NEP PG

1-YEAR CURRICULUM

M.Sc. ZOOLOGY PROGRAMME

SUBJECT CODE = ZOO

FOR POSTGRADUATE COURSES UNDER RANCHI UNIVERSITY, RANCHI

Implemented w.e.f.
Academic Session 2026-27 Onwards

Members of the Board of Studies of NEP PG Syllabus of Zoology
As per Guidelines of the Ranchi University, Ranchi

Chairperson

Dr. Nayni Saxena
Associate Professor, University Department of Zoology, RU

13.08.25
Head
University Department of Zoology
Ranchi University, Ranchi

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Subject Experts:

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   Former Head, University Department of Zoology, Ranchi University, Ranchi
2. **Dr. Sajalendu Ghosh**
   Head, Department of Zoology, Dr. Shyama Prasad Mukherjee University, Ranchi
3. **Dr. Rāja Kishore Mishra**
   Assistant Professor, Department of Life Sciences, Central University of Jharkhand, Ranchi

Alumnus Member:

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Additional Secretary cum Director
Technical Education, Higher & Technical Education Department,
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Chairperson
Head
University Department of Zoology
Ranchi University, Ranchi

Approval by the Members of the NEP Implementation and Monitoring Committee of Ranchi University, Ranchi

The Curriculum of Bachelor's Degree (Honours)/ (Honours with Research) has been approved by the NEP Implementation and Monitoring Committee of R.U., duly forwarded by the Head of the Department; it will be offered to the students of the 4-year Undergraduate Programme (FYUGP). It is implemented from the 1st Semester of the Academic Session 2025-26 and onwards.

10/9/25 10/09/25 10/9/2025

Anuchhka Rani 10/09/2025 10/09/25 10/9/25

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Member Secretory

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HIGHLIGHTS OF NEP PG CURRICULUM

CREDIT OF COURSES

The term 'credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. The workload relating to a course is measured in terms of credit hours. It determines the number of hours of instruction required per week over a semester (minimum 15 weeks).

a) One hour of teaching/ Lectures or two hours of laboratory /practical work will be assigned per class/interaction.
One credit for Theory = 15 Hours of Teaching
One credit for Practicum = 30 Hours of Practical work
One credit for Internship = 02 Weeks of Practical experience

b) For credit determination, instruction is divided into three major components:
Hours (L) – Classroom Hours of one hour duration.
Tutorials (T) – Special, elaborate instructions on specific topics of one hour duration
Practical (P) – Laboratory or field exercises in which the student has to do experiments or other practical work of a two-hour duration.

Internship – For the Exit option after 1st year of the 2-year P.G. Programme for the award of P.G. Diploma, Level 6.5, Students can either complete two 4-week internships worth 2 credits each or one 8-week internship for all 4 credits. This practical experience connects academic learning with real-world applications, offering valuable exposure to professional environments in their fields of study

PG CURRICULUM

1. The PG Curriculum will be either of 1-year duration for students who studied the four-year UG Programme (FYUGP) or a 2-year duration for students who studied a three-year UG programme from a CBCS/LOCF/FYUGP Curriculum.
2. There is a flexible mode in the PG programme offered to the students of Ranchi University, Ranchi. The total credit for any semester will be 20 credits.
3. **Two-year PG curriculum:** The First year of the PG curriculum offers coursework only. There will be 3 courses at level 400 and 2 courses at level 500 in the first and the second semesters of any 2-year PG programme.
4. **One-year PG curriculum:** The Courses in the 1-year PG programme and the second year of the 2-year PG programme are the same.
   a. **Course work only**: There will be 5 courses at level 500 of 4 credits each in every semester for the coursework offered in the programme.
   b. **Course work and Research**: There will be 5 courses at the level 500 bearing 4 credits each in the first semester of a 1-year PG or in the third semester of a 2-year PG. Research work will be offered in the next semester for this mode of the programme. The eligibility for this mode is available in the NEP PG curriculum of Ranchi University, Ranchi.
   c. **Research work only**: The eligible student will be offered this mode to conduct extensive research under the supervision of a guide. Each semester will be equivalent to 20 credits. The selection of a candidate for the research mode will depend upon the eligibility of the student, availability of the guide and seat in the department/institution of Ranchi University, Ranchi.

PROMOTION CRITERIA

One Year Post-graduation programme having coursework only:

i. Each course shall be of **100 marks** having two components: **30 marks for Sessional Internal Assessment (SIA), conducted by the Department/College and 70 marks shall be assigned to the End Semester University Examination (ESUE), conducted by the University**.
ii. The marks of SIA shall further break into, 20 for Internal Written Examinations, 05 for Written Assignment/ Seminar presentation and 05 for overall performance of a student including regularity in the classroom lectures and other activities of the Department/College.

iii. The Requisite Marks obtained by a student in a particular subject will be the criterion for promotion to the next Semester.

iv. There shall be two written internal examinations, each of 1 hour duration and each of 20 marks, in a semester, out of which the '**Better One out of Two**' shall be taken for computation of marks under SIA.

v. If a student failed to secure pass marks in the Mid Semester, he/she has to reappear in Mid & End Semester Examinations.

vi. In case a student fails to secure pass marks in End Semester Examination, then he/she has to appear only in the End Semester Examination of the following session within the period of Upper Limit of Two Years and the Marks of the Mid Semester will be carried for the preparation of the result.

vii. Students' final marks and the result will be based on the marks obtained in the Mid Semester and End Semester Examination taken together.

viii. The pass marks in the programme will be 45% of the total marks obtained in each Core/ Elective/ Other Courses offered.

ix. In absolute terms of marks obtained in a course, **a minimum of 28 marks is essential in the ESUE** and **a minimum of 17 marks is to be secured in the SIA** to clear the course. In other words, a student shall have to pass separately in the ESUE and in the SIA by securing the minimum marks prescribed here.

x. Every candidate seeking to appear in the ESUE shall be issued an Admit Card by the University. **No candidate will be permitted to appear in the examination without a valid admit card.**

xi. A candidate shall be permitted to proceed in the next Semester (2^{nd}), **provided he/she has passed at least 3 courses out of 5 courses** in the respective semester in theory and practical/ project courses taken together.

xii. A student will have to clear all his papers within a maximum of Two Years of duration to qualify for the degree.

However, it will be necessary to procure pass marks in each of the papers before completion of the programme.

VALUE ADDED COURSES

1. The Value-added course will be of **2 credits** to be covered during the first semester.
2. There will be objective-type questions asked in the End Semester University Examination (ESUE).
3. There will be an OMR-based examination and the correct answer is to be marked by a black ballpoint pen only on the OMR sheet provided by the University.
4. For **50 Marks Examination,** the student will be provided **two hours** for marking their responses.
5. Students are not allowed to choose or repeat courses already undergone at the undergraduate level in the proposed major and minor streams.
6. The performance in this course will not influence the SGPA or CGPA of the PG Programme where the student is registered to obtain the Master's Degree. However, it will be mandatory to secure minimum pass marks in the course before exiting from the PG Programme.
7. If the student fails to secure the minimum pass marks in the Value-added course in the first semester, he may appear in the examination of the said course with the following batch of the next session.
8. The student may appear in the examination of the said course further if they could not clear the course in the following attempt, subject to the date of validation of the Registration.

The Regulations related to any concern not mentioned above shall be guided by the existing Regulations of the PG Curriculum of Ranchi University, Ranchi.

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COURSE STRUCTURE FOR **'PG DIPLOMA/ COURSEWORK ONLY/ COURSEWORK WITH RESEARCH/ RESEARCH ONLY'**

Table 1: Credit Framework for One Year Postgraduate Programme (PG) [Total Credits = 80]

Academic Level	**Level of Courses**	**Semester**	**Coursework** Level 400	**Coursework** Level 500	**Research Preparedness**	**Research thesis/ Project/ Patent**	**Total Credits**
YEAR 1							
Level 6.5	**Coursework**	**III**	**---**	**4+4+4+4+4**	**---**	**---**	**20**
		IV	**---**	**4+4+4+4+4**	**---**	**---**	**20**
OR							
Level 6.5	**Coursework + Research**	**III**	**---**	**4+4+4+4+4**	**---**	**---**	**20**
		IV	**---**	**---**	**20**		**20**
OR							
Level 6.5	**Research**	**III**	**---**	**---**	**20**	**---**	**20**
		IV	**---**	**---**	**---**	**20**	**20**
Total credits of P.G. Programme = **80**							

Note: **There is no 'Exit' allowed in the One-year PG Curriculum**.

AIMS OF MASTER'S DEGREE PROGRAMME IN ZOOLOGY

The aim of the Master's degree programme in Zoology is to provide:

The aim of the Master's degree programme in Zoology is to provide advanced and comprehensive knowledge of animal biology, integrating structural, functional, developmental, ecological, and evolutionary perspectives. The programme is designed to develop a deep understanding of biodiversity, the interrelationships among organisms, and their adaptations to diverse environments. It seeks to equip students with both theoretical insights and practical skills in taxonomy, anatomy, physiology, genetics, molecular biology, ecology, conservation, and applied zoology. Through laboratory work, field studies, and research projects, the programme fosters scientific inquiry, critical thinking, and analytical skills. A key objective is to prepare students for careers in research, education, environmental management, aquaculture, wildlife conservation, and related applied sectors, while also enabling them to pursue higher studies and contribute to addressing contemporary biological and environmental challenges. Ultimately, the programme aims to nurture professionals with scientific competence, ethical responsibility, and a commitment to the sustainable management of animal resources.

PROGRAMME LEARNING OUTCOMES

The broad aims of Master's degree programme in Zoology are:

(a) Academic Aim:

The Master's degree programme in Zoology aims to provide students with an in-depth understanding of animal biology, spanning molecular, cellular, physiological, developmental, ecological, and evolutionary perspectives. The curriculum is designed to strengthen foundational knowledge while integrating advanced concepts, enabling students to critically analyze biological phenomena. It emphasizes interdisciplinary learning, linking traditional zoological studies with modern scientific approaches such as molecular genetics, biostatistics, and environmental management. By engaging with both theoretical and practical components, students develop analytical skills, scientific literacy, and a comprehensive grasp of biodiversity, preparing them for academia, industry, and competitive examinations.

(b) Research Aim:

The programme seeks to cultivate a strong research aptitude by training students in scientific inquiry, experimental design, data analysis, and interpretation. Through exposure to diverse research methodologies in fields such as toxicology, histology, reproductive physiology, developmental biology, and applied zoology (including fisheries and sericulture), students gain hands-on experience in laboratory and field-based studies. The focus is on developing problem-solving abilities, critical thinking, and innovation to address contemporary biological challenges. By fostering originality, ethical scientific practices, and effective communication skills, the programme prepares graduates to contribute to cutting-edge research, environmental conservation, and sustainable development.

The Courses in One Year P.G. Programme and in the Second year of Two years P.G. Programme are Common.

Table 2: Semester-wise Course Code and Credit Points

Sem	Core, AE/ GE/ DC/ EC & Compulsory FC Courses				Examination Structure		
	Paper	**Paper Code**	**Credit**	**Name of Paper**	**Mid Semester Evaluation (F.M.)**	**End Semester Evaluation (F.M.)**	**End Semester Practical/ Viva (F.M.)**
I	Core Course	ECZOO301	4	IKS & Human Physiology	30	70	----
	Skill Enhancement Course	CCZOO302	4	A. Fisheries B. Sericulture	30	70	----
	Core Course	CCZOO303	4	Reproductive Physiology and Developmental Biology	30	70	----
	Core Course	CCZOO304	4	Non-Chordates	30	70	----
	Practicals on Core	CPZOO305	4	Practical-III	----	----	100
II	Elective	ECZOO401	4	A. Fish and Fisheries-I B. Entomology-I C. Ecology-I	30	70	----
	Elective	ECZOO402	4	A. Fish and Fisheries-II B. Entomology-II C. Ecology-II	30	70	----
	Core Course	CCZOO403	4	Histology and Histochemistry	30	70	----
	Practicals on Elective	EPZOO404	4	A. Practical – IV A B. Practical – IV B C. Practical – IV C	----	----	100
	PROJECT	PRZOO405	4	Dissertation/ Project/ Teaching Aptitude	----	----	100

Note: There is no 'Exit' allowed in the One-year PG Curriculum.

INSTRUCTION TO QUESTION SETTER

SEMESTER INTERNAL EXAMINATION (SIE):

There **Marks Weightage of a Course:** Each non-practical/non-project course shall be of **100 marks** having two components: **70 marks shall be assigned to the End Semester University Examination (ESUE), conducted by the University, and, 30 marks for Sessional Internal Assessment (SIA), conducted by the Department/College**.

The marks of SIA shall further break into, 20 for Internal Written Examinations, 05 for Written Assignment/ Seminar presentation and 05 for overall performance of a student including regularity in the class room Lectures and other activities of the Department/College. There shall be two written internal examinations, each of 1-hour duration and each of 20 marks, in a semester out of which the **'Better One out of Two'** shall be taken for computation of marks under SIA.

In absolute terms of marks obtained in a course, **a minimum of 28 marks is essential in the ESUE and a minimum of 17 marks is to be secured in the SIA to clear the course**. In other words, a student shall have to pass separately in the ESUE and in the SIA by securing the minimum marks prescribed here.

A. (SIE 20+5=25 marks):

There will be a uniform pattern of questions for mid-semester examinations in all the courses and of all the programmes. There will be **two** groups of questions in 20 marks written examinations. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered. Department may conduct Sessional Internal Examinations in other format as per needs of the course.

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 20 Marks, (b) Class Attendance Score (CAS) of 5 marks.

Conversion of Attendance into score may be as follows:

Attendance Upto 45%, 1mark; 45<Attd.<55, 2 marks; 55<Attd.<65, 3 marks; 65<Attd.<75, 4 marks; 75<Attd, 5 marks.

END SEMESTER UNIVERSITY EXAMINATION (ESUE):

A. (ESUE 70 marks):

There will be a uniform pattern of questions for all the courses and all the programmes. There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short-answer type** consisting of five questions of 1 mark each. **Question No.2 will be a short-answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered. The questions will be so framed that examinee could answer them within the stipulated time.

[**Note:** There may be subdivisions in each question asked in Theory Examinations]

B. (ESUE 100 marks):

Practical/ Project courses would also be of 100 marks but there **shall be no internal written examinations** of the type specified above. The total 100 marks will have two components: **70 marks for the practical ESUE and 20 marks for the Viva-voce examination** conducted during the ESUE to assess the applied and practical understanding of the student.

The written component of the project (**Project Report**) shall be of **70 marks and 20 marks will be for the Viva-voce examination** jointly conducted by an external examiner, appointed by the University, and the internal supervisor/ guide.

10 marks will be assigned on the cumulative assessment of the examinee during the semester and will be awarded by the department/faculty concerned.

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FORMAT OF QUESTION PAPER FOR MID/ END SEMESTER EXAMINATIONS

Question format for **20 Marks**:

Subject/ Code

F.M. =20 **Time**=1Hr. Exam Year

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]

Group B

3. ..... [10]
4. ..... [10]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **70 Marks**:

Subject/ Code

F.M. =70 **Time**=3HrS. Exam Year

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]

Group B

3. ..... [15]
4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

SEMESTER I

I. CORE COURSE [CCZOO301]

IKS & HUMAN PHYSIOLOGY

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objective:

1. To explore classical and indigenous knowledge of plants in Indian traditions.
2. To apply IKS concepts in agriculture, herbal medicine, environmental conservation, and sustainable living.
3. To understand the structure and function of the human body systems at molecular, cellular, tissue, organ, and systemic levels, and to explain how these systems interact to maintain homeostasis under normal and altered physiological conditions.
4. To develop the ability to analyze physiological data, interpret experimental results, and apply core physiological principles to assess the effects of disease, exercise, and environmental changes on human body function.

Course Learning Outcomes:

After completing this course, students will be able to:

1. Identify and interpret key IKS-based Zoological knowledge. Translate IKS concepts into real-world solutions in agriculture, health, and conservation. Students will be able to describe and explain the physiological functions of major human organ systems (e.g., nervous, circulatory, respiratory, digestive) and their roles in maintaining homeostasis.
2. Students will be able to analyze and interpret physiological data, demonstrating the ability to connect theoretical knowledge with experimental observations in laboratory or clinical settings.

Course Content:

PART-A: IKS

UNIT I: Introduction to Indian Knowledge Systems (5 Lectures)

1. Concept, definition, and scope of IKS; importance in the global context
2. Overview of IKS related to natural sciences (botany, zoology, ecology)
3. Historical sources of zoological knowledge: oral traditions, manuscripts, inscriptions
4. Role of local knowledge holders (tribal elders, farmers, traditional healers)

UNIT II: Zoological Knowledge in Ancient Indian Texts (5 Lectures)

1. Animal references in the Vedas and Upanishads (symbolism, rituals, ecological insights)
2. Arthashastra's contributions: wildlife management, elephant capture, fisheries, animal laws
3. Ayurvedic texts: animal products in medicine, animal physiology, understanding
4. Zoological themes in Jataka tales, Panchatantra, and Puranic stories (behavioral insights)
5. Case study: Nāgashastra (serpent knowledge) in Indian tradition
6. Debate: separating myth from ethnozoological facts

UNIT III: Indigenous Taxonomy and Ethnozoology (5 Lectures)

1. How indigenous communities classify animals: folk taxonomy vs. Linnaean system
2. Ethnozoological practices: knowledge of local fauna by tribes and rural people
3. Fish classification and folk knowledge in coastal and inland fishing communities
4. Indigenous insect knowledge: bees, silkworms, lac insects

UNIT IV: Traditional Practices and Animal Use (5 Lectures)

1. Traditional animal husbandry and breeding practices (cattle, buffalo, goats, poultry)
2. Ethno-veterinary medicine: herbal treatments, disease management
3. Traditional pest control, use of natural enemies, biocontrol methods
4. Pedigree analysis of the marriage system in Mithila (Sourasthra Sabha)

UNIT V: Conservation, Ethics, and Integration with Modern Zoology (5 Lectures)

1. Sacred groves, totem animals, and conservation ethics in traditional societies
2. Cultural taboos and their role in species protection. Sacred water bodies and aquatic biodiversity conservation
3. Integrating IKS with modern wildlife management and policy
4. Challenges: documentation, intellectual property rights, biopiracy, ethical concerns
5. Case study: Involving local communities in conservation projects (successes and failures)
6. Course review, student presentations, open discussion

PART-B: HUMAN PHYSIOLOGY

UNIT I: Blood and circulation: (7 Lectures)

1. Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation,
2. Blood groups, haemoglobin, immunity, homeostasis
3. Diseases – Anaemia, Leukemia, Hemophilia, Deep Vein Thrombosis (DVT)

UNIT II: Cardiovascular System: (6 Lectures)

1. Comparative anatomy of heart structure, myogenic heart, specialized tissue,
2. ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above
3. Diseases – Hypertension, Myocardial Infarction

UNIT III: Respiratory system: (7 Lectures)

1. Comparison of respiration in different species, anatomical considerations,
2. Transport of respiratory gases,
3. Exchange of respiratory gases, waste elimination, neural and
4. Chemical regulation of respiration
5. Disease – Asthma, Chronic Obstructive Pulmonary Disease, COVID-19

UNIT IV: Excretory system: (6 Lectures)

1. Comparative physiology of excretion, kidney,
2. Urine formation, urine concentration, waste elimination, micturition, regulation of water balance,
3. Blood volume, blood pressure, electrolyte balance, and acid-base balance
4. Diseases – Kidney Stones (Renal Calculi), Chronic Kideny Disease (CKD)

UNIT V: Thermoregulation: (1 Lecture)

Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.

UNIT VI: Stress and adaptation (2 Lectures)

Disorders – Generalized Anxiety Disorder (GAD)

UNIT VII: Digestive system: (6 Lectures)

1. Digestion, absorption, and assimilation of digested food.
2. Energy balance, BMR.
3. Diseases- Gastritis, Irritable Bowel Syndrome (IBS)

Reading Resources:

Text Books:

1. Guyton, A. C., & Hall, J. E. (2021). *Guyton and Hall Textbook of Medical Physiology* (14th ed.). Elsevier.
2. Ganong, W. F., Barrett, K. E., Barman, S. M., Brooks, H. L., & Yuan, J. X.-J. (2020). *Ganong's Review of Medical Physiology* (26th ed.). McGraw Hill Education.

Reference Books:

IKS:

1. Gadgil, Ramakrishnan, Jain, and Saini focus on India's indigenous environmental and zoological knowledge.
2. Singh, R. H. (2007). *Ayurveda: The Science of Life*. Chaukhambha Surbharati Prakashan.
3. Vrikshayurveda by Surapala – Translated by Nalini Sadhale (Agri-History Foundation)
4. Dravyaguna Vigyana – P.V. Sharma (Vol. 1 & 2)
5. EthnoZoology: Principles and Applications – C.M. Cotton
6. Posey, D. A. (1999). *Cultural and Spiritual Values of Biodiversity*. United Nations Environment Programme & Intermediate Technology Publications.
7. Saini, D. C. (2020). *Ethnozoology of India: An Annotated Bibliography*. Indian National Science Academy (INSA).
8. The Sacred Groves of India – M.D. Subash Chandran
9. Biology in the Vedas – B.G. Matapurkar
10. Vedic Zoology – N. Sivarajan
11. Textbook of Pharmacognosy – Trease & Evans

Human Physiology:

1. Sherwood, L. (2015). *Human Physiology: From Cells to Systems* (9th ed.). Cengage Learning.
2. Tortora, G. J., & Derrickson, B. (2017). *Principles of Anatomy and Physiology* (15th ed.). Wiley.
3. Chatterjee, C. C. (2018). *Human Physiology: Volume 1 & 2* (13th ed.). CBS Publishers & Distributors Pvt. Ltd.
4. Sembulingam, K., & Sembulingam, P. (2019). *Essentials of Medical Physiology* (8th ed.). Jaypee Brothers Medical Publishers.
5. Vander, A. J., Sherman, J. H., & Luciano, D. S. (2014). *Human Physiology: The Mechanisms of Body Function* (13th ed.). McGraw Hill Education.
6. Bijlani, R. L. (2004). *Understanding Medical Physiology* (3rd ed.). Jaypee Brothers Medical Publishers.

II. SKILL ENHANCEMENT COURSE - A [ECZOO302A]
FISHERIES

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objectives

By the end of this course, learners will be able to:

1. Understand the taxonomy, biology, and physiological adaptations of inland and marine fin fishes with emphasis on economically important species.
2. Gain practical insights into aquaculture systems, fishery resources, fish health management, and processing technology.
3. Develop research aptitude through exposure to modern applications such as transgenic fish production, model fish systems, and ornamental fish culture.

Course Outcomes

After successful completion of this course, learners will be able to:

1. Identify and classify major taxa of freshwater and marine fin fishes of India up to the order level, recognizing key morphological features.
2. Describe the structure and function of major organ systems, physiological processes (including osmoregulation, respiration, and sensory mechanisms), and adaptations to diverse aquatic habitats.
3. Diagnose common fish diseases, suggest preventive and curative measures, and implement scientific fish health management practices.
4. Compare and evaluate various aquaculture systems (pond, pen, cage, biofloc, RAS) and apply principles to design sustainable fish culture operations.
5. Demonstrate understanding of fish preservation, processing, and by-product utilization, as well as research applications like transgenic fish and zebrafish models.

COURSE CONTENTS:

FISHERIES

UNIT I: Taxonomy of Fin Fish (08 Lectures)

1. Major taxa of inland and Marine fishes up to order.
2. Commercially important freshwater and marine fishes of India. Morphological characteristics.

UNIT II: Biology of Fin fish (10 Lectures)

1. A brief idea of the Circulatory, respiratory, Nervous, Urinogenital system, endocrine system, skeletal system and sensory system of fin fishes.

UNIT III: Physiology of Fin fish (10 Lectures)

2. Effects of environmental factors on the physiology of Fin fish.
3. Study of Osmoregulation, excretion and stress related changes, bioluminescence, electric organs
4. ARO (accessory respiratory organs)
5. Lateral line organ system

UNIT IV: Fish pathology and Health management (04 Lectures)

1. A brief idea of Fish parasites, diseases, and their treatment

UNIT V: Fish and Adaptation (04 Lectures)

1. Hill stream fishes
2. Cold-water fisheries of India. Fishing crafts and gears.

UNIT VI: Marine fishery (04 Lectures)

1. Marine fishery resources in India, Estuarine fishes.

UNIT VII: Aquaculture (10 Lectures)

1. Principles of Aquaculture: Definition and scope
2. Systems of Aquaculture – Pond culture, Pen culture, Cage culture, Biofloc culture, RAS
3. Extensive and intensive fish culture
4. Monoculture, Polyculture, Composite and integrated culture system, fish culture system of India.

UNIT VIII: Fish technology and research (10 Lectures)

1. Preservation and processing of harvested fish, fishery by-products, transgenic fish, and Zebra fish as a model of research. Introductory Ornamental fish culture and aquarium maintenance.

Reading Resources:

1. The Laboratory Fish (A Hand book of Experimental Animals) : Gary Ostrander
2. Fish feeding Experiments: T. Lovell
3. Laboratory Fish in Biomedical Research – Springer. Link
4. Laboratory Zebra Fish: Claudia Harper.
5. Eco-immunotoxic studies on a fish during Experimental plumbism (Pb) clarias batrachus: Dr. P.C. Rout
6. Fish of U.P. and Bihar: C.B.L. Srivastav
7. An Introduction to the Study of Fishes – Albert C.L.G. Gunther, Discovery Publishing House, New Delhi – 110 002
8. Q Bone and R Moore, Biology of Fishes, Talyor and Francis Group, CRC Press, U.K.
9. D.H. Evans and J.d. Claiborne, The Physiology of Fishes, Taylor and Francis Group, CRC Press, UK von der Emde, R.J. Mogdans and B.G. Kapoor. The Senses of Fish: Adaptations for the Reception of Natural Stimuli, Springer, Netherlands
10. C.B.L. Srivastava, Fish Biology, Narendra Publishing House
11. J.R. Norman, A history of Fishes, Hill and Wang Publishers
12. S.S. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House
13. Modern Ichthyology, S.M. Shafi, Inter India Publications
14. Feeding and Digestive Functions of Fishes, J.E.P. Cyrino, D.P. Bureau, B.G. Kapoor, CRC Press, Taylor & Francis Group, Boca Raton, London, New York

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OR SKILL ENHANCEMENT COURSE - B [ECZOO302B]

SERICULTURE

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	**Pass Marks: (MSE: 17 + ESE: 28) = 45**

(Credits: Theory-04, 60 Hours)

Course Objectives

By the end of this course, the learner will be able to:

1. Understand the historical background, biology, and diversity of silkworms with emphasis on their economic and cultural significance.
2. Acquire knowledge of silkworm rearing technology, pest and disease management, and mulberry cultivation for quality silk production.
3. Develop entrepreneurial insights into sericulture as a sustainable livelihood and commercial enterprise in India.

Course Outcomes

After successful completion of the course, the learner will be able to:

1. Identify exotic and indigenous silkworm races, describe their life cycle, silk gland structure, and chemistry of silk.
2. Apply scientific methods in mulberry cultivation, silkworm rearing, cocoon harvesting, and pest/disease control to maximize yield and quality.
3. Evaluate the economic potential of sericulture, design small-scale sericulture projects, and explore entrepreneurial opportunities in mulberry and non-mulberry silk production.

Course Content:

SERICULTURE

UNIT I: Introduction (6 Lectures)

1. Sericulture: Definition, history and present status; Silk route.
2. Types of silk worms
3. Distribution and Races- exotic and indigenous races.
4. Mulberry and non-mulberry Sericulture.

UNIT II: Biology of Silk worm (12 Lectures)

1. Life cycle of *Bombyx mori* and *Antheraea mylitta*
2. Structure of the silk gland and the secretion of silk
3. Chemistry of silk

UNIT III: Rearing of Silkworm (26 Lectures)

1. Selection of mulberry variety and establishment of mulberry garden
2. Rearing house and rearing appliances
3. Disinfectants: Formalin, bleaching powder, RKO
4. Silk worm rearing technology: Early age and Late age rearing
5. Types of Spinning, harvesting, and storage of cocoons mountages

UNIT IV: Pests and Diseases (10 Lectures)

1. Pests of silk worm: Uzifly, dermestid beetles, and vertebrates.
2. Pathogenesis of silk worm diseases: Protozoan, viral, fungal, and bacterial control and prevention of pests and diseases

UNIT V: Entrepreneurship in Sericulture (6 Lectures)

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

Reading Resources:

1. A Textbook of Sericulture, Hemraj, Vinesh Publication, India
2. Handbook of Practical Sericulture: S.R. Ullaland M.N. Narasimhanna CSB, Bangalore
3. Appropriate Sericultural Techniques; Ed. M.S. Jolly, Director, CSR & TI, Mysore.
4. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub.Co. Ltd., Tokyo, Japan 1972.
5. Manual of Silkworm Egg Production; M.N. Narasimhanna, CSB, Bangalore 1988.
6. Silkworm Rearing; Wupang —Chunand Chen Da-Chung, Pub. By FAO, Rome 1988.
7. A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989.
8. Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986

III. CORE COURSE [CCZOO303]
REPRODUCTIVE AND DEVELOPMENTAL BIOLOGY

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objective

1. To understand the structure, function, and hormonal regulation of the reproductive system, including gametogenesis, fertilization, pregnancy, and reproductive technologies in humans and animals.
2. To study the molecular and cellular mechanisms of embryonic development, from fertilization to organogenesis, using model organisms and focusing on gene regulation, differentiation, and developmental disorders.

Course Learning Outcomes

1. To describe the structure and functions of the male and female reproductive systems.
2. Explain the hormonal regulation of reproductive cycles and reproductive events.
3. Illustrate the processes of gametogenesis, fertilization, implantation, and parturition. Analyze the physiological basis of pregnancy, lactation, and menopause. Interpret causes of infertility and evaluate assisted reproductive technologies (ART).

Course Content:

PART-A: REPRODUCTIVE PHYSIOLOGY (30 Lectures)

UNIT I: Introduction to Reproductive Physiology:

Overview of reproduction: sexual vs. asexual, Historical and recent advances in reproductive biology, Comparative reproductive strategies in animals, Development and evolution of reproductive systems

UNIT II: Anatomy and Histology of Reproductive Organs:

Male reproductive system: testes, epididymis, vas deferens, seminal vesicles, prostate, penis.
Female reproductive system: ovaries, fallopian tubes, uterus, cervix, vagina.
Histology of gonads and accessory reproductive organs

UNIT III: Reproductive Cycles and Hormonal Regulation:

Estrous and menstrual cycles: phases, hormonal control, physiological changes, Puberty and menopause
Seasonality and photoperiodism in reproduction (in animals), Pregnancy recognition and maintenance
Placenta: structure, types, function, hormone secretion, Physiological changes in the maternal body during pregnancy, Mechanism of labour and parturition, Role of oxytocin and prostaglandins

UNIT IV: Lactation and Postpartum Physiology:

Development of mammary glands, Hormonal regulation of lactogenesis and galactopoiesis
Milk ejection reflex, Neuroendocrine control of lactation

UNIT V: Reproductive Health and Disorders:

Infertility: causes (male and female), diagnosis, treatment. Polycystic ovarian syndrome (PCOS), endometriosis, azoospermia, oligospermia. Sexually transmitted diseases (STDs). Hormonal contraceptives and family planning methods

UNIT VI: **Assisted Reproductive Technologies (ART):**

In vitro fertilization (IVF), ICSI, GIFT, ZIFT. Embryo transfer and cryopreservation. Preimplantation genetic diagnosis (PGD), Ethical issues, and regulations in ART

PART-B: DEVELOPMENTAL BIOLOGY (30 Lectures)

UNIT I: Basic concepts of development:

Potency, commitment, specification, induction (Eye lens induction), competence, determination, and differentiation.

Basic understanding of Paracrine, Juxtacrine, and Autocrine factors. Cell signaling transduction pathways – Wnt, Shh, Jak-Stat, TGF-beta superfamily, etc.

Morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in the analysis of development.

UNIT II: Gametogenesis, fertilization, and early development:

Production of gametes, Molecular signaling pathways in gonad development cell surface molecules in sperm-egg recognition in animals; embryo sac development.

Zygote formation, cleavage, blastula formation, embryonic fields, gastrulation, and formation of germ layers in animals; embryogenesis.

UNIT III: Morphogenesis and organogenesis in animals:

Cell aggregation and differentiation in *Dictyostelium.*

Axes and pattern formation in amphibia, and chick.

Organogenesis – vulva formation in *Caenorhabditis elegans.*

Limb development and regeneration in vertebrates.

Differentiation of neurons, muscle, post-embryonic development, larval formation, and metamorphosis.

Environmental regulation of normal development.

Sex determination.

Reading Resources:

Text Books:

1. Reproductive Physiology by H. H. Cole, H. H. Cole, Academic Press (Elsevier), London / New York (commonly Academic Press imprint)
2. Developmental Biology by Scott F. Gilbert (and Barresi in recent editions), Scott F. Gilbert (co-author Michael J.F. Barresi in later editions), Sinauer Associates (an imprint of Oxford University Press), Oxford / Sunderland, MA, USA

Reference Books:

1. Knobil & Neill's Physiology of Reproduction, Ernst Knobil & Jimmy D. Neill (plus numerous contributors; e.g. Tony M. Plant & Anthony J. Zeleznik in later editions), Academic Press (Elsevier Science & Technology Books), based in San Diego / Amsterdam / Boston
2. Human Reproductive Biology by Richard E. Jones & Kristin H. Lopez, Elsevier Academic Press, Amsterdam / Boston (hardcover ed. c. 2006; later editions through Academic Press / Elsevier)
3. Guyton & Hall's Textbook of Medical Physiology, John E. Hall (following Arthur C. Guyton's original editions), and Michael E. Hall in recent editions, Elsevier (Saunders / Elsevier Health Sciences), based in Philadelphia / St. Louis / United States
4. Ganong's Review of Medical Physiology, William F. Ganong, Kim E. Barrett, Susan M. Barman, Heddwen L. Brooks, Jason X.-J. Yuan (latest editions: 26th, 27th), McGraw-Hill Education (Medical), New York, USA

IV. CORE COURSE [CCZOO304]
NON-CHORDATES

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Learning Objective:

1. To understand functional anatomy and physiological processes of non-chordates.
2. To understand phylogeny of non-chordates.

Course Learning Outcomes:

On successful completion of this course the student will:

1. Be able to understand functional anatomy and physiological processes of non-chordates.
2. Be able to learn the concept of non-chordate phylogeny.

UNIT I: GENERAL ORGANIZATION OF NON-CHORDATES (14 Lectures)

General organization of digestive systems of Protostomes (Annelids, Arthropods, and Molluscs) and Deuterostomes (Echinoderms and Hemichordates)

Coelom

Organs and glands of the digestive system of:

- Annelids — Clamworm – Denticles or Paragnaths, Jaws
- Arthropods — Prawn: Buccal cavity, Cardiac and Pyloric stomach, Hepatopancreas
- Molluscs — *Pila*: Odontophore, Sub-radular organ, Radula, Oesophageal pouches, Cardiac and Pyloric chambers, Salivary gland, Hepatopancreas
- Echinoderms — Starfish: Cardiac and Pyloric stomach, Intestinal Caeca, Digestive glands
- Hemichordates — Balanoglossus: Buccal Diverticulum, Digestive Pharynx, Post-branchial canal, Hepatic and post-hepatic regions

General organization of excretory systems of Protostomes (Annelids, Arthropods and Molluscs) and Deuterostomes (Echinoderms and Hemichordates)

Excretory Systems with Special emphasis on the organs/structures or glands of:

- Annelids — Clamworm: Coiled Nephridia
- Arthropods — Prawn: Antennal glands or Green glands or Maxillary glands, Bladder, Renal sac
- Molluscs — *Pila*: Organ of Bojanus, anterior Renal chamber, posterior Renal chamber
- Echinoderms — Starfish: Water Vascular System, Coelomocytes, Intestinal caeca
- Hemichordate — Balanoglossus: Glomerulus or Proboscis glands

UNIT II: RESPIRATION AND CIRCULATION (14 Lectures)

General organization of respiratory systems of Protostomes (Annelids, Arthropods and Molluscs) and Deuterostomes (Echinoderms and Hemichordates)

Respiratory Systems with Special emphasis on the organs/structures or glands of:

- Annelids — Clamworm: Parapodia, Body wall
- Arthropods — Prawn: Branchiostegites, Branchiae, Epipodite
- Molluscs — *Pila*: Ctenidium, Pulmonary sac
- Echinoderms — Starfish: Dermal papulae, Tube Feet
- Hemichordates — *Balanoglossus*: Gill slits, Branchial sac, Gill pores

General organization of circulatory systems of Protostomes (Annelids, Arthropods, and Molluscs) and Deuterostomes (Echinoderms and Hemichordates)

- Annelids — Clamworm: Dorsal blood vessel, Ventral blood vessel, Transverse vessels
- Arthropods — Prawn: Heart and Blood lacunae
- Molluscs — Pila: Pericardium, Heart
- Echinoderms — Starfish: Perihaemal sinuses, Axial gland
- Hemichordates — Balanoglossus: Central Sinus (Heart), Dorsal vessel, Ventral vessel

UNIT III: NERVOUS SYSTEM, CHEMICAL CO-ORDINATION SYSTEM (14 Lectures)

General organization of Nervous systems& Chemical Co-ordination in Protostomes (Annelids, Arthropods and Molluscs) and Deuterostomes (Echinoderms and Hemichordates)

Nervous system & Chemical Co-ordination with special emphasis on the organs/structures or glands of:

- Annelids Clamworm: Corpora pedunculata, Giant fibre, Circumpharyngeal ganglion, Peristomal cirri, Nuchal organ, pigmented Retinal cells
- Arthropods Prawn: Brain, Circum-oesophageal commissure, Compound eyes, Chromatophore, Statocysts, Tactile setae, Olfactory setae, Proprioreceptors, Sinus gland X organ complex, Y organ
- Molluscs *Pila*: Cerebral Ganglia, Buccal Ganglia, Pleuro-pedal Ganglionic Mass, Supraintestinal Ganglion, Visceral Ganglion, Osphradium, Tentacles, Statocysts,
- Echinoderms Starfish: Ectoneural nervous system, Langer's nerve, Eyes, Terminal tentacles, Neurosecretory cells
- Hemichordates *Balanoglossus*: Epidermal Plexus, Preoral ciliary organ, Neurosecretory cells

General organization of reproductive systems in Protostomes (Annelids, Arthropods and Molluscs) and Deuterostomes (Echinoderms and Hemichordates)

UNIT IV: REPRODUCTIVE SYSTEMS WITH SPECIAL EMPHASIS ON THE ORGANS/STRUCTURES OR GLAND (14 Lectures)

- Annelids Clam worm: Gonads – Testes and Ovaries (Temporary)
- Arthropods Prawn: Male – Testes, Vasa deferentia, Vasiculae seminalis; Female – Ovaries, Oviducts
- Molluscs *Pila*: Male – Testes, Vasa efferentia, Vasa deferens, Vasicula seminalis, Hypobranchial glands; Female – Ovary, Oviduct, Receptaculum seminis, Uterus, Vagina, Hypobranchial gland
- Echinoderms Starfish: Male / Female gonads
- Hemichordates Balanoglossus: Saccular gonads

Unit IV: Phylogeny (4 Lectures)

Phylogenetic affinities of Annelida, Arthropoda, Mollusca

1. Phylogenetic relationships of the Trochophore larva
2. Similarities and differences between Annelids and Molluscs
3. Phylogeny of Arthropods – Monophyletic theory and polyphyletic theory

Reading Resources:

Test Books:

1. Invertebrates by Richard C. Brusca, Wendy Moore, Stephen M. Shuster.
2. Textbook of Zoology: Invertebrates Vol I 7/e by Haswell.

Reference Books:

Invertebrates –

1. Protozoa to Echinodermata, Ashok Verma, Publisher- Narosa Publishing House.
2. Invertebrate Zoology, E. L Jordan and P. S. Verma, Publisher: S. Chand and Company Ltd.
3. Invertebrate Zoology 3rd edition, Paul A. Meglitsch and Fredrick R. Schram, Publisher – Oxford University Press.
4. Introduction to General Zoology Vol. I & II, Korak Kanti Chaki, Gautam Kundu and Supriti Sarkar, New Central Book Agency (P) Ltd.
5. Medical Zoology and Prasitology, Singh S., Keshari S. & Abhishek K. S., Jharkhand Jharokha, India
6. Modern Text Book of Zoology: Invertebrates. R. L. Kotpal.
7. Invertebrate Zoology: A Functional Evolutionary Approach, Authors: Richard Fox, Robert D. Barnes, Edward E. Ruppert.
8. An Introduction to Mollusca by G. S. Sandhu and Harshvardhan Bhaskar, Campus Book International.
9. An Introduction to Echinodermata by G. S. Sandhu and Harshvardhan Bhaskar, Campus Book International.
10. Invertebrate Zoology by P. S. Dhami and J. K. Dhami.

I. CORE COURSE [CPZOO305]
PRACTICAL-III

Marks: 100 (ESE Pr: 6 Hrs) = 100	Pass Marks = 45

(Credits: Practical-04, 120 Hours)

Instructions to Question Setter for
Scheme of examinations **Time: 6 Hrs**

End Semester Examination (ESE):
There will be one Practical Examination of 3Lectures in duration. Evaluation of Practical Examination may be as per the following guidelines:

a. *Experiments from Unit I/II(HP)* = *20 marks*
b. *Experiment from Unit IV* = *20 marks*
c. *Spotting Unit I/II* = *20 marks*
d. *Practical Records (include IKS)* = *20 marks*
e. *Viva-voce* = *20 marks*

List of Practicals:

UNIT I: Research in Non-Chordates:

1. Study of Non-chordate Taxonomy & Morphometrics
   a. Field/lab identification using dichotomous keys and morphometric measurements.
   b. Data recording and preparation of research-grade specimen records.
2. Microanatomy and Histology of Invertebrates
   a. Histological preparation and microscopic study of organs (digestive gland of molluscs, nervous system of annelids, etc.) b. Staining techniques and interpretation for functional analysis.

UNIT II: Reproductive Physiology & Developmental Biology:

1. Gonad Histology & Gametogenesis Study
   a. Histological slides of testis/ovary of vertebrates and invertebrates; staging of gametogenesis.
2. Experimental Embryology
   a. Induced fertilization in aquatic model organisms (e.g., fish or amphibians).
   b. Recording of cleavage stages, gastrulation, and organogenesis under stereomicroscope.

UNIT III: Indian Knowledge System (IKS) & Human Physiology:

1. Ethnozoological Survey & Documentation
   a. Field-based collection of indigenous knowledge related to animal use in medicine, agriculture, and ecosystem management. b. Data tabulation for IKS digital repository.
2. Physiological Experiments
   a. Blood pressure measurement, ECG, reflex studies, and interpretation.
   b. Impact of yoga/pranayama on physiological parameters (experimental design).

UNIT IV: Fisheries or Sericulture:
(Choose one branch depending on specialization)

Fisheries Option:

1. Water quality analysis (DO, pH, salinity, hardness) for aquaculture suitability.
2. Study of induced breeding techniques in fish – hormonal injection simulation & spawning observation.

Sericulture Option:

1. Identification of silkworm races and their morphological features.
2. Rearing of silkworm larvae & assessment of cocoon parameters (shell ratio, reelability).

Reading Resources:

1. Kotpal, R.L. (Latest Edition). *Modern Textbook of Zoology: Invertebrates*. Rastogi Publications, Meerut. *(for Non-Chordates)*
2. Barnes, R.D. (Latest Edition). *Invertebrate Zoology*. Cengage Learning. *(Comprehensive international text for morphology & systematics)*
3. Fox, S.I. (Latest Edition). *Human Physiology*. McGraw-Hill Education. *(Clear concepts with applied lab examples)*
4. Knobil, E. & Neill, J.D. (Eds.) (Latest Edition). *Encyclopedia of Reproduction*. Academic Press. *(Advanced coverage of reproductive physiology)*
5. Gilbert, S.F. (Latest Edition). *Developmental Biology*. Sinauer Associates. *(Gold-standard text for experimental and molecular embryology)*
6. Jhingran, V.G. (Latest Edition). *Fish and Fisheries of India*. Hindustan Publishing Corporation. *(Indian standard reference for Fisheries science)*
7. Krishnaswami, S. (Latest Edition). *Sericulture: Science & Technology*. Central Silk Board, Bangalore. *(Definitive Indian text for Sericulture research)*

SEMESTER II

I. ELECTIVE COURSE-A [ECZOO401A]

FISH AND FISHERIES-I

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objectives*:*

By the end of this course/unit, students will be able to:

1. To understand the biological, ecological, and economic aspects of fishes, including their nutritional value, adaptations, and ecological roles in freshwater and marine ecosystems.
2. To acquire knowledge of aquaculture practices, fish classification, anatomy, physiology, and specialized adaptations, with emphasis on Indian fish diversity and culture techniques.

Course Learning Outcomes*:*

After successful completion of the course, students will be able to:

1. Explain the taxonomy, adaptations, anatomy, physiology, and ecological significance of various groups of fishes, including their economic and nutritional value.
2. The ability to describe aquaculture methods, identify important fish species of India, and analyze adaptations in relation to habitat and environmental conditions.

Course Contents:

1. Nutritional value and economic importance of fishes: a brief account of byproducts **(4 Lectures)**
2. Aquaculture – Definition and classification **(4 Lectures)**
3. Outlines of fish culture in ponds **(4 Lectures)**
4. Ornamental fishes, larvivorous fishes **(5 Lectures)**
5. Classification of living fishes up to orders **(5 Lectures)**
6. Freshwater and important marine fishes of India **(5 Lectures)**
7. Adaptations in teleosts- hill stream, cave dwelling, antifreeze, colouration, bioluminescence **(5 Lectures)**
8. Migratory behaviour in fishes **(5 Lectures)**
9. Locomotion in teleosts **(4 Lectures)**
10. Aquatic respiration in teleosts **(5 Lectures)**
11. Structure of gills, gill areas and their significance, gas exchange and ventilation of gills **(4 Lectures)**
12. Digestive system of teleosts **(5 Lectures)**
13. Alimentary canal and its modification about food and feeding habits in teleosts **(5 Lectures)**

Reading Resources:

1. Jhingran, V. G. (1997). *Fish and fisheries of India* (3rd ed.). Delhi: Hindustan Publishing Corporation.
2. Pandey, K., & Shukla, J. P. (2019). *Fish and fisheries*. New Delhi: Rastogi Publications.
3. Lagler, K. F., Bardach, J. E., Miller, R. R., & May Passino, D. R. (1977). *Ichthyology* (2nd ed.). New York, NY: John Wiley & Sons.
4. Pillay, T. V. R., & Kutty, M. N. (2005). *Aquaculture: Principles and practices* (2nd ed.). Oxford, UK: Blackwell Publishing.
5. Moyle, P. B., & Cech, J. J. (2004). *Fishes: An introduction to ichthyology* (5th ed.). Upper Saddle River, NJ: Prentice Hall.
6. Khanna, S. S., & Singh, H. R. (2019). *A textbook of fish biology and fisheries*. New Delhi: Narendra Publishing House.
7. Qureshi, T. A., & Qureshi, N. A. (2002). *Ornamental fish culture and aquarium management*. New Delhi: CBS Publishers & Distributors.

OR ELECTIVE COURSE-B [ECZOO401B]

ENTOMOLOGY-I

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objectives:

By the end of this course/unit, students will be able to:

1. Provide comprehensive knowledge of insect external and internal morphology, including specialized adaptations across orders.
2. Explain the physiological systems of insects with emphasis on endocrine regulation, reproduction, and developmental processes.
3. To develop analytical skills for interpreting insect structure–function relationships with ecology, behaviour, and evolution.

Learning Outcomes:

After successful completion of this module, students will be able to:

1. Identify and describe the key morphological structures and physiological systems of insects with correct terminology.
2. Analyze the roles of endocrine glands and hormones in insect growth, metamorphosis, reproduction, and embryonic development.
3. Apply morphological and physiological knowledge to solve entomological problems in research, pest management, and biodiversity studies.

Course Contents:

UNIT I: Classification and phylogeny of Insects (12 Lectures)

1. Classification of the Apterygote Orders: Thysanura, Diplura, Protura, and Collembola
2. Classification of Exopterygote Orders: Orthoptera, Dictyoptera, Hemiptera
3. Classification of Endopterygote Orders: Lepidoptera, Diptera, Hymenoptera, and Coleoptera

UNIT II: Structures and life processes : (10 Lectures)

1. Integument: Structure and chemistry, cuticular modifications, Apolysis, Ecdysis, and sclerotization
2. Head and Thorax: Its appendages and their modifications

UNIT III: Sense organs and perception: (8 Lectures)

1. Sense organs: Visual organs and Auditory organs,
2. Receptor organs: Mechanoreceptors, Chemoreceptors, Thermoreceptors, Humidity receptors
3. Effector organs: The sound and light-producing organs

UNIT IV: Insect Physiology: (12 Lectures)

1. Digestive system: Alimentary canal, salivary glands, mechanism of digestion, micro-organisms of the intestine
2. Respiration - Respiration in aquatic, terrestrial, and endoparasitic insects
3. Excretion - Malpighian tubules and other organs of excretion, Metabolic pathways of nitrogenous excretion, i.e., urea, uric acid, ammonia, and amino acids
4. Endocrine system and hormones & pheromones

UNIT V: Reproductive Physiology: (8 Lectures)

1. Oogenesis, yolk formation, ovulation, and oviposition
2. spermatogenesis, transfer of sperm and spermatophores,
3. Mating and fertilization

UNIT VI: Post-embryonic development of insects: (10 Lectures)

1. Types of metamorphosis
2. General features and types of larvae and pupae
3. Axes formation of *Drosophila melanogaster*

Reading Resources:

1. Richards, O. W., & Davies, R. G. (Eds.). (1977). *Imms' General Textbook of Entomology: Volume I: Structure, Physiology and Development* (1st ed.). Springer Dordrecht.
2. Kerkut, G. A., & Gilbert, L. I. (Eds.). (1985). *Comprehensive insect physiology, biochemistry and pharmacology: Vol. 7: Endocrinology I*. Pergamon Press.
3. Tembhare, D. B. (1984). *A Text Book of Insect Morphology, Physiology and Endocrinology*. S. Chand.
4. Nijhout, H. F. (1994). *Insect hormones*. Princeton University Press.
5. Chapman, R. F. *The insects: Structure and function* (5th ed.). Hodder Arnold.
6. Fakhri, M. S. A., Gindaba, A., & Negeri, M. (2022). *Handbook of insect morphology, physiology & taxonomy* (1st ed.). AkiNik Publications.

OR ELECTIVE COURSE-C [ECZOO401C]

ECOLOGY-I

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objectives:

By the end of this course/unit, students will be able to:

1. To develop a comprehensive understanding of ecosystem structure, function, and processes, including energy flow, productivity, community dynamics, and population ecology.
2. To analyze ecological patterns across habitats, assess biodiversity, and evaluate environmental challenges such as pollution and conservation needs.

Course Learning Outcomes:

Students will be able to

1. Explain ecosystem functions, productivity types, energy transfer, community organization, niche concepts, and ecological adaptations in major biomes.
2. The analytical skills in evaluating population models, biodiversity conservation approaches, habitat characteristics, and ecological implications of pollution.

Course Content:

UNIT I: Basic Ecosystem Concept (10 Lectures)

1. Concept of Productivity: Primary, Secondary and Tertiary; Factors and Methods of measurement.
2. Energy Flow in Ecosystem: Food chain, Food web, Food pyramid, Lindeman's Trophic Dynamic concept, Energy flow models.
3. Concept of Limiting Factor: Shelford's Law of Tolerance, Leibig's Law of Minimum
4. Fundamentals of Limnology

UNIT II: Community Ecology (15 Lectures)

1. The community concept. Development of the community through succession.
2. Community organization and stratification.
3. Classification of the community on the basis of life forms;
4. Ecological Dominants, Species Diversity, Ecotypes, Ecotone and Edge Effect,
5. Concept of Ecological Niche: Niche Overlap, Niche Breadth, Ecological Release and Ecological Compression. Periodicity (Seasonal, Lunar and Diel) as a niche dimension.

UNIT III: Major Biomes of the world: Forests, Tropical, Tundra, Grassland & Deserts, and adaptations. **(5 Lectures)**

UNIT IV: Population Ecology (10 Lectures)

1. Population Growth and attributes: Exponential, Sigmoid, Time lag Model, Stochastic Model; Natural Regulation of Population: Theories and Model for Population Regulation
2. Competition: Intra and Interspecific competition, Competitive ability, Lotka & Volterra models for competing species.

UNIT V: Habitat Ecology (10 Lectures)

1. Physico-chemistry and Biological Characteristics of Freshwater and Marine System;
2. Origin and Classification of Lakes, Types and significance of Freshwater Biota.

UNIT VI: Biodiversity: **(10 Lectures)**

1. Definition, Status, monitoring and documentation, Major factors affecting biodiversity destruction,
2. Biodiversity conservation and management strategies

Reading Resources:

1. Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of ecology* (5th ed.). Belmont, CA: Thomson Brooks/Cole.
2. Begon, M., Townsend, C. R., & Harper, J. L. (2006). *Ecology: From individuals to ecosystems* (4th ed.). Malden, MA: Blackwell Publishing.
3. Smith, R. L., & Smith, T. M. (2015). *Elements of ecology* (9th ed.). Boston, MA: Pearson Education.
4. Krebs, C. J. (2014). *Ecology: The experimental analysis of distribution and abundance* (6th ed.). San Francisco, CA: Benjamin Cummings.
5. Pandey, B. N., & Shukla, J. P. (2019). *Ecology and environmental biology*. Meerut: Rastogi Publications.
6. Dash, M. C. (2017). *Fundamentals of ecology* (4th ed.). New Delhi: McGraw Hill Education.
7. Chapin, F. S., Matson, P. A., & Vitousek, P. (2011). *Principles of terrestrial ecosystem ecology* (2nd ed.). New York, NY: Springer.

II. ELECTIVE COURSE-A [ECZOO402A]
FISH AND FISHERIES-II

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objectives:

By the end of this course/unit, students will be able to:

1. To understand the physical, chemical, and biological parameters of aquatic environments that influence fish culture and productivity.
2. To acquire technical knowledge of aquaculture practices, including breeding, feeding, weed control, culture systems, seed production, and fishing technologies.

Course Learning Outcomes:

By the end of the course, students will be able to:

1. Analyze water quality parameters, identify natural food resources, and explain the role of plankton, benthos, and fertilizers in fish culture.
2. Proficient in describing aquaculture techniques, seed production methods, culture systems, and the use of fishing gear and modern technologies.

Course Contents:

UNIT I: Cultivable water – quality and quantity **(25 Lectures)**

1. Physical and chemical properties of water influencing fish culture
2. Natural food for fish in pond
3. Role of plankton, blooms and benthos in fish culture
4. Fertilizers and their role
5. Supplementary feeding and artificial feeds
6. Sewage-fed fisheries, Integrated fish culture, paddy field fish culture and cage culture.
7. Important reservoirs and rivers of Jharkhand – their problems and commercial
8. Common aquatic weed and their control

UNIT II: Cultivable species **(10 Lectures)**

Introduction of exotic species – Composite culture, extensive and intensive culture

UNIT III: Fish seed production **(15 Lectures)**

1. Induced breeding – importance, technique, physiology and new generation of commercial agents
2. Collection of seeds from natural resources - transport of carp seeds and breeders
3. Management of nursery, rearing and stocking ponds

UNIT IV: Fishing technology – nets, crafts, gears, acoustic and other recent techniques. **(10 Lectures)**

Reading Resources:

1. Jhingran, V. G. (1997). *Fish and fisheries of India* (3rd ed.). Delhi: Hindustan Publishing Corporation.
2. Pillay, T. V. R., & Kutty, M. N. (2005). *Aquaculture: Principles and practices* (2nd ed.). Oxford, UK: Blackwell Publishing.
3. Bhatnagar, A., & Singh, G. (2010). Culture fisheries in village ponds: A multi-location study in Haryana, India. *Agricultural Biology Journal of North America, 1*(5), 961–968.
4. Khan, A. A., & Khan, M. (2014). *Textbook of fish biology and fisheries*. New Delhi: Anmol Publications.
5. Qureshi, T. A., & Qureshi, N. A. (2002). *Ornamental fish culture and aquarium management*. New Delhi: CBS Publishers & Distributors.
6. Santhanam, R., & Srinivasan, A. (1994). *A manual of freshwater ecology*. New Delhi: Oxford & IBH Publishing.
7. Boyd, C. E., & Tucker, C. S. (1998). *Pond aquaculture water quality management*. New York, NY: Springer Science & Business Media.

OR ELECTIVE COURSE-B [ECZOO402B]

ENTOMOLOGY-II

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objectives:

By the end of this course/module, students will be able to:

1. Understand the mode of entry and action of various insecticides.
2. Identify commonly used insecticides and their chemical classes.
3. Evaluate the toxicological effects of insecticides on humans and non-target organisms.

Course Learning Outcomes:

After successful completion of this course, students will be able to:

1. Differentiate between stomach, contact, and fumigant poisons
2. Describe the chemical structure and mode of action of chlorinated hydrocarbons, organophosphates, carbamates, and pyrethroids
3. Analyze insecticide toxicity concerning the respiratory, integumentary, and nervous systems in humans

Course Contents

UNIT I: Cultural Control: (12 Lectures)

1. Ecological management of the crop environment:
2. Sanitation, destruction, or modification of alternate hosts and habitats
3. Tillage, irrigation, and water management
4. Trap cropping and strip harvesting

UNIT II: Chemical Control: (20 Lectures)

1. Classification of insecticides based on- Mode of entry (stomach poison, contact poison, & Fumigants), Mode of action (Respiratory and Nervous poisons), Chemical nature (Inorganic and Organic insecticides)
2. Liquid and Dry formulations of insecticides
3. Structure and mode of action of – Chlorinated hydrocarbons, Organophosphates, Carbamates, and Pyrethoids
4. Common insecticides used in pest control
5. Mode of action of insecticides and toxicity to humans.

UNIT III: Biological Control: (8 Lectures)

1. Definition of Biological control, agents of Biological Control: Parasites, Parasitoids, Predators and Pathogenic microorganisms.
2. Mass production and distribution. Advantages and disadvantages of Biological control

UNIT IV: Integrated Pest Management (IPM): (15 Lectures)

1. History, concept, and principles of IPM, Critical uses of IPM, Procedures of integrated control of pests
2. Other Methods of Insect Pest Management
3. Management of Insect Pests by Sterile-Insect Technique (Chemosterilants)
4. Attractants, Repellants, Antifeedants, and Pheromones.

UNIT V: Insect – Plant Interaction: (5 Lectures)

1. Theory of coevolution
2. Role of allochemicals in host-plant, medication, and host plant selection

Reading Resources:

1. Dent, D. (2000). *Insect pest management*. CABI Publishing.
2. Metcalf, R. L., & Luckmann, W. H. (1994). *Introduction to insect pest management* (3rd ed.). Wiley-Interscience.
3. Pedigo, L. P., & Rice, M. E. (2014). *Entomology and pest management* (6th ed.). Waveland Press.
4. Koul, O., & Cuperus, G. W. (Eds.). (2007). *Ecologically based integrated pest management*. CABI Publishing.
5. Subramanyam, B., & Hagstrum, D. W. (Eds.). (2012). *Integrated management of insects in stored products*. CRC Press.
6. Dhaliwal, G. S., Jindal, V., & Mohindru, B. (2013). *Crop losses due to insect pests*. Indian Journal of Entomology, 75(2), 165–176.
7. Flint, M. L., & Dreistadt, S. H. (1998). *Natural enemies handbook: The illustrated guide to biological pest control*. University of California Press.
8. van Emden, H. F., & Harrington, R. (2017). *Aphids as crop pests* (2nd ed.). CABI Publishing.
9. Norris, R. F., Caswell-Chen, E. P., & Kogan, M. (2003). *Concepts in integrated pest management*. Prentice Hall.
10. Dhaliwal, G. S., Singh, R., & Chhillar, B. S. (2006). *Essentials of agricultural entomology*. Kalyani Publishers.
11. Thakur, A. K. A Journey into Entomology (Vol. 1 & 2). Lekh Publications, India

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OR ELECTIVE COURSE-C [ECZOO402C]

ECOLOGY-II

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	**Pass Marks: (MSE: 17 + ESE: 28) = 45**

(Credits: Theory-04, 60 Hours)

Course Objectives:

By the end of this course/unit, students will be able to:

1. To understand population ecology concepts, models, and interactions, and their application in agriculture, fisheries, and forestry management.
2. To gain comprehensive knowledge of ecotoxicological principles, including toxicant behavior, dose-response relationships, and biotransformation processes in organisms.

Course Learning Outcomes:

Students will be able to:

1. Explain population attributes, growth models, species interactions, and regulatory mechanisms, and apply these concepts to real-world ecological and resource management problems.
2. Demonstrate the ability to analyze toxicological processes, environmental influences on toxicity, and mechanisms of toxicant transformation and effects in ecosystems.

Course Content:

UNIT I: Pollution Ecology: (20 Lectures)

1. Pollution - Types, entry of pollutants in biological systems
2. Air, Water, Soil, Noise, and Radioactive – Sources, Effects, and Control measures
3. Solid waste management

UNIT II: Ecotoxicology: (20 Lectures)

1. Toxicology: Routes and rate of administration
2. Environmental and behavioral factors affecting Toxicity
3. Synergism and Antagonism; Mechanism of action
4. Basic Principle of Dose Response Relationship
5. Biotransformation of Toxicants
6. Translocation of Toxicants Antidotes; Toxicity Tests, Xenobiotics

UNIT III: Environment Assessment, Management, and Legislation (15 Lectures)

1. Environmental Impact Assessment (EIA), Environmental Impact Assessment (EIA), and Environmental Management Plan (EMP).
2. Overview of Environmental Laws in India – Wildlife Protection Act, 1972, amendments 1991; The Solid Waste Management Rules, 2016, and The e-Waste (Management) Rules 2016

UNIT IV: Contemporary Environmental Issues (05 Lectures)

Global Environmental Issues – Biodiversity Loss, Climate Change, Green House Effects, Ozone Layer Depletion, and Carbon Neutrilty

Reading Resources:

Textbook:

Krebs, C. J. (2014). *Ecology: The experimental analysis of distribution and abundance* (6th ed.). San Francisco, CA: Benjamin Cummings.

Reference Books:

1. Begon, M., Townsend, C. R., & Harper, J. L. (2006). *Ecology: From individuals to ecosystems* (4th ed.). Malden, MA: Blackwell Publishing.
2. Newman, M. C. (2015). *Fundamentals of ecotoxicology: The science of pollution* (4th ed.). Boca Raton, FL: CRC Press.
3. Rand, G. M., & Petrocelli, S. R. (1985). *Fundamentals of aquatic toxicology: Methods and applications*. Washington, DC: Hemisphere Publishing.
4. Connell, D. W., & Miller, G. J. (2006). *Chemistry and ecotoxicology of pollution* (2nd ed.). Hoboken, NJ: John Wiley & Sons.
5. Odum, E. P., & Barrett, G. W. (2005). *Fundamentals of ecology* (5th ed.). Belmont, CA: Thomson Brooks/Cole.
6. Sibly, R. M., Hone, J., & Clutton-Brock, T. H. (2003). Population growth rate and its determinants: An overview. *Philosophical Transactions of the Royal Society B: Biological Sciences, 358*(1438), 1429–1436.

III. CORE COURSE [CCZOO403]
HISTOLOGY AND HISTOCHEMISTRY

Marks: 30 (MSE: 20 Th. 1 Hr + 5 Attd. + 5 Assign.) + 70 (ESE: 3 Hrs) = 100	Pass Marks: (MSE: 17 + ESE: 28) = 45

(Credits: Theory-04, 60 Hours)

Course Objectives:

After completion of the course, the learner will be able to understand:

1. To equip learners with the knowledge of the evolutionary progression of Protochordates and Chordates.
2. To familiarize the learner with the origin, morphology, and phylogeny of the Protochordates and Chordates.

Course Learning Outcomes:

Students would be able to understand:

1. Learners would be equipped with an understanding of the morphology and phylogeny of Protochordates and Chordates.

Course Content:

UNIT-I: PROTOCHORDATES (20 Lectures)

1. **Protochordates:** Origin and ancestry of Protochordates, similarities and differences with Invertebrates and Chordates
2. Comparison of characteristics between subphyla Urochordates and Cephalochordates
3. **Urochordates:** Life history of *Herdmania* and its phylogenetic affinities,
4. **Cephalochordates:** General features and phylogenetic affinities, Life history of *Branchiostoma*
5. **Ostracoderm:** Salient features and biological significance, Interrelationship and affinities with fish
6. **Cyclostomes:** Resemblance with Cephalochordates, Vertebrates, and differences from Fishes, Life history of *Petromyzon*

UNIT II: PHYLOGENY OF CHORDATES (20 Lectures)

1. Ancestry of Chordates
2. **Pisces:** General characters of Dipnoi and affinities with Fishes, Elasmobranchs and Amphibia, Origin of air bladder and its relationship with tetrapod lungs, Deep sea adaptations of fishes, and Origin of fins.
3. **Amphibia:** Origin of Tetrapods, Pedomorphosis, Adaptive radiation in amphibians, Lepospondyli and Lissamphibia
4. **Reptilia:** Origin of Reptiles and Affinities with Amphibia, Terrestrial adaptations in Reptiles, Skull of reptiles
5. **Aves:** Origin of Birds and affinities with Reptiles, Adaptive radiation in Birds – Ratitae (Flightless Birds) and Carinatae (Flying Birds), Origin of Flight – Theory of Cursorial and Arboreal origin
6. **Mammals:** Phylogeny of mammals

UNIT III: ASSORTED TOPICS ON CHORDATES (20 Lectures)

1. Retrogressive metamorphosis in Ascidians
2. **Pisces:** Evolutionary significance Crossopterygians, Placoderms, Migration, Lateral line sense organ and electric organs
3. **Amphibia** – Evolutionary significance of Labyrinthodonts
4. **Aves:** Migration, Flight adaptations
5. **Mammalia:** Dentition in mammals, Habitat diversification

Reading Resources:

Text Books:

1. Romer, A. S., & Parsons, T. S. (1986). *The vertebrate body* (6th ed.). Saunders College Publishing.
2. Kotpal, R. L. (2015). *Modern text book of zoology: Vertebrates*. Rastogi Publications.

Reference Books:

3. Young, J. Z. (1981). *The life of vertebrates* (3rd ed.). Clarendon Press.
4. Pough, F. H., Janis, C. M., & Heiser, J. B. (2012). *Vertebrate life* (9th ed.). Pearson Education.
5. Kardong, K. V. (2019). *Vertebrates: Comparative anatomy, function, evolution* (8th ed.). McGraw-Hill Education.
6. Saxena, R. K., & Saxena, S. (2010). *Comparative anatomy of vertebrates*. Viva Books Private Limited.
7. Ekambaranatha Ayyar, C. N., & Ananthakrishnan, T. N. (2002). *Manual of zoology: Chordata*. S. Viswanathan (Printers & Publishers) Pvt. Ltd.

IV. ELECTIVE COURSE-A [EPZOO404A]
PRACTICAL-IVA

Marks: 100 (ESE Pr: 6 Hrs) = 100	Pass Marks = 45

(Credits: Practical-04, 120 Hours)

Scheme of examinations **Time: 6 Hrs**

Items		Marks Distribution
Anatomical observation		10
Gut analysis and determination of feeding habit		10
Temporary slides		10
Spotting – 5 [Representative of major classes–1, histological slides–1, Endocrine section–1, fish showing adaptation–1, exotic/ornamental/ larvivorous fish-1]		15
Plankton identification		5
Taxonomic identification of freshwater fishes	(2x5)	10
Fish showing adaptive feature	(2x5)	10
Records and Sessional work		10
Viva voce		20

List of Practical

UNIT I: Anatomical observation of a bony fish:

1. General anatomy, Digestive system of herbivore and carnivore fishes, Reproductive system,
2. Pituitary gland, Weberian Ossicle.
3. Representatives of major groups (except teleosts)
4. Taxonomic identification of important freshwater and marine fishes up to genus

UNIT II: Study of histological slides of various organs:

1. Study of slides, related to annual breeding cycles - ovary, testis, pituitary etc.
2. Study of the skeletal system of bony fish
3. Study of exotic, ornamental, larvicidal fishes
4. Study of adaptive features: hill stream fishes, fishes showing parental care, bioluminescence, adaptations - feeding, respiratory, flying, poisonous, electric organs, etc
5. Haematology – blood corpuscles, T.C., D.C., and Hb content/ Haematocrit

UNIT III: Study of fishing gears and ecological equipment:

1. Collection, identification of plankton, weeds, and aquatic plants
2. Determination of feeding habit based on gut/ gut content

Visit to fish market, landing site, fish pond, and fish farm, breeding centers, fish reservoir and National Institutes of Fisheries Research

Reading Resources:

1. Lagler, K. F., Bardach, J. E., Miller, R. R., & May Passino, D. R. (2021). *Ichthyology*. Wiley.
2. Khanna, S. S., & Yadav, P. R. (2020). *A Textbook of Fish Biology and Fisheries*. Narendra Publishing House.
3. Bhatnagar, G. K., & Singh, H. D. (2016). *Practical Zoology: Vertebrates*. Rastogi Publications.
4. Biswas, S. P. (1993). *Manual of Methods in Fish Biology*. South Asian Publishers.
5. Qureshi, T. A., & Qureshi, N. A. (2011). *Fish Biology and Ecology*. APH Publishing.

OR ELECTIVE COURSE-B [EPZOO404B]

PRACTICAL-IVB

Marks: 100 (ESE Pr: 6 Hrs) = 100	**Pass Marks = 45**

(Credits: Practical-04, 120 Hours)

Scheme of examinations **Time: 6 Hrs**

Items		Marks Distribution
Adapting feature of aquatic/Semiaquatic/terrestrial insects		10
Temporary mounting of any body parts of insects		10
Calculation of species diversity of insects by Shannon-Weiner index from generated data		10
Taxonomic description of a member of any order studied		10
Pest studies/life cycle of beneficial insects		10
Spotting	(2x10)	20
Records and Sessional work		10
Viva voce		20

List of Practical

Taxonomy description & identification of the following order:

1. Orthoptera, Dictyoptera, Hemiptera, Hymenoptera, Diptera, Coleoptera & Lepidoptera.
2. Study of permanent slides of body parts.
3. Study of Histological slides.
4. Pest study on affected objects.
5. Life history of beneficial insects like- lac & tasar.
6. Study of parasites, predators, parasitoids & pathogens.
7. Embryological study through *Drosophila* culture.
8. Study of adaptive features in some order of insects.
9. Minor dissection: Temporary mounting of special types of mouth parts, wings, legs, ovpositer,
10. Sting apparatus antennae- adaptation – arista.
11. Calculation of species diversity by Shannon-Weiner index from generated data
12. Study of the external morphology of an insect, wings, halteres, and elytra
13. Study of the adaptive feature of terrestrial and aquatic insects
14. Study of parasitic insects (Fleas and Lice)
15. Study of the mouthparts of the representatives of the order: Orthoptera, Dictyoptera, Hemiptera, Lepidoptera and Hymenoptera.
16. Study of respiratory structure of terrestrial, semi-aquatic, and aquatic insects.
17. Study of the life cycles of Termites, Honeybees, and Mosquitoes.

Reading Resources:

1. Imms, A. D. (1977). *A General Textbook of Entomology: Including the Anatomy, Physiology, Development and Control of Insects*. Chapman and Hall.
2. Borror, D. J., Triplehorn, C. A., & Johnson, N. F. (2017). *An Introduction to the Study of Insects*. Cengage Learning.
3. Saxena, S. C. (2015). *Entomology: At a Glance*. Scientific Publishers, India.
4. Tembhare, D. B. (2012). *Modern Entomology*. Himalaya Publishing House.
5. Snodgrass, R. E. (1993). *Principles of Insect Morphology*. Cornell University Press.

OR ELECTIVE COURSE-C [EPZOO404C]

PRACTICAL-IVC

Marks: 100 (ESE Pr: 6 Hrs) = 100	**Pass Marks = 45**

(Credits: Practical-04, 120 Hours)

Course Contents:

Scheme of examinations **Time: 6 Hrs**

Items	Marks Distribution
Water analysis	10
Soil analysis	10
Biotic analysis	10
Bio-statistical analysis	15
Adaptation Study Spotting (5 X 3)	15
Records and Sessional work	10
Viva voce	20

List of Practicals

UNIT I: Water Analysis

1. Estimation of BOD of sample
2. Estimation of Carbonate, Bicarbonate and Hydroxide & chloride in sample water
3. Estimation of hardness & Oxygen and Carbon of sample water
4. Estimation of Magnesium and Calcium in sample water

UNIT II: Soil Analysis

1. Estimation of OMC / Total Carbon of a soil sample
2. Estimation of $CaCO_3$ in a soil sample
3. Estimation of soil respiration rate in a sample

UNIT III: Biotic Analysis

1. Sampling and identification of freshwater planktons.
2. Qualitative, quantitative assessment and working of Indices of diversity and dominance of
3. Plankton, Benthos, Soil fauna, Soil microbes

UNIT IV: Biostatistical Analysis

1. Analysis of correlation coefficient and simple linear regression in a set of data
2. Estimation of density and relation frequency by quadrate analysis
3. Analysis of similarity index in the species composition by 2X2 contingency table

UNIT V: Adaptation study

1. Aquatic insects, Terrestrial Insects, Freshwater fish (Hill Stream fish)
2. Marine fish & Higher Vertebrates
3. Ecological Equipments
4. Ecological significance of plants and earthworm
5. Identification of Aquatic Plants and Bioindicator Species

Reading Resources:

1. APHA, AWWA, & WEF. (2017). *Standard Methods for the Examination of Water and Wastewater* (23rd ed.). American Public Health Association.
2. Piper, C. S. (1966). *Soil and Plant Analysis*. Hans Publishers.
3. Welch, P. S. (1948). *Limnological Methods*. McGraw-Hill.
4. Mishra, S. R., & Pani, K. C. (2008). *Practical Ecology and Environmental Science*. Discovery Publishing House.
5. Krebs, C. J. (2014). *Ecological Methodology* (3rd ed.). Pearson.

V. PROJECT [PRZOO405]

DISSERTATION/ PROJECT/ TEACHING APTITUDE

Marks: 30 (MSE: 20 Viva + 5 Attd. + 5 Record) + 70 (ESE Pr: 6 Hrs) = 100	Pass Marks: = 45

(Credits: 04, 120 Hours)

Guidelines to Examiners for
End Semester Examination (ESE):

The evaluation of the dissertation will be done in 100 marks (70 marks + 30 marks of the session). The sessional component will be evaluated by the concerned supervisor.

The end term evaluation (70 marks) will be done by a board of examiners. The end term evaluation in 70 marks will include the literary and scientific presentation of the dissertation and the performance in the viva-voce.

Overall project dissertation may be evaluated under the following heads:

- *Motivation for the choice of topic*
- *Project dissertation design*
- *Methodology and Content depth*
- *Results and Discussion*
- *Future Scope & References*
- *Participation in Internship programme with reputed organization*
- *Application of Research technique in Data collection*
- *Report Presentation*
- *Presentation style*
- *Viva-voce*

Course Objectives:

1. To develop research skills and scientific inquiry through independent investigations of a topic of problem.

Course Outcomes:

On successful completion of this course the student should know:

1. About conducting a research with approve stages of research methodology in Zoology. Dissertation will enable student to further investigate and navigate different aspects and events of life through research.

PROJECT WORK

Each student has to submit three copies of hard bound dissertation work (along with the raw data), duly forwarded by the HOD of Department concerned. The forwarded copies will be submitted in the Department of Zoology, Ranchi University, for evaluation (one month before the viva voce examination).

The paper may involve:

(a) Laboratory research/ Field work/ Lab work related to the project.

(b) Survey research, Case Study or any other type of research related with zoology.

(c) One Large study/ Experiment or several studies/ Experiments depending on the objectives of the research.

(d) The writing of dissertation must be within 80 to 100 pages including references and appendices.

(e) Content must be typed in Font: Times New Roman with Line Spacing: 1.5 and Font Size 14 points.

Presentation of project work in the seminar on the assigned topic in the P.G. Department of Zoology, Ranchi University, Ranchi & open viva there on.

Topics: As decided by the Supervisor/Guide

Teaching Aptitude: Only selected candidates, in alternative to the Dissertation, may be provided duty to teach the assigned topics in selected colleges. The performance may be evaluated based on the organized feedback for the candidate.
