - cocoon weight, shell weight, shell ratio, and filament length from different types of silk cocoons - Mulberry, Tassar, Eri, Muga. (D)	1P

8.	To study the mounting methods of mature silkworms for spinning and harvesting of cocoons. (D)	1P
9.	Compulsory submission of photographs / sketches of mulberry, tassari, eri and muga silk moths. (E) (Compulsory)	1P
10.	Compulsory field visit to sericulture institute / industry / silk farm, report writing and submission.	3P

OE - 252 – ZOO – P : Practicals in Crab Culture Management (P)**खेकडे पालन आणि व्यवस्थापन (P)**

Year: II

Semester: IV

Teaching Scheme**Evaluation Scheme**

Course Type	Credits	Number of Teaching hours	Practical per week	Internal Assessment	Semester End Exam	Total
GE / OE	02	60	01	15	35	50

Course Outcomes:**After completion of this course, students should be able to :**

CO1: Identify and differentiate key morphological features of commercially important crab species like *Scylla* sp. and perform sex differentiation and grading techniques.

CO2: Demonstrate safe and effective methods for handling and transporting live crabs under aquaculture conditions.

CO3: Apply techniques for brood stock collection, maintenance, and induced breeding in crab hatcheries, including setup and larval rearing operations.

CO4: Compare and implement different grow-out systems - pond, pen, box for crabs and assess the effectiveness of monoculture vs. polyculture practices.

CO5: Formulate appropriate crab feeds and apply scientifically guided feeding practices for optimal growth and health.

CO6: Identify common crab diseases, describe their symptoms, and apply effective disease prevention and control strategies.

Detailed Syllabus :

Sr. No.	Title of the Practical	Practical Allotted
1.	Study of morphological identification of mud crab <i>Scylla</i> sp. and other commercial species. (D) (Compulsory)	1P

2.	Sex differentiation and grading of crabs. (D)	1P
3.	Making of a hatchery setup and collection and rearing of larva. (E) (Compulsory)	3P
4.	Study of grow-out systems and feeding - pond, pen, and box culture methods, Monoculture vs. polyculture systems. (D)	2P
5.	Study of feeding of growing larva and adult crabs. (D)	2P
6.	Monitoring water quality parameters of the crab culture and adjustment - measure pH, temperature, salinity, and dissolved oxygen levels. (D)	2P
7.	Study of disease management and harvesting - common diseases and their control measures. (D)	2P
8.	Study of harvesting methods and post-harvest handling. (D)	1P
9.	Study of handling, transportation methods and marketing management. (D)	2P
10.	Preparation of a Detailed Project Report (DPR). (D) (Compulsory)	2P

ZOO – 281 – CEP : Community Engagement Program (P)						
Year: II				Semester: IV		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Practical per week	Internal Assessment	Semester End Exam	Total
FP / OJT / CEP	02	60	01	15	35	50

The National Education Policy (NEP) 2020 strongly advocates integrating community-based learning in higher education to foster social responsibility, ethical awareness, and real-world relevance of academic disciplines. Introducing CEP in the S. Y. B. Sc. Zoology syllabus aligns perfectly with these goals.

1. **Bridges Science and Society:** Encourages students to apply Zoological knowledge to real-life societal and ecological issues.
2. **Promotes Environmental & Social Awareness:** Addresses local biodiversity loss, waste management, zoonotic diseases, conservation awareness, etc.
3. **Experiential & Contextual Learning:** Students learn by doing - interacting with communities, conducting outreach, and seeing the impact of their work.
4. **Ethical & Value-based Education:** Builds empathy, civic sense, responsibility, and environmental stewardship - core goals of NEP 2020.

5. **Interdisciplinary and Holistic Development:** Encourage integration of Zoology with public health, sociology, environment, and policy-making.
6. **Fosters 21st Century Skills:** Develops communication, problem-solving, leadership, teamwork, and project management skills.
7. **Local Relevance:** Allows students to work on issues affecting their own communities - such as human - animal conflicts, sanitation, or vermicomposting etc..

Course Outcomes:

After completion of this course, students should be able to :

CO1: Identify and understand community-level biological and environmental issues such as animal welfare, waste management, or vector-borne diseases.

CO2: Plan and participate in outreach or awareness activities related to biodiversity conservation, zoonotic diseases, or eco-friendly practices.

CO3: Demonstrate ability to communicate Zoological knowledge to non-scientific audiences through charts, talks, street plays, or demonstrations.

CO4: Engage with local communities, ethically and respectfully while gathering or sharing biological and environmental data.

CO5: Apply Zoological concepts in designing small-scale community solutions, e.g. compost pits, bird feeders, mosquito control.

CO6: Reflect on personal growth and social responsibility through self-assessment, diaries, or community feedback.

CO7: Work collaboratively in team-based service-learning projects and manage roles effectively.

CO8: Document and present community service outcomes in the form of reports, presentations, or exhibitions.

Programme Report:

Programme report should be typed on A4 sheets, Font Times New Roman, Font Size 12, one and a half spacing on executive bond paper. The programme report shall have appropriate chapter scheme and be presented with minimum 20 pages.

Programme report arrangement :

- 1) Title Page
- 2) Certificate by the department
- 3) Certificate by the Guide

- 4) Student's Declaration
- 5) Acknowledgement
- 6) Index
- 7) Abstract : (200-300 words)
- 8) Table of contents :
- 9) Content :
 - Chapter - 1: Introduction
 - Chapter - 2: Methodology
 - Chapter - 3: Result, Observations and Analysis
 - Chapter - 4: Discussion, Conclusion and Recommendations if any

Evaluation Pattern :

Evaluation of the CEP involves two key components:

- a) Internal Evaluation (30%) : By the Guide (Marks 15).
- b) External Evaluation (70%) : By Internal and External Examiners (Marks 35).

SEC - 251 - ZOO: Practicals in Sericulture (P)						
Year: II				Semester: IV		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Practical per week	Internal Assessment	Semester End Exam	Total
SEC	02	60	01	15	35	50

Course Outcomes:

After completion of this course, students should be able to :

- CO1: To learn the rearing technique of silkworms for entrepreneurship.
- CO2: To learn the complete life cycle of silkworm in practice.
- CO3: To learn different types of diseases and the causes of diseases in silkworms and take measures accordingly.
- CO4: To Identify different sericulture products and their outcome.
- CO5: Identify the enemies and damages caused by them.
- CO6: Understand the sericulture industries across the States in India
- CO7: Explore the knowledge about appliances in sericulture.
- CO8: Experience the silk farming practices.

Detailed Syllabus:

Sr. No.	Title of the Practical	Practical Allotted
1.	Study of external morphology and life cycle of different silkworms. (D)	2P
2.	Study of digestive system and silk gland in silkworm. (D)	2P
3.	Study of silkworm enemies, nature of damage and their control measures. (D)	2P
4.	Study of various diseases of silkworms and their control measures - grasserie, flacherie, muscardine and pebrine. (D)	2P
5.	Preparation of a map showing distribution of silk moth and rearing / sericulture practices in India. (D) (Compulsory)	2P
6.	Study of any five rearing appliances in sericulture. (E) (Compulsory)	2P
7.	Estimation of cocoon quality parameters - cocoon weight, shell weight, shell ratio, and filament length from different types of silk cocoons (Mulberry, Tassar, Eri, Muga). (D)	1P
8.	To study methods of mounting mature silkworms for spinning and harvesting of cocoons. (D)	1P
9.	Identification and importance of <i>Morus alba</i> (Mulberry), Arjun, Castor, Tapioca, etc. (D)	1P
10.	Planning of crop cycles, disinfection schedule, larval stage timing, and harvesting period. (D)	1P
11.	Compulsory submission of photographs / sketches of Mulberry, Tassar, Eri and Muga silk moths. (D) (Compulsory)	1P
12.	Compulsory field visit to sericulture institute / industry / silk farm, report writing and submission. (E)	3P

SEC - 251 - ZOO: Practicals in Aquarium Management (P)						
Year: II				Semester: IV		
Teaching Scheme				Evaluation Scheme		
Course Type	Credits	Number of Teaching hours	Practical per week	Internal Assessment	Semester End Exam	Total
SEC	02	60	01	15	35	50

Course Outcomes:

After the completion of the course, students should be able to:

CO1: Identify and differentiate various types of aquaria like glass, acrylic, planted, marine, nano tanks and their suitable applications in ornamental fish keeping.

CO2: Demonstrate knowledge and practical skills in the use of aquarium accessories such as filters, aerators, heaters, lighting systems, and chillers for optimal aquarium conditions.

CO3: Classify and compare exotic and indigenous species of ornamental fishes and identify sexual dimorphism in selected species.

CO4: Apply appropriate handling and transportation techniques for ornamental fishes, ensuring minimal stress and mortality.

CO5: Design and construct aquarium layouts incorporating aqua scaping principles, and perform regular setup and maintenance procedures.

CO6: Monitor and analyze physical and chemical water parameters critical for the health and breeding of aquarium fish.

CO7: Diagnose common fish diseases through microscopic and symptomatic study, and recommend suitable treatment protocols.

CO8: Evaluate live feed culture techniques and observe natural and induced breeding behaviours in ornamental fishes through hands-on demonstrations and field visits.

Detailed Syllabus:

Sr. No.	Title of the Practical	Practical Allotted
1.	Study of different types of aquaria - glass, acrylic, planted, marine, nano tanks. (D)	1P
2.	Study of aquarium accessories - filters, aerators, heaters, lighting, chillers etc. (D)	1P
3.	Study of indigenous and exotic species of ornamental fishes. (D)	1P
4.	Study of sexual dimorphism in common aquarium fish species - Any 2.	1P
5.	Study of various fish handling techniques for routine check-up and transportation. (E)	1P
6.	Preparation of aquarium layout - designing aquascapes and structural setup. (E) (Compulsory)	1P
7.	Measurement of physical water parameters relevant to aquarium fish culture. (E) (Compulsory)	1P

8.	Analysis of chemical water parameters in aquarium systems. (E)	1P
9.	Study of live fish feeding organisms and their culture techniques.	1P
10.	Study of factors affecting fish mortality during transportation.	1P
11.	Demonstration of freshwater aquarium setup and routine maintenance procedures. (D) (Compulsory)	2P
12.	Study of cleaning tools and maintenance equipments for aquarium hygiene. (E) (Compulsory)	1P
13.	Microscopic study of parasitic and protozoan infections in aquarium fishes. (D)	1P
14.	Study of symptoms and treatment methods for common bacterial, viral, and fungal fish diseases. (D)	1P
15.	Demonstration of natural and induced breeding techniques in aquarium fishes. (D)	2P
16.	Observation of courtship and spawning behavior in ornamental fishes. (D)	1P
17.	Compulsory visit to an Aquarium / Fishery center / Irrigation dam / nearby waterbody and submission of report. (E)	3P

END OF THE SEMESTER - IV