R.E. Society's

R. P. GOGATE COLLEGE OF ARTS & SCIENCE AND R.V. JOGALEKAR COLLEGE OF COMMERCE (AUTONOMOUS), RATNAGIRI

NAAC accredited 'A' Grade (4th Cycle)
Ratnagiri-415612 (Maharashtra-India)

Bachelor of Science (B. Sc.) Programme

Program: T.Y.B. Sc.
Course: Zoology (Major)

Syllabus for Semester V & VI

Department of Zoology under NEP 2020

Framed According to the National Education Policy (NEP 2020)

To be implemented from Academic Year: 2025-2026

PREAMBLE:

The T.Y.B.Sc. Zoology syllabus has been meticulously designed to provide students with a comprehensive understanding of foundational and advanced concepts in Zoology, in alignment with modern educational and research standards. The syllabus for Semesters V and VI integrates theoretical knowledge with practical skills, fostering employability, entrepreneurship, and lifelong learning.

In Semester V, students explore the fundamentals and advanced taxonomy of invertebrates, mammalian histology, toxicology, physiology, and immunology. These subjects provide a deep understanding of organismal diversity, structural biology, defence mechanisms, and the effects of environmental toxins on health. Semester VI builds on this foundation by introducing chordate biology, molecular biology, genetics, biostatistics, and bioinformatics, encompassing vertebrate structure and function, molecular processes, principles of inheritance, statistical methods, and computational tools that are increasingly valuable in biological research and industry.

The curriculum emphasizes hands-on learning through practical sessions that reinforce theoretical knowledge while developing analytical and technical competencies. Laboratory exercises are designed to enhance problem-solving abilities, research aptitude, and an understanding of complex biological systems.

This syllabus aims to equip students with a robust scientific foundation, preparing them for diverse career pathways, including research, teaching, and industry roles. It also supports skill development and interdisciplinary approaches, promoting innovation and critical thinking essential in today's dynamic biological sciences landscape.

Chairperson,
BOS in Zoology,
Gogate Jogalekar College,
Ratnagiri.

Syllabus for T. Y. B. Sc. Course: ZOOLOGY

(To be implemented from the Academic Year 2025-2026)

SEMESTER – V
MAJOR COURSES

COURSE CODE		UNIT	TOPIC	CREDITS
25_USZOM501	Invertebrates and Type Study	I	Foundations of Invertebrate Taxonomy	**02**
		II	Advanced Invertebrate Taxonomy and Type Study	
25_USZOM 502		I	Physiology	**02**
		II	Immunology	
25_USZOM 503		I	Mammalian Histology	**02**
		II	Toxicology	
25_USZOM 504			Zoology Practical V	**02**
25_USZOM 505			Zoology Practical VI	**02**
Total Number of Credits and Workload				**10**

SEMESTER – VI
MAJOR COURSES

COURSE CODE	UNIT	TOPIC	CREDITS
25_USZOM601	I	Fundamentals of Chordate Biology	**02**
	II	Advanced Chordate Taxonomy and Type Study	
25_USZOM602	I	Molecular Biology	**02**
	II	Genetics	
25_USZOM603	I	Biostatistics	**02**
	II	Bioinformatics	
25_USZOM604		Zoology Practical	**02**
25_USZOM605		Zoology Practical	**02**
Total Number of Credits and Workload			**10**

Syllabus for (T. Y. B. Sc.) Autonomous from the year 2025-26

Name of the Course	**Invertebrates and Type Study**
Course Code (refer to the student handbook)	25_USZOM501
Class	T.Y.B. Sc.
Semester	V
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	Major
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: **Invertebrates and Type Study**

CO1: Learners will understand the principles of taxonomy, including classification systems, binomial nomenclature, and the significance of symmetry, coelom, and metamerism.

CO2: Learners will explore levels of biological organization and the differences between unicellular and multicellular organisms.

CO3: Learners will classify Protozoa and lower invertebrates, focusing on their characteristics and biological significance.

CO4: Learners will study higher invertebrate phyla, including Annelida, Arthropoda, Mollusca, and Echinodermata, and their ecological roles.

CO5: Learners will analyze the general characteristics and anatomy of Sepia (Cuttlefish) through a detailed type study.

CO6: Learners will examine the classification and characteristics of minor invertebrate phyla like Acanthocephala, Chaetognatha, and Onychophora.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Fundamentals of Chordate Biology**	**1. Principles of Taxonomy** 1.1 Levels of Organization • Unicellularity and Multicellularity • Types: Acellular, Cellular, Tissue, Organ, Organ-system 1.2 Symmetry in Organisms • Types of Symmetry: Radial, Bilateral, Asymmetrical • Evolutionary significance of symmetry types 1.3 Coelom • Types of body cavities: Acoelomate, Pseudocoelomate, Eucoelomate • Coelom formation and its evolutionary significance 1.4 Metamerism • Concept of metamerism (segmentation) • Types: Pseudometamerism and True Metamerism • Evolutionary significance 1.5 Taxonomy • Basic concepts, objectives, and importance • Linnaean hierarchy of classification • Binomial nomenclature system **2. Kingdom Protista & Animalia (Lower**	**15**

		Invertebrates) 2.1 Kingdom Protista • General characteristics of Protozoa • Classification up to Phylum level with examples: Sarcodina, Mastigophora, Ciliophora, Sporozoa 2.2 Kingdom Animalia (Lower Invertebrates) • Phylum Porifera: General characters, classification up to class level (Calcarea, Hexactinellida, Demospongiae) • Phylum Cnidaria: General characters, classification up to class level (Hydrozoa, Scyphozoa, Anthozoa) • Phylum Platyhelminthes: General characters, classification, and life cycle of *Fasciola hepatica* • Phylum Nematoda: General characters, classification, and life cycle of *Ascaris*	
II	**Advanced Invertebrate Taxonomy and Type Study**	**1. Kingdom Animalia (Higher Invertebrates)** 1.1 Phylum Annelida • General characters, classification up to class level (Polychaeta, Oligochaeta, Hirudinea) 1.2 Phylum Arthropoda • Overview and classification of major subphyla and classes (Chelicerata, Crustacea, Uniramia) 1.3 Phylum Mollusca • General characters, classification up to class level (Gastropoda, Cephalopoda, Pelecypoda) 1.4 Phylum Echinodermata • General characters, classification up to class level (Asteroidea, Ophiuroidea, Echinoidea, Holothuroidea, Crinoidea) 1.5 Overview of Minor Phyla • General characteristics of Acanthocephala, Chaetognatha, and Onychophora **2. Type Study of Sepia (Cuttlefish)** 2.1 General Characteristics • Habit and habitat, economic importance of Sepia 2.2 Structural Overview • Digestive, Respiratory, Circulatory, Nervous, Excretory, and Reproductive systems 2.3 Key Anatomical Features • Overview of mantle cavity, chromatophores, radula, and spermatophores	**15**

Learning Resources recommended:

1. A Manual of Zoology - Part I, Invertebrates by M. Ekambar Anath Ayyar; Published by The University of Madras, India.

2. Invertebrate Zoology (Volumes on Different Phyla) by L.H. Hyman; Published by McGraw-Hill Book Company.
3. Instant Notes in Animal Biology by Richard D. Jurd; Published by Taylor & Francis Group.
4. Introduction to Zoology - Vol I by K. K. Chaki, G. Kundu, and S. Sarkar; Published by New Central Book Agency Pvt. Ltd.
5. Modern Textbook of Zoology - Invertebrates by Professor R.L. Kotpal; Published by Rastogi Publications.
6. Invertebrate Zoology by E. L. Jordan & P. S. Verma; Published by S. Chand & Company Ltd.
7. Zoology for Degree Students, Non-Chordates by V.K. Agarwal; Published by S. Chand Publishing.
8. Zoology for Degree Students, B.Sc. First Year by V.K. Agarwal; Published by S. Chand Publishing.
9. Invertebrate Zoology by Fatik Baran; Published by Levant Books.
10. A Textbook of Invertebrates by N.C. Nair, P. Natarajan, S. Leelavathy, and R. G. Ramachandra; Published by S. Viswanathan (Printers and Publishers) Pvt. Ltd.
11. Invertebrate Zoology by D.T. Anderson; Published by Oxford University Press.
12. Biology of the Invertebrates by Jan A. Pechenik; Published by McGraw-Hill Education.
13. An Introduction to the Invertebrates by Janet Moore; Published by Cambridge University Press.
14. Protozoology by S.V. Nikam & S.T. Tanveer; Published by LAP Lambert Academic Publishing.

Evaluation Pattern:

A. Internal Evaluation- 40 % 20 Marks

Method	**Marks**
Class test	10
Assignment	10
Total	**20**

B. External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- 30 Marks

1. The examination will have a duration of 1 hour and will carry a maximum of 30 marks.
2. There will be three questions, each carrying 10 marks. Each unit will have one question, and the third question will cover the entire syllabus.
3. All questions will be compulsory, with internal choices provided within each question.
4. Questions may be divided into sub-questions (A and B), with the allocation of marks based on the weightage of the topic.

Distribution of marks for descriptive external examination (30 marks)
All the Questions are compulsory

Time: 1 hour **Total marks: 30**

Question No.	Options	Unit	Marks
1.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1	10
2.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	2	10
3.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1&2	10

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Syllabus for (T. Y. B. Sc.) Autonomous from the year 2025-26

Name of the Course	**Physiology and Immunology**
Course Code (refer to the student handbook)	25_USZOM502
Class	T.Y.B. Sc.
Semester	V
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	Major
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: **Physiology and Immunology**

CO1: The learner shall comprehend the concept of homeostasis, its importance, and regulatory mechanisms in maintaining body stability.

CO2: The learner shall understand feedback mechanisms, including positive and negative feedback, in regulating body temperature, blood pressure, and pH.

CO3: The learner shall explain thermoregulation and osmoregulation, focusing on physiological adaptations to temperature extremes and water balance in different environments.

CO4: The learner shall analyze the physiological role of enzymes, their classification, mechanisms of action, and factors influencing enzyme activity.

CO5: The learner shall describe the basic components of the immune system, including innate and adaptive immunity, and the functions of immune cells and organs.

CO6: The learner shall differentiate between antigens and antibodies, understanding their structure, types, and roles in immune responses.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Physiology**	**1.1 Homeostasis** • Concept of homeostasis: Definition and importance • Feedback mechanisms: Positive and negative feedback systems • Examples of homeostasis: Regulation of body temperature, blood pressure, and pH 1.2 **Thermoregulation** • Mechanisms of temperature regulation: Heat • production and heat loss • Role of hypothalamus in thermoregulation • Physiological adaptations to extreme temperatures: Endothermy vs. ectothermy • Disorders of thermoregulation: Hypothermia, hyperthermia, and fever 1.3 **Osmoregulation** • Concept and significance of osmoregulation • Osmoregulation in aquatic organisms: Freshwater vs. marine adaptations • Osmoregulatory mechanisms in humans: Role of kidneys, ADH, and aldosterone	**15**

		• Disorders of osmoregulation: Dehydration, overhydration 1.4 **Physiological Importance of Enzymes and Their Actions** • Enzyme basics: Definition, classification, and properties • Mechanism of enzyme action: Lock-and-key model and induced-fit model • Factors affecting enzyme activity: pH, temperature, substrate concentration, and inhibitors • Physiological roles of enzymes: Digestive enzymes, • metabolic enzymes, and regulatory enzymes	
II	**Immunology**	2.1 **Basics of Immunology** • Overview of the immune system: Innate and adaptive • immunity • Cells of the immune system: T cells, B cells, macrophages, and dendritic cells • Organs of the immune system: Thymus, spleen, bone marrow, and lymph nodes 2.2 **Antigens and Antibodies** • Antigen: Properties, types, and examples • Antibodies: Structure, types (IgG, IgA, IgM, IgE, IgD), and physiological roles 2.3 **Immune Mechanisms** • Phagocytosis and inflammation: Processes and significance • Primary and secondary immune responses • Complement system: Overview and functions 2.4 **Immunopathology** • Hypersensitivity reactions: Types I to IV (introduction) • Autoimmune disorders: Mechanisms and examples (e.g., rheumatoid arthritis, lupus) • Immunodeficiency: Overview of primary (e.g., SCID) and secondary (e.g., HIV/AIDS) immunodeficiency	**15**

Learning Resources recommended:

1. Human Physiology - Volume 1 by C.C. Chatterjee; Published by CBS Publishers & Distributors Pvt. Ltd.

2. Essentials of Haematology by Shirish M. Kawthalkar; Published by Jaypee Brothers Medical Publishers.
3. Williams Hematology by Kenneth Kaushansky, Marshall A. Lichtman, E. Beutler, Thomas J. Kipps, Josef Prchal, Uri Seligsohn; Published by McGraw-Hill Education.
4. Essential Haematology by Victor Hoffbrand, Paul Moss, John Pettit; Published by Wiley-Blackwell.
5. Rapid Review of Hematology by Ramadas Nayak; Published by Jaypee Brothers Medical Publishers.
6. Precise Haematology by Usha Rusia, Meera Sikka, Renu Saxena; Published by Wiley India.
7. Short Textbook of Haematology by Shah B.S.; Published by CBS Publishers & Distributors Pvt. Ltd.
8. Mechanisms of Body Functions (Second Edition) by Dexter M. Easton; Published by Prentice-Hall of India Pvt. Ltd.
9. A Textbook of Practical Physiology (First Edition) by V.G. Ranade; Published by A.V.G. Prakashan, Pune.
10. Principles of Anatomy & Physiology (Thirteenth Edition) by Gerard J. Tortora & Bryan Derrickson; Published by Wiley.
11. Biochemistry (Fourth Edition) by U. Satyanarayana & U. Chakrapani; Published by Elsevier.
12. Medical Biochemistry (Fourth Edition) by John Baynes & Marek Dominiczak; Published by Saunders (Elsevier).
13. Immunology- Introductory Textbook by N. Shetty; Published by New Age International Publishers.
14. Immunology: A Textbook by C.V. Rao; Published by Alpha Science International.
15. Kuby Immunology (Sixth Edition) by Thomas J. Kindt, Richard A. Goldsby, Barbara Osborne, Janis Kuby; Published by W.H. Freeman.

Evaluation Pattern:

C. Internal Evaluation- 40 % 20 Marks

Method	**Marks**
Class test	10
Assignment	10
Total	**20**

D. External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- 30 Marks

1. The examination will have a duration of 1 hour and will carry a maximum of 30 marks.

2. There will be three questions, each carrying 10 marks. Each unit will have one question, and the third will cover the entire syllabus.

3. All questions will be compulsory, with internal choices provided within each question.

4. Questions may be divided into sub-questions (A and B), and marks will be allocated based on the topic's weightage.

Distribution of marks for descriptive external examination (30 marks)

All the Questions are compulsory

Time: 1 hour **Total marks: 30**

Question No.	Options	Unit	Marks
1.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1	10
2.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	2	10
3.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1& 2	10

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Syllabus for (T. Y. B. Sc.) Autonomous from the year 2025-26

Name of the Course	**Histology and Environmental Toxicology**
Course Code (refer to the student handbook)	25_USZOM503
Class	T.Y.B. Sc.
Semester	V
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	Major
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: **Histology and Environmental Toxicology**
CO1: Understand the definition, scope, and significance of histology in health sciences and recognize the four main tissue types: epithelial, connective, muscular, and nervous tissues.

CO2: Analyze the structure and function of various tissues and study the histological features of major organs, relating tissue structure to organ function.

CO3: Apply microscopic techniques and staining methods to examine tissue samples and identify diseases based on histological findings.

CO4: Comprehend the basic principles of toxicology, including toxicity, dose-response relationships, and the significance of LD_{50} and LC_{50} values in assessing toxins.

CO5: Study the biological effects and mechanisms of action of plant and animal toxins, including venoms and alkaloids.

CO6: Understand environmental toxicology, focusing on pollutants like heavy metals and pesticides, and apply knowledge of bioaccumulation and its impact on ecosystems and human health.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Mammalian Histology**	1.1 **Introduction to Histology:** • Definition, scope, and importance of histology in health sciences. • Overview of the four main tissue types: epithelial, connective, muscular, and nervous tissues. 1.2 **Tissue Types and Their Functions:** • Detailed study of the structure and function of epithelial, connective, muscular, and nervous tissues. • Special emphasis on the role of connective tissues in supporting body structures. 1.3 **Histology of Organs and Systems:** • Study of the histological structure of major organs like the heart, lungs, liver, and kidneys. • Correlation of tissue structure with organ function. 1.4 **Microscopic Techniques and Staining:** • Introduction to microscopy techniques used in histology (light microscopy, electron microscopy).	**15**

		• Common histological stains: Hematoxylin and Eosin, Masson's Trichrome, and their clinical applications. 1.5 **Application of Histology in Health and Disease:** • Role of histology in diagnosing diseases like cancer, infections, and genetic disorders. • Practical histological examination of tissue samples.	
II	**Toxicology**	2.1 **Introduction to Toxicology:** • Basic principles of toxicology: understanding toxicity, dose-response relationships, and the types of toxicity (acute, chronic). • Introduction to the concept of LD50 and LC50 in assessing toxin potency. 2.2 **Plant and Animal Toxins:** • Overview of plant-derived toxins (e.g., alkaloids, cyanogenic glycosides) and their biological effects. • Study of animal toxins, including venoms from snakes, spiders, and marine organisms, and their mechanisms of action. 2.3 **Toxicology Testing Methods:** • Methods for testing acute toxicity, including determination of LC50 and LD50 values. • Chronic toxicity testing and understanding bioaccumulation in organisms. 2.4 **Environmental Toxicology:** • Environmental pollutants: heavy metals (lead, mercury), pesticides, and endocrine disruptors. • The concept of bioaccumulation and biomagnification in the food chain. 2.5 **Clinical Toxicology and Treatment:** • Diagnosis and management of poisoning: recognition of symptoms, treatment strategies. • Use of antidotes, activated charcoal, and supportive care in toxicology cases.	**15**

Learning Resources recommended:

1. A Textbook of Histology by Deshmukh Shivaji; Published by Dominant Publishers & Distributors.
2. Colour Textbook of Histology by Leslie P. Gartner; Published by Saunders, an imprint of Elsevier.
3. A Textbook of Histology by Ramesh Mathur; Published by Anmol Publications Pvt. Ltd.

4. A Textbook of Histology and A Practical Guide by J. P. Gunasegaran; Published by Elsevier India.
5. A Textbook of Histology by D. R. Khanna; Published by Sonali Publications.
6. Practical Zoology (Second Edition) by Dr. K. C. Ghose & Dr. B. Manna; Published by New Central Book Agency Pvt. Ltd., Kolkata, 1999.
7. Casarett and Doull's Toxicology: The Basic Science of Poisons by Curtis Klaassen; Published by McGraw-Hill Education, 2001.
8. Toxicological Testing Handbook: Principles, Applications, and Data Interpretation by David Jacobson-Kram and Kit Keller; Published by CRC Press, 2006.
9. Principles and Methods of Toxicology by A. Wallace Hayes; Published by CRC Press, 2007.
10. Toxicology - Principles and Methods by M.A. Subramanian; Published by MJP Publishers, Chennai, 2004.
11. Fundamentals of Toxicology by Kamleshwar Pandey and J.P. Shukla; Published by New Central Book Agency Ltd., Kolkata, 2011.
12. Elements of Toxicology by Kamleshwar Pandey and J.P. Shukla; Published by Wisdom Press, New Delhi, 2010.
13. Principles and Applications of Toxicology by Y.K. Lahir; Published by Seekay Publications, 2013.
14. Essentials of Clinical Toxicology by S. Lall; Published by Narosa Publishing House, 1998.
15. A Textbook of Veterinary and General Pathology (Second Edition) by J. L. Vagad; Published by IBDC Publishers.

Evaluation Pattern:

E. Internal Evaluation- 40 % **20 Marks**

Method	**Marks**
Class test	10
Assignment	10
Total	**20**

F. External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- **30 Marks**

1. The examination will have a duration of 1 hour and will carry a maximum of 30 marks.

2. There will be three questions, each carrying 10 marks. Each unit will have one question, and the third will cover the entire syllabus.

3. All questions will be compulsory, with internal choices provided within each question.

4. Questions may be divided into sub-questions (A and B), and marks will be allocated based on the topic's weightage.

Distribution of marks for descriptive external examination (30 marks)

All the Questions are compulsory

Time: 1 hour **Total marks: 30**

Question No.	Options	Unit	Marks
1.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1	10
2.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	2	10
3.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1& 2	10

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Syllabus for (T. Y. B. Sc.) Autonomous from the year 2025-26

Name of the Course	**Zoology Practical V**
Course Code (refer to the student handbook)	25_USZOM504
Class	T.Y.B. Sc.
Semester	V
No of Credits	2
Nature	Practical
Type (applicable to NEP only)	Major
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

	PRACTICALS	2 Credits
1.	**Study of Symmetry in Invertebrates** Examine and classify the types of symmetry (radial, bilateral, asymmetry) in preserved specimens or models. Examples: Hydra (radial), Earthworm (bilateral), Sponge (asymmetry).	
2.	**Observation of Coelom Types** Acoelomate (Planaria), Pseudocoelomate (Ascaris), Eucoelomate (Earthworm).	
3.	**Binomial Nomenclature and Identification** Identify and classify invertebrates using taxonomic keys. Examples: Porifera, Cnidaria, and Platyhelminthes specimens.	
4.	**Classification of Molluscan Shells** Examine and classify different molluscan shells (e.g., Pila, Sepia, Unio) based on morphological features.	
5.	**Study of Echinoderm Features** Observe preserved specimens of Asterias (sea stars) to study the water vascular system and pentaradial symmetry.	
6.	**Estimation of Blood Pressure** Measure systolic and diastolic blood pressure using a sphygmomanometer under different conditions (e.g., resting vs. post-exercise).	
7.	**Effect of Exercise on Heart Rate** Record heart rate before and after mild physical activity to study physiological adaptation.	
8.	**Effect of Substrate Concentration on Enzyme Activity** Perform an experiment to observe the Michaelis-Menten kinetics using amylase and starch.	
	Effect of Temperature on Enzyme Activity Analyze the activity of amylase on starch at different temperatures and record the optimum temperature.	
9.	**Effect of pH on Enzyme Activity** Test the effect of varying pH levels on the activity of catalase (using hydrogen peroxide).	
10.	**Effect of Enzyme Concentration on Reaction Rate** Vary enzyme concentrations to study their impact on the breakdown of a substrate.	
11.	**Inhibition of Enzymatic Activity** Demonstrate competitive and non-competitive inhibition using specific inhibitors on amylase or catalase activity.	
12.	**Preparation of Blood Smear and Identification of WBCs** Observation of neutrophils, lymphocytes, monocytes, eosinophils, and basophils under a microscope.	
13.	**Study of Lymphoid Organs**	

	Identification and significance of spleen, thymus, and lymph nodes in immune function.	
14.	**Observation of Protozoan Movement (Phagocytosis Simulation)** Use ink particles and yeast cells in Daphnia or a suitable model to observe phagocytosis under a microscope.	
15.	**Antigen-Antibody Interaction via Precipitation Reaction** Demonstration of precipitation in test tubes using antigen-antibody solutions.	

Practical Examination Pattern:

(A) Internal Examination 40 % 20 Marks

Heading	**Practical**
Journal	05
Lab Participation	05
Lab work/ Fieldwork	05
Viva-voce	05
Total	**20**

(B) External (Semester end practical examination) 60% 30 Marks

Particulars	**Practical**
Lab work	30
Total	**30**

PRACTICAL BOOK/JOURNAL

Students must present a duly certified journal to be eligible for the practical examination; otherwise, they will not be permitted to participate. If a journal and/or report is lost, a Lost Certificate must be obtained from the Head/Coordinator/Department In-charge. Failure to do so will result in the student being unable to participate in the practical examination.

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Syllabus for (T. Y. B. Sc.) Autonomous from the year 2025-26

Name of the Course	**Zoology Practical VI**
Course Code (refer to the student handbook)	25_USZOM505
Class	T.Y.B. Sc.
Semester	V
No of Credits	2
Nature	Practical
Type (applicable to NEP only)	Major
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

	PRACTICALS	2 credits
1.	**Study of Mammalian Tissues:** Preparation and examination of the vertical section (V.S.) of a tooth, and transverse sections (T.S.) of the stomach, small intestine, and liver. Students will identify different tissue types and structures under a microscope.	
2.	**Microtomy:** Tissue preservation, fixation, dehydration, infiltration, and paraffin embedding. Students will prepare blocks, section tissue samples, and perform staining for microscopic observation.	
3.	**Histological Staining Techniques:** Learn and perform common histological staining methods, such as Hematoxylin and Eosin (H&E), to distinguish between different tissue types and structures under the microscope.	
4.	**Effect of CCl_4 on Enzyme Activity**: In vitro experiment to study the effect of carbon tetrachloride (CCl_4) on the level of liver enzymes like aspartate aminotransferase (AST), alanine aminotransferase (ALT), and alkaline phosphatase (ALP). Students will measure enzyme activity after exposure to the toxin.	
5.	**Interpretation of Abnormal Pathological Reports:** Study and interpret clinical reports for blood (CBC), urine (routine), and stool (routine) tests. Students will correlate abnormal results with histological and physiological changes.	
6.	**Estimation of Total Protein Concentration (Lowry Method)** To estimate the total protein concentration in a biological sample.	
7.	**Estimation of Lipid Concentration (Folin-Wu Method)** To quantify lipids in a given sample.	
8.	**Estimation of Cholesterol Level (Abell–Levy–Brodie–King Method)** To measure cholesterol concentration in a biological sample.	
9.	**Estimation of Carbohydrates Using Anthrone Method** To estimate the carbohydrate content in a biological sample.	
10.	**Quantification of Vitamin C Using DCPIP Titration** To determine the concentration of Vitamin C (ascorbic acid) in fruit juices or food samples.	
11.	**Determination of Urease Activity** To determine the urease enzyme activity in a sample.	
12.	**Immobilization of Enzyme Using Encapsulation in Polymeric Materials** To immobilize an enzyme by encapsulation within a polymer matrix and study its enzymatic activity.	
13	**Fermentation Process for Ethanol Production** To produce ethanol through the fermentation of glucose by yeast.	

14.	**Animal Toxicity Testing (LC_{50} Determination):** Calculate the lethal concentration (LC_50) of a specific chemical (e.g., pesticides or toxins) by exposing a controlled population of aquatic organisms (e.g., fish or algae) to various concentrations and assessing mortality rates.	
15.	**Bioassay for Pesticide Toxicity**: Perform a bioassay to assess the toxicity of a pesticide by exposing Daphnia or brine shrimp to varying concentrations and observing the effects on mortality and movement patterns.	

Practical Examination Pattern:

(A) Internal Examination 40 % 20 Marks

Heading	**Practical**
Journal	05
Lab Participation	05
Lab work/ Fieldwork	05
Viva-voce	05
Total	**20**

(B) External (Semester end practical examination) 60% 30 Marks

Particulars	**Practical**
Lab work	30
Total	**30**

PRACTICAL BOOK/JOURNAL

Students must present a duly certified journal to be eligible for the practical examination; otherwise, they will not be permitted to participate. If a journal and/or report is lost, a Lost Certificate must be obtained from the Head/Coordinator/Department In-charge. Failure to do so will result in the student being unable to participate in the practical examination.

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Syllabus for (T. Y. B. Sc.) Autonomous from the year 2025-26

Name of the Course	**Taxonomy - Chordates and Type Study**
Course Code (refer to the student handbook)	25_USZOM601
Class	T.Y.B. Sc.
Semester	VI
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	Major
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: **Taxonomy - Chordates and Type Study**

CO1: Learners will comprehend the evolutionary significance of chordate characteristics, including the notochord, dorsal nerve cord, and pharyngeal slits, and their role in the classification of chordates.

CO2: Learners will analyze the structural and functional adaptations in non-vertebrate chordates, including Urochordates and Cephalochordates, through practical observations and dissections.

CO3: Learners will understand the anatomical and physiological adaptations of vertebrate groups (fishes, amphibians, reptiles, birds, and mammals) about their habitats and ecological roles.

CO4: Learners will develop skills in identifying and classifying chordates based on morphological and skeletal features, enabling a deeper understanding of vertebrate biodiversity.

CO6: Learners will document and appreciate chordate biodiversity, highlighting its ecological and evolutionary importance in maintaining ecosystem balance.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Fundamentals of Chordate Biology**	1.1 **Introduction to Phylum Chordata** • General characteristics of chordates • Evolutionary significance of notochord, dorsal nerve cord, pharyngeal slits, endostyle, and post-anal tail 1.2 **Subphylum Urochordata and Cephalochordata** • **Urochordata (e.g., *Herdmania*)**: Habit, habitat, and general features • **Cephalochordata (e.g., *Branchiostoma*)**: Morphology and significance in chordate evolution 1.3 **Subphylum Vertebrata** • Key features distinguishing vertebrates from protochordates • Overview of vertebrate organ systems 1.4 **Detailed Study of Pisces** • Characteristics and classification of cartilaginous (Chondrichthyes) and bony fishes (Osteichthyes) • Economic and ecological importance of fishes	**15**

		1.5 **Amphibia and Their Transition to Land** • General features and adaptations for semi-aquatic life • Examples: *Rana* (frog), *Ichthyophis*	
II	**Advanced Chordate Taxonomy and Type Study**	2.1 **Reptilia: Adaptations for Terrestrial Life** • General characteristics and classification • Overview of adaptations: scales, amniotic egg, and temperature regulation • Aves: The Evolution of Flight 2.2 General features of modern birds • Key adaptations: feathers, skeletal modifications, and respiratory system • Mammalia: Diversity and Adaptations 2.3 **General characteristics and classification of mammals** • Key adaptations: hair, mammary glands, dentition, and advanced brain functions 2.4 **Type Study of Herdmania** • Detailed study of Herdmania: Habit, habitat, external morphology, and internal anatomy (digestive, respiratory, circulatory, and reproductive systems) • Role of Herdmania in understanding protochordate evolution **2.5 Applications of Chordate Studies** • Importance in evolutionary biology, ecology, and conservation • Contributions to agriculture, medicine, and biodiversity management	**15**

Learning Resources recommended:

1. Modern Textbook of Zoology - Vertebrates; R.L. Kotpal; Rastogi Publications; Third Edition, 2012.
2. Vertebrate Zoology for Degree Students; V.K. Agarwal; S. Chand Publications; 2012.
3. Fundamentals of Zoology; K.C. Ghosh and B. Manna; New Central Book Agency (P) Ltd.
4. Chordate Zoology Volume II; N. Arumugam; Saras Publications.
5. Chordate Anatomy; Mohan P. Arora; Himalaya Publishing House; First Edition.
6. The Life of Vertebrates; J.Z. Young; ELBS - Oxford University Press; Third Edition, 2006.
7. Textbook of Chordate Zoology Vol. II; G.S. Sandhu and H. Bhaskar; Campus Book International; First Edition, 2005.
8. Introduction to Zoology - Vol II; K.K. Chaki, G. Kundu, and S. Sarkar; New Crystal Book Agency.
9. Chordate Zoology; E.L. Jordan and P.S. Verma; Chand Publications; 2009 Edition.
10. Modern Textbook of Zoology Vertebrates; R.L. Kotpal; Rastogi Publications; January 2015 Edition.
11. Practical Zoology: Vertebrate; S.S. Lal; 2015 Edition.

12. The Animal Kingdom: An Elementary Textbook in Zoology; Ellis Davidson; Forgotten Books; September 2015 Edition.
13. Chordate Zoology by P.S. Verma; Chand Publications; 2009 Edition.
14. A Textbook of Invertebrate Zoology & Cell Biology; V.S. Kanwate, A.N. Kulkarni et al.; Alka Prakashan.
15. The Animal Kingdom: Specially Classified and Arranged for Science Classes; Ellis Davidson; Forgotten Books; September 2015 Edition.

Evaluation Pattern:

(A) Internal Evaluation- 40 % **20 Marks**

Method	**Marks**
Class test	10
Assignment	10
Total	**20**

(B) External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- **30 Marks**

1. The examination will have a duration of 1 hour and will carry a maximum of 30 marks.
2. There will be three questions, each carrying 10 marks. Each unit will have one question, and the third will cover the entire syllabus.
3. All questions will be compulsory, with internal choices provided within each question.
4. Questions may be divided into sub-questions (A and B), and marks will be allocated based on the topic's weightage.

Distribution of marks for descriptive external examination (30 marks)

All the Questions are compulsory

Time: 1 hour **Total marks: 30**

Question No.	**Options**	**Unit**	**Marks**
1.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1	10
2.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	2	10
3.	A) Answer any one of the following questions (6 marks each)	1&2	10

	B) Answer any one of the following questions (4 marks each)		

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Syllabus for (T. Y. B. Sc.) Autonomous from the year 2025-26

Name of the Course	**Molecular Biology and Genetics**
Course Code (refer to the student handbook)	25_USZOM602
Class	T.Y.B. Sc.
Semester	VI
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	Major
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: **Molecular Biology and Genetics**

CO1 – The learner shall understand the fundamentals of enzyme structure, action and kinetics.
CO2 – The learner shall appreciate the enzyme assay procedures and the therapeutic applications of enzymes.
CO3 – The learner shall comprehend the adaptive responses of animals to environmental changes for their survival.
CO4 – The learner shall understand the types and secretions of endocrine glands and the functions.
CO5 –The learner shall understand the significance of tissue culture as a tool in specialized areas of research.
CO6 – The learner will appreciate its applications in various industries.

Curriculum:

Unit	Title	Learning Points	No of Lectures
1.	**Molecular Biology and Mutations**	1.1 **Molecular Biology Overview** • Central Dogma of Molecular Biology • DNA as the genetic material: Griffith, Avery-Macleod-McCarty, Hershey-Chase experiments 1.2 **DNA Structure and Function** • DNA Structure: Double helix, A/B/Z forms • DNA Replication: Enzymes involved and mechanisms in prokaryotes and eukaryotes 1.3 **Gene Expression** • Transcription: Mechanisms in prokaryotes and eukaryotes • Translation: Genetic code, protein synthesis, and post-translational modifications 1.4 **Gene Regulation** • Prokaryotic Regulation: Lac Operon • Eukaryotic Regulation: Transcription factors and epigenetics 1.5 **Mutations** • Types of Mutations: Point mutations, frameshift mutations, chromosomal mutations • Causes: Physical, chemical, and biological mutagens • Effects: Silent, missense, nonsense, and frameshift mutations • DNA Repair Mechanisms: Mismatch repair, nucleotide excision repair, and base excision repair	**15**

2.	**Human Genetics and Abnormalities**	2.1 **Human Genome Overview** • Structure and organization of human chromosomes • Chromosomal theory of inheritance 2.2 **Genetic Inheritance Patterns** • Mendelian Genetics: Autosomal dominant and recessive inheritance • Non-Mendelian Inheritance: Codominance, incomplete dominance, and mitochondrial inheritance 2.3 **Genetic Disorders** • Chromosomal Abnormalities: Aneuploidy (Down Syndrome, Turner Syndrome, Klinefelter Syndrome) • Gene-related disorders: Sickle Cell Anaemia, Haemophilia, Cystic Fibrosis 2.4 **Pedigree Analysis** • Reading and interpreting pedigrees • Identifying autosomal and sex-linked traits 2.5 **Techniques in Human Genetics** • Karyotyping • Prenatal Diagnosis: Amniocentesis and chorionic villus sampling • Molecular Techniques: PCR and DNA sequencing 2.6 **Ethical Issues in Human Genetics** • Genetic counselling • Ethical implications of genetic testing	**15**

Learning Resources recommended:

1. Molecular Biology of the Cell by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter; Published by Garland Science, 2015.
2. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox; Published by W.H. Freeman, 2017.
3. Human Molecular Genetics by Tom Strachan and Andrew P. Read; Published by CRC Press, 2018.
4. Introduction to Genetic Analysis by Anthony J.F. Griffiths, John Doebley, and Susan R. Wessler; Published by W.H. Freeman, 2020.
5. Gene Cloning and DNA Analysis: An Introduction by T.A. Brown; Published by Wiley-Blackwell, 2016.
6. Molecular Biology: Principles and Practice by Michael M. Cox, Jennifer Doudna, and Michael O'Donnell; Published by W.H. Freeman, 2019.

7. Essential Genetics: A Genomics Perspective by Daniel L. Hartl and Bruce Cochrane; Published by Jones & Bartlett Learning, 2018.
8. Genomes 4 by Terence A. Brown; Published by Garland Science, 2020.

9. Human Genetics: Concepts and Applications by Ricki Lewis; Published by McGraw-Hill Education, 2021.
10. DNA Repair and Mutagenesis by Errol C. Friedberg, Graham C. Walker, Wolfram Siede, and Richard D. Wood; Published by ASM Press, 2005.
11. Genetic Counseling: Ethical Challenges and Clinical Applications by Uta Francke; Published by Springer, 2018.
12. Human Genetic Disorders by Edward S. Tobias, Michael Connor, and Malcolm Ferguson-Smith; Published by Cambridge University Press, 2011.
13. Human Genetics and Genomics by Bruce R. Korf and Mira B. Irons; Published by Wiley-Blackwell, 2018.
14. Principles of Genetics by D. Peter Snustad and Michael J. Simmons; Published by Wiley, 2016.

Evaluation Pattern:

G. Internal Evaluation- 40 % **20 Marks**

Method	**Marks**
Class test	10
Assignment	10
Total	**20**

H. External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- **30 Marks**

1. The examination will have a duration of 1 hour and will carry a maximum of 30 marks.
2. There will be three questions, each carrying 10 marks. Each unit will have one question, and the third will cover the entire syllabus.
3. All questions will be compulsory, with internal choices provided within each question.
4. Questions may be divided into sub-questions (A and B), and marks will be allocated based on the topic's weightage.

Distribution of marks for descriptive external examination (30 marks)

All the Questions are compulsory

Time: 1 hour **Total marks: 30**

Question No.	Options	Unit	Marks
1.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1	10
2.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	2	10
3.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1&2	10

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Syllabus for (T. Y. B. Sc.) Autonomous from the year 2025-26

Name of the Course	**Biostatistics and Bioinformatics**
Course Code (refer to the student handbook)	25_USZOM603
Class	T.Y.B. Sc.
Semester	VI
No of Credits	2
Nature	Theory
Type (applicable to NEP only)	Major
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: **Biostatistics and Bioinformatics**

CO1: Learners will develop a strong foundation in probability concepts and distributions, enabling them to apply these principles to predict genetic outcomes and analyze biological data.

CO2: Learners will gain the ability to perform hypothesis testing using statistical methods, such as t-tests and Chi-square tests, to evaluate biological research questions.

CO3: Learners will understand and apply correlation and regression techniques to explore relationships between biological variables and interpret biological phenomena quantitatively.

CO4: Learners will acquire skills to conduct ANOVAs to compare multiple biological groups, enhancing their ability to analyze experimental designs in biology.

CO5: Learners will explore bioinformatics tools and databases, enabling them to retrieve, align, and analyze biological sequences for applications in genomics and proteomics.

CO6: Learners will develop expertise in phylogenetic analysis using bioinformatics software, facilitating studies in genetic diversity, evolutionary relationships, and comparative genomics.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Core Concepts and Statistical Techniques in Biostatistics**	1.1 **Probability and Probability Distributions** • **Basic Probability Concepts**: Definitions and rules of probability, including independent and dependent events. • **Probability Distributions**: Introduction to discrete (e.g., binomial distribution) and continuous (e.g., normal distribution) probability distributions. • **Applications in Biology**: • Use of probability in predicting genetic outcomes and population-level traits. 1.2 **Hypothesis Testing** • **Concept of Hypothesis Testing**: Null and alternative hypotheses, Type I and Type II errors, p-values, and significance levels. • **Common Statistical Tests**: **t-tests** (independent and paired) and **Chi-square test** for categorical data. • **Applications in Biological Research**:	**15**

		Examples of hypothesis testing in experimental biology, such as testing differences in treatment effects or comparing population proportions. 1.3 **Correlation and Regression Analysis** • **Correlation**: Pearson's and Spearman's correlation coefficients, interpretation, and applications in biology. • **Linear Regression**: Simple linear regression, interpretation of slope and intercept, and the concept of the line of best fit. • **Applications**: Examining relationships between biological variables, such as height and weight, or enzyme concentration and reaction rate. 1.4 **Analysis of Variance (ANOVA)** • **One-Way ANOVA**: Concept and assumptions of ANOVA, partitioning of variance, F-ratio, and interpretation. • **Applications in Biological Studies**: Comparing means across multiple groups, such as treatment vs. control in biological experiments.	
	Introduction to Bioinformatics and Key Tools	1.1 **Introduction to Bioinformatics** • **Definition and Scope**: Overview of bioinformatics and its role in life sciences, including applications in genomics, proteomics, and evolutionary biology. • **Key Areas in Bioinformatics**: Genomics, proteomics, structural bioinformatics, and functional genomics. 1.2 **Biological Databases** • **Types of Databases**: Overview of primary and secondary biological databases, including sequence, structure, and functional databases. • **Key Databases**: NCBI (GenBank), EMBL-EBI, UniProt, Protein Data Bank (PDB). • **Data Retrieval and Analysis**: Accessing and retrieving biological sequences and structural data from public databases. 1.3 **Sequence Alignment and Analysis** • **Concept of Sequence Alignment**: Basics of sequence alignment, including pairwise and multiple sequence alignment. • **Alignment Tools**: Introduction to popular tools like BLAST (Basic Local Alignment Search Tool) and Clustal Omega. • **Applications in Biological Research**:	

		Gene identification, evolutionary studies, and protein function prediction. 1.4 **Basic Phylogenetics and Evolutionary Analysis** • **Phylogenetic Analysis**: Basic principles of phylogenetic tree construction and evolutionary relationships. • **Tools for Phylogenetic Analysis**: Introduction to software tools like MEGA (Molecular Evolutionary Genetics Analysis) for constructing phylogenetic trees. • **Applications**: Study of genetic diversity, tracking evolutionary lineage, and comparative genomics.	

Learning Resources recommended:

1. Biostatistics: A Foundation for Analysis in the Health Sciences by Wayne W. Daniel and Chad L. Cross; Published by Wiley, 2018.
2. Introduction to Probability and Statistics for Engineers and Scientists by Sheldon M. Ross; Published by Academic Press, 2020.
3. Practical Statistics for Field Biology by Jim Fowler, Lou Cohen, and Phil Jarvis; Published by Wiley-Blackwell, 2013.
4. Statistical Methods in Biology: Design and Analysis of Experiments and Regression by Sokal and Rohlf; Published by W.H. Freeman, 2011.
5. Biostatistics: The Bare Essentials by Geoffrey R. Norman and David L. Streiner; Published by People's Medical Publishing House, 2014.
6. Introduction to Bioinformatics by Arthur M. Lesk; Published by Oxford University Press, 2019.
7. Bioinformatics: Sequence and Genome Analysis by David W. Mount; Published by Cold Spring Harbor Laboratory Press, 2004.
8. Essential Bioinformatics by Jin Xiong; Published by Cambridge University Press, 2006.
9. Developments in Biological Databases and Tools by Jonathan M. Keith and Peter C. Jones; Published by Springer, 2021.
10. Bioinformatics for Dummies by Jean-Michel Claverie and Cedric Notredame; Published by Wiley, 2011.
11. BLAST: An Essential Guide to Basic Local Alignment Search Tool by Ian Korf, Mark Yandell, and Joseph Bedell; Published by O'Reilly Media, 2003.
12. MEGA Software Guide: Molecular Evolutionary Genetics Analysis by Koichiro Tamura et al.; Published as a resource for MEGA users, freely available online.
13. Computational Biology: A Practical Introduction to Biodata Analysis and Literature Mining by Röbbe Wünschiers; Published by Springer, 2017.

Evaluation Pattern:

A. Internal Evaluation- 40 % **20 Marks**

Method	Marks
Class test	10
Assignment	10
Total	**20**

B. External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- 30 Marks

1. The examination will have a duration of 1 hour and will carry a maximum of 30 marks.
2. There will be three questions, each carrying 10 marks. Each unit will have one question, and the third question will cover the entire syllabus.
3. All questions will be compulsory, with internal choices provided within each question.
4. Questions may be divided into sub-questions (A and B), with the allocation of marks based on the weightage of the topic.

Distribution of marks for descriptive external examination (30 marks)

All the Questions are compulsory

Time: 1 hour **Total marks: 30**

Question No.	Options	Unit	Marks
1.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1	10
2.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	2	10
3.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1&2	10

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Syllabus for (T. Y. B. Sc.) Autonomous from the year 2025-26

Name of the Course	**Zoology Practical VII**
Course Code (refer to the student handbook)	25_USZOM604
Class	T.Y.B. Sc.
Semester	VI
No of Credits	2
Nature	Practical
Type (applicable to NEP only)	Major
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

	PRACTICALS	2 Credits
1.	**Group Protochordata** Subphylum Urochordata • Class Larvacea e.g. Oikopleura (Sea squirt) • Class Ascidiacea e.g. Ciona (Transparent Sea squirt) • Class Thaliacea e.g. Salpa (Common salp) Subphylum Cephalochordata • Class Leptocardii e.g. Branchiostoma (Amphioxus) Subphylum Vertebrata: Division Agnatha • Class Ostracodermi e.g. Pharyngolepis • Class Cyclostomata e.g. Petromyzon (Lamprey)	
2.	**Division Gnathostomata** Superclass Pisces: • Class Placodermi e.g. Bothriolepis • Class Chondrichthyes e.g. Rhinobatos (Guitar fish), Chimaera (Rabbitfish) • Class Osteichthyes e.g. Protopterus, Clarius (Catfish) Superclass Tetrapoda: • Class Amphibia e.g. Alytes (Midwife toad) and Triton (Salamander) • Class Reptilia e.g. Varanus (Monitor lizard) and Crocodylus (Crocodile)	
3.	**Class Aves**: Examples: Eudyptes (Penguin), Phoenicopterus (Flamingo) and Gyps (Vulture)	
4.	**Class Mammalia**: Examples: Dasyurus (Quoll), Petaurista (Flying squirrel) and Macaca (Monkey).	
5.	Identification and classification of Chondrichthyes and Osteichthyes.	
6.	**Economic Importance of Fishes** Identification and categorization of commercially important fish species.	
7.	**Mammalian Dentition** Study of different types of teeth (incisors, canines, molars) and their adaptations for diet (herbivorous, carnivorous, and omnivorous).	
8.	**Bird Feather Analysis** Microscopic examination of feather adaptations in birds.	
9.	**Study of Bird Beaks and Claws**: Examination of variations in bird beaks and claws in relation to feeding habits and locomotion.	
10.	**Study of Fish Scales**: Collection and microscopic examination of fish scales to differentiate between placoid, cycloid, and ctenoid types.	
11.	**Respiratory Adaptations in Fishes**: Observation of gill structures in bony and cartilaginous fishes, highlighting adaptations for aquatic respiration.	

12.	Eggshell Thickness in Birds:	
13.	Measure the eggshell thickness of bird eggs (e.g., chicken) and discuss its ecological and evolutionary significance.	
14.	**Comparative Study of Vertebrate Heart Models**: Analyze preserved hearts or 3D models to compare structural differences between fishes, amphibians, reptiles, birds, and mammals.	
15.	**Chordate Life Cycle Models:** Build life cycle models for representative chordates (e.g., frog, fish, bird).	

Practical Examination Pattern:

(A) Internal Examination 40 % 20 Marks

Heading	**Practical**
Journal	05
Lab Participation	05
Lab work/ Fieldwork	05
Viva-voce	05
Total	**20**

(B) External (Semester end practical examination) 60% 30 Marks

Particulars	**Practical**
Lab work	30
Total	**30**

PRACTICAL BOOK/JOURNAL

Students must present a duly certified journal to be eligible for the practical examination; otherwise, they will not be permitted to participate. If a journal and/or report is lost, a Lost Certificate must be obtained from the Head/Coordinator/Department In-charge. Failure to do so will result in the student being unable to participate in the practical examination.

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Syllabus for (T. Y. B. Sc.) Autonomous from the year 2025-26

Name of the Course	**Zoology Practical VIII**
Course Code (refer to the student handbook)	25_USZOM605
Class	T.Y.B. Sc.
Semester	VI
No of Credits	2
Nature	Practical
Type (applicable to NEP only)	Major
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

	PRACTICALS	2 Credits
1.	**Extraction of Genomic DNA** Isolation of DNA from animal tissues or plant sources and quantifying it using UV spectrophotometry.	
2.	**RNA Extraction and Quantification** Extraction of RNA from animal or plant tissues and quantifying it using UV spectrophotometry.	
3.	**Gel Electrophoresis** Visualization of DNA fragments using agarose gel electrophoresis.	
4.	**Protein Electrophoresis (SDS-PAGE)** Analyze protein samples based on molecular weight.	
5.	**Introduction to NCBI Databases** Accessing genetic and protein data.	
6.	**BLAST Tool for Sequence Analysis** Performing pairwise alignment and identifying homologous sequences.	
7.	**Protein Structure Visualization** Use of tools like Pymol or Rasmol to analyze protein 3D structures.	
8.	**Phylogenetic Tree Construction** Using MEGA software for evolutionary analysis.	
9.	**Data Distribution Analysis** Study the distribution pattern of biological data (normal, skewed, or bimodal).	
10.	**Statistical Tests in Biology** Application of t-tests and Chi-square tests using statistical software.	
11.	**Correlation and Regression Analysis** Biological data interpretation through statistical tools.	
12.	**Analysis of Variance (ANOVA)** Compare multiple groups for statistical differences.	
13.	**Cluster Analysis** Group biological data based on similarities.	
14.	**Time Series Analysis** Analyze trends in biological data collected over time.	
15.	**Biodiversity Audit of a Local Ecosystem** Analyze species diversity in a nearby habitat using statistical tools.	

Practical Examination Pattern:

(A) Internal Examination 40 % 20 Marks

Heading	Practical
Journal	05
Lab Participation	05
Lab work/ Fieldwork	05
Viva-voce	05

Total	**20**

(B) External (Semester end practical examination) 60% 30 Marks

Particulars	**Practical**
Lab work	30
Total	**30**

PRACTICAL BOOK/JOURNAL

Students must present a duly certified journal to be eligible for the practical examination; otherwise, they will not be permitted to participate. If a journal and/or report is lost, a Lost Certificate must be obtained from the Head/Coordinator/Department In-charge. Failure to do so will result in the student being unable to participate in the practical examination.

N.B:

I) It is pertinent to note that we have to adhere strictly to the directions as given in the UGC Circular F14-4/2006 (CPP-II).

II) Apart from the Institutional Animal Ethics Committee (IAEC) and any other Committee appointed by a Competent Authority / Body from time to time, every college should constitute the following Committees:

1) A Committee for Care and Supervision of Experimental Animals (CPCSEA) and
2) A Dissection Monitoring Committee (DMC) to ensure that no dissections or mountings are done using animals.

The composition of DMC shall be as follows:

i) Head of the Concerned Department (Convener / Chairperson)
ii) Two Senior Faculty Members of the concerned Department
iii) One Faculty of a related department from the same College
iv) One or two members of related departments from neighbouring colleges.

USE OF ANIMALS FOR ANY EXPERIMENT /DISSECTION /MOUNTING IS BANNED. SIMULATIONS, AUTHORIZED PERMANENT SPECIMENS/SLIDES, CHARTS, MODELS AND OTHER INNOVATIVE METHODS ARE ENCOURAGED.

Date:
Place: Ratnagiri

Signature
Chairperson and HoD

R.E. Society's

R. P. GOGATE COLLEGE OF ARTS & SCIENCE AND R.V. JOGALEKAR COLLEGE OF COMMERCE (AUTONOMOUS), RATNAGIRI

NAAC accredited 'A' Grade (4th Cycle)
Ratnagiri-415612 (Maharashtra-India)

S.Y. B. Sc. SYLLABUS FOR

ZOOLOGY

Major Elective Course (MEC)

Department of Zoology Under NEP 2020

Framed According to the National Education Policy (NEP 2020)

To be implemented from Academic Year: 2025-2026

PREAMBLE:

The Vocational Skill Courses for T.Y.B.Sc. Zoology, to be implemented from the academic year 2025-2026 under the Choice-Based Credit System (CBCS), aim to equip students with practical, industry-relevant skills. Designed with a strong focus on employability and sustainable practices, these courses provide a robust platform for learners to transition seamlessly from academia to professional environments.

The curriculum covers diverse and impactful areas, such as Entomology and Pest Management and Sustainable Aquaculture Practices, emphasizing skill development, innovation, and real-world applications. Students will gain expertise in integrated pest management, biological control techniques, sustainable aquaculture models, and emerging technologies. The syllabus incorporates a blend of theoretical knowledge and hands-on experience, empowering students to address environmental challenges while fostering economic growth and resource management.

In alignment with global scientific advancements and industry trends, these courses also highlight the importance of ecological balance, sustainable development, and ethical practices. Practical sessions, case studies, and fieldwork have been included to provide a comprehensive learning experience that nurtures critical thinking and problem-solving skills.

As the Head of the Zoology Department, I am proud to present a curriculum that reflects our commitment to excellence in education, sustainability, and innovation. I am confident that these vocational skill courses will inspire students to pursue meaningful careers and contribute positively to society.

Chairperson,
BOS in Zoology,
Gogate Jogalekar College,
Ratnagiri.

Syllabus for T. Y. B. Sc. Course: ZOOLOGY
Credit-Based Semester and Grading System
(To be implemented from the Academic Year 2025-2026)

SEMESTER – V

COURSE CODE	UNIT	TOPIC	CREDITS
25_USZOE506	I	Introduction to Human Osteology and the Axial Skeleton	**02**
	II	Appendicular Skeleton and Functional Anatomy of Joints	
25_USZOE507		Osteology Practical	**02**
		OR	
25_USZOE508	I	Gametogenesis, Fertilization, and Early Development	**02**
	II	Organogenesis, Morphogenesis, and Post-Embryonic Development	
25_USZOE509		Developmental Biology Practical	**02**
Total Number of Credits and Workload			**04**

SEMESTER – VI

COURSE CODE	UNIT	TOPIC	CREDITS
25_USZOE606	I	Foundations of Animal Behavior and Control Mechanisms	02
	II	Social Behaviour, Communication, and Chronobiology	
25_USZOE607		Ethology Practical	02
		OR	
25_USZOE608	I	Principles of Endocrinology and Hormone Function	02
	II	Advanced Topics in Endocrinology and Disorders	
25_USZOE609		Endocrinology Practical	02
Total Number of Credits and Workload			**04**

Syllabus for (T. Y. B. Sc.) Autonomous from the year 2025-26

Name of the Course	**Human Osteology**
Course Code (refer to the student handbook)	25_USZOE506 and 25_USZOE507
Class	T.Y.B. Sc.
Semester	V
No of Credits	4
Nature	Theory
Type (applicable to NEP only)	Elective
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: **Human Osteology**

CO1 - Learners will understand the fundamentals of osteology, including the importance, structure, composition, and development of bones.
CO2 - Learners will be able to classify and identify various bone types and anatomical landmarks, emphasizing gender differences in skeletal structure.
CO3 - Learners will gain knowledge of the axial skeleton, including the structure, function, and unique features of cranial, facial, vertebral, and rib cage bones.
CO4 - Learners will comprehend the structure and function of the appendicular skeleton, with a focus on adaptations in limbs and girdles for mobility and weight-bearing.
CO5 - Learners will be familiar with the classification, structure, and biomechanics of joints and the roles of cartilage, ligaments, and tendons.
CO6 - Learners will understand the functional anatomy of common human movements, including gait and upper limb mechanics, in the context of joint and muscle interaction.
CO7 - Learners will recognize age-related skeletal changes and common disorders, such as osteoporosis and arthritis, affecting bone density and movement.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Introduction to Human Osteology and the Axial Skeleton**	**1.1 Fundamentals of Osteology** • **Introduction to Osteology**: Definition, scope, and importance in anthropology, forensics, and medicine • **Bone Structure**: Histology of bone tissue, chemical composition, physical properties, and functions of bones • **Bone Development and Growth**: Ossification processes (intramembranous and endochondral), factors affecting bone growth, bone remodelling, and repair **1.2 Bone Classification and Identification** • **Types of Bones**: Long, short, flat, irregular, and sesamoid bones; their characteristics and examples in the human body • **Bone Identification Techniques**: Anatomical landmarks and differences between male and female skeletal structures **1.3 Axial Skeleton - Skull** • **Cranial Bones**: Structure, function, and anatomical landmarks of the frontal, parietal, temporal, occipital, sphenoid, and ethmoid bones • **Facial Bones**: Maxilla, mandible, zygomatic, nasal, lacrimal, vomer, palatine, and inferior nasal conchae; their roles in protection and sensory function • **Dentition**: Types and structure of teeth, dental formula, and their use in age estimation	**15**

		1.4 Vertebral Column and Thoracic Cage • **Vertebral Column**: General structure, regional differences (cervical, thoracic, lumbar, sacral, and coccygeal), and functions of vertebrae • **Ribs and Sternum**: Types of ribs, structure of the sternum, and roles in respiratory movement and organ protection • **Hyoid Bone**: Unique structure and function, importance in forensic analysis ○	
II	**Appendicular Skeleton and Functional Anatomy of Joints**	**2.1 Introduction to the Appendicular Skeleton** • **Pectoral Girdle**: Structure and function of the clavicle and scapula • **Upper Limbs**: Anatomy of humerus, radius, ulna, carpal bones, metacarpals, and phalanges **2.2 Pelvic Girdle and Lower Limbs** • **Pelvic Girdle**: Structure of ilium, ischium, and pubis; gender differences in the pelvic bones • **Lower Limbs**: Detailed structure of femur, patella, tibia, fibula, tarsal bones, metatarsals, and phalanges; their roles in weight-bearing and locomotion **2.3 Joint Types and Movements** • **Classification of Joints**: Fibrous, cartilaginous, and synovial joints with examples • **Joint Structure**: Anatomy of synovial joints, cartilage types, ligaments, and tendons involved in joint stability and movement • **Common Joint Movements**: Flexion, extension, rotation, abduction, adduction, pronation, and supination **2.4 Functional Anatomy and Analysis of Common Human Movements** • **Human Locomotion**: Basic gait cycle, the role of the hip, knee, and ankle joints in walking • **Functional Analysis of Upper Limb Movements**: Anatomy of shoulder, elbow, and wrist movements • **Age-Related Changes**: Bone density variations, common skeletal disorders (osteoporosis, arthritis)	**15**

	PRACTICALS	2 credits
1.	Identification and classification of bones (long, short, flat, irregular, and sesamoid) based on physical characteristics and anatomical landmarks.	
2.	Sex determination using pelvic and cranial bones.	
3.	Study of the human skull – cranial and facial bones.	
4.	Analysis of vertebral column – cervical, thoracic, lumbar, sacral, and coccygeal vertebrae.	
5.	Examination of the thoracic cage – ribs and sternum.	
6.	Study of the pectoral girdle and bones of the upper limbs.	
7.	Microscopic examination of bone tissue.	
8.	Chemical composition analysis of bones. (Demineralization Experiment)	
9.	Identification and study of major joint types in the human body (fibrous, cartilaginous, and synovial joints)	
10.	Functional analysis of synovial joints and their movements (shoulder, elbow, hip, knee).	
11.	Study the role of bone marrow in blood cell production.	
12.	Comparing Human and Non-Human Primate Bones	
13.	Study of Degenerative Changes in Bones	
14.	Case Study on Bone Fractures and Healing/Osteoporosis	
15.	Visit to Medical College Anatomical Lab	

Learning Resources recommended:

1. Atlas of Human Anatomy – Vol. I; R.D. Sinelnikov; Mr. Publishers Moscow. A Guide of Osteology (for medical students); Prakash Kendra, Lucknow.
2. Human Osteology-Tim D White.
3. Text Book of Human Osteology- Singh Inderbir.
4. Mechanisms of Body Functions; Second Edition; Dexter M. Easton; Prentice-Hall of India Pvt. Ltd., New Delhi;1978.
5. Human Anatomy-John W. Hole, Jr., Karen A. Koos, Publisher: W.C. Brown Publisher, USA.
6. Principles of Anatomy and Physiology- Gerard T. Tortora and Sandra Reynolds Grabowski. Publisher: Harpers Collins College Publishers (7th edition).

Evaluation Pattern:

A. Internal Evaluation- 40 % **20 Marks**

Method	Marks
Class test	10
Assignment	10
Total	**20**

B. External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- **30 Marks**

1. The examination will have a duration of 1 hour and will carry a maximum of 30 marks.

2. There will be three questions, each carrying 10 marks. Each unit will have one question, and the third will cover the entire syllabus.

3. All questions will be compulsory, with internal choices provided within each question.

4. Questions may be divided into sub-questions (A and B), and marks will be allocated based on the topic's weightage.

Distribution of marks for descriptive external examination (30 marks)

All the Questions are compulsory

Time: 1 hour **Total marks: 30**

Question No.	Options	Unit	Marks
1.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1	10
2.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	2	10
3.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1&2	10

Practical Examination Pattern:

(A) Internal Examination 40 % **20 Marks**

Heading	Practical
Journal	05
Lab Participation	05
Lab work/ Fieldwork	05
Viva-voce	05
Total	**20**

(B) External (Semester end practical examination) 60% **30 Marks**

Particulars	Practical
Lab work	30
Total	**30**

PRACTICAL BOOK/JOURNAL

Students must present a duly certified journal to be eligible for the practical examination; otherwise, they will not be permitted to participate. If a journal and/or report is lost, a Lost Certificate must be obtained from the Head/Coordinator/Department In-charge. Failure to do so will result in the student being unable to participate in the practical examination.

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Syllabus for (T. Y. B. Sc.) Autonomous from the year 2025-26

Name of the Course	**Developmental Biology**
Course Code (refer to the student handbook)	25_USZOE508 and 25_USZOE508
Class	T.Y.B. Sc.
Semester	V
No of Credits	4 (2+2)
Nature	Theory and Practical
Type (applicable to NEP only)	Elective
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: **Developmental Biology**

CO1 – Understand the basic concepts of developmental biology, including gametogenesis, fertilization, and early development processes.
CO2 – Learn the mechanisms of fertilization, prevention of polyspermy, and egg activation in early development.
CO3 – Gain knowledge of cleavage, blastulation, and gastrulation, and understand germ layer formation in different organisms.
CO4 – Explore organogenesis, including the development of organs like limbs and eyes, and the role of Spemann's Organizer in axis formation.
CO5 – Study post-embryonic development processes such as metamorphosis, regeneration, apoptosis, and aging.
CO6 – Understand the applications of developmental biology, including stem cells, teratogenesis, developmental disorders, and current research trends.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Gametogenesis, Fertilization, and Early Development**	**1.1 Introduction to Developmental Biology** • Definition and scope of developmental biology • Historical perspective and key concepts- phases of development, cell-cell interactions, pattern formation, and differentiation. **1.2 Gametogenesis** • **Spermatogenesis in Mammals**: Process and structure of sperm. • **Oogenesis in Mammals**: Process, structure of the egg, and types of eggs. **1.3 Fertilization** • Mechanisms of fertilization in animals (external and internal). • Biochemical aspects of sperm-egg recognition and binding. • **Prevention of Polyspermy**: Fast and slow blocks to polyspermy. • **Activation of Egg Metabolism**: Role of egg activation in early development. **1.4 Cleavage and Blastulation** • Types and patterns of cleavage; factors affecting cleavage Formation and types of blastulae in different organisms **1.5 Gastrulation and Germ Layer Formation** • Process of gastrulation in various model organisms (e.g., sea urchin, frog, chick) • Formation of primary germ layers: ectoderm, mesoderm, and endoderm	**15**

II	**Organogenesis, Morphogenesis, and Post-Embryonic Development**	**2.1 Basic Concepts of Developmental Biology** • **Potency, Commitment, and Specification**: Definitions and examples. • **Induction and Competence**: Mechanisms of tissue interactions. • **Determination and Differentiation**: Pathways and factors. **2.2 Morphogenetic Gradients and Cell Fate** • Concept of morphogenetic gradients, cell fate mapping, and cell lineage. 2**.3 Organogenesis** • Developmental processes for selected organs (e.g., limb and eye lens in vertebrates). • **Primary Embryonic Induction**: Spemann's Organizer and its role in axis formation. 2.4 **Post-Embryonic Development** • **Metamorphosis**: Hormonal control in amphibians and insects. • **Regeneration**: Types (epimorphosis, morphallaxis) with examples. 2.5 **Programmed Cell Death and Aging** • Apoptosis and its significance in development. • Overview of ageing and theories of senescence (e.g., telomeric theory, free radical theory). 2.6 **Applications of Developmental Biology** • Stem cell biology: Embryonic and adult stem cells. • Teratogenesis: Effects of teratogenic agents (e.g., alcohol, drugs) on development. • Case studies of developmental disorders and their genetic/environmental origins • Current research trends in developmental biology and its future scope	**15**

	PRACTICALS	**2 credits**
1.	Observation of various egg types (e.g., isolecithal, mesolecithal) and cleavage patterns through prepared slides and charts.	
2.	Study of permanent slides of Human Testis and Ovary sections to observe spermatogenesis and oogenesis processes.	
3.	Sperm Count Estimation: Using Neubauer's chamber to study sperm concentration and motility.	
4.	To observe and compare the structure of the placenta in different species (photomicrograph / slides).	
5.	Mounting of chick embryo and determination of its embryonic age based on morphological characteristics.	
6.	Examination of Human Developmental Stages Using Model Systems	

7.	Study of permanent slides showing frog developmental stages, including cleavage, blastula, gastrula, neurula, tail-bud stage, and tadpole.	
8.	Observation of whole mounts of chick development at various stages: 16, 18, 24, 33, 36, 48, 72, and 96 hours (Hamilton and Hamburger stages) to understand organogenesis and development progression.	
9.	Drosophila Life Cycle Study: Observation of Drosophila developmental stages (larva, pupa, adult) using stock culture.	
10.	Pond Snail (Lymnaea) Development: Observation of developmental stages and spiral cleavage.	
11.	Study of gastrulation and morphogenetic movements in frog or chick embryo models/diagrams.	
12.	Observation of cell death in chick embryo (e.g., by using toluidine blue staining).	
13.	Study of tadpole tail regeneration and the effect of vitamin A.	
14.	Window preparation to study live chick embryo development and identify developmental structures.	
15.	Teratogen Exposure Experiment in Zebrafish or Chick Embryos -Exposing zebrafish or chick embryos to mild concentrations of common teratogens (e.g., alcohol or caffeine) under controlled conditions.	

Learning Resources recommended:

1. **Developmental Biology** by Scott Gilbert – Comprehensive text on core concepts of developmental biology, including gametogenesis, fertilization, and organogenesis.
2. **Principles of Development** by Lewis Wolpert – Focuses on principles governing development from a genetic and molecular standpoint.
3. **Developmental Biology** by Balinsky – A detailed approach to embryology and development in various organisms.
4. **Developmental Biology** by Berril – Provides an in-depth exploration of development, including comparative embryology.
5. **Developmental Biology** by Waddington – Covers the principles of developmental biology and its theoretical frameworks.
6. **An Introduction to Embryology** by Balinsky – Focuses on the processes of development, specifically for vertebrates.
7. **Development** by Karp G and Berrill NJ – A concise introduction to the development of various species with an emphasis on cellular and molecular aspects.
8. **Regeneration in Vertebrates** by C.S. Thornton – Detailed exploration of regeneration processes in vertebrates, with case studies.
9. **Introduction to Embryonic Development** by Oppenheimer SB – Provides a strong foundation in the principles of embryonic development.

Evaluation Pattern:

(A) Internal Evaluation- 40 % **20 Marks**

Method	**Marks**
Class test	10
Assignment	10
Total	**20**

(B) External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- 30 Marks

1. The examination will have a duration of 1 hour and will carry a maximum of 30 marks.
2. There will be three questions, each carrying 10 marks. Each unit will have one question, and the third will cover the entire syllabus.
3. All questions will be compulsory, with internal choices provided within each question.
4. Questions may be divided into sub-questions (A and B), and marks will be allocated based on the topic's weightage.

Distribution of marks for descriptive external examination (30 marks)

All the Questions are compulsory

Time: 1 hour **Total marks: 30**

Question No.	Options	Unit	Marks
1.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1	10
2.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	2	10
3.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1&2	10

Practical Examination Pattern:

(A) Internal Examination 40 % **20 Marks**

Heading	Practical
Journal	05
Lab Participation	05
Lab work/ Fieldwork	05
Viva-voce	05
Total	**20**

(B) External (Semester end practical examination) 60% 30 Marks

Particulars	Practical
Lab work	30
Total	**30**

PRACTICAL BOOK/JOURNAL

Students must present a duly certified journal to be eligible for the practical examination; otherwise, they will not be permitted to participate. If a journal and/or report is lost, a Lost Certificate must be obtained from the Head/Coordinator/Department In-charge. Failure to do so will result in the student being unable to participate in the practical examination.

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Syllabus for (T. Y. B. Sc.) Autonomous from the year 2025-26

Name of the Course	**Ethology**
Course Code (refer to the student handbook)	25_USZOE506 and 25_USZOE507
Class	T.Y.B. Sc.
Semester	VI
No of Credits	4 (2+2)
Nature	Theory & Practical
Type (applicable to NEP only)	Elective
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: **Ethology**

CO1 - Learners will understand the basics of ethology, key historical figures, and the distinction between proximate and ultimate causation in behaviour.

CO2 - Learners will explore the classification of behaviour, ethograms, and the difference between innate and learned behaviour.

CO3 - Learners will study sensory perception mechanisms and how animals filter and respond to stimuli in communication.

CO4 - Learners will learn about neural, hormonal, and genetic control mechanisms of behaviour, including various learning processes.

CO5 - Learners will understand social behaviour, communication methods, and the structure of animal societies.

CO6 - Learners will study reproductive behaviour, sexual selection, and biological rhythms, including circadian and photoperiodic patterns.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Foundations of Animal Behavior and Control Mechanisms**	**1.1 Introduction to Ethology** • Definition, scope, and significance of ethology as a branch of biology. • Brief history and contributions of key figures: Karl von Frisch, Ivan Pavlov, Konrad Lorenz, and Niko Tinbergen. • Proximate vs. ultimate causation in behaviour; objectives of studying behaviour. **1.2 Classification and Patterns of Behaviour** • Ethograms and Behavioral patterns. • Innate vs. learned behaviours: Instinct, reflexes, and fixed action patterns. • Orientation behaviours: Kinesis, taxis, and navigation. **1.3 Perception and Environmental Interaction** • Sensory perception mechanisms: mechanical, chemical, visual, electrical, auditory. • Sign stimuli and stimulus filtering in animal communication. • Examples of sensory modalities across species. **1.4 Neural, Hormonal, and Genetic Control of Behaviour** • Role of the nervous system in behaviour regulation. • Hormonal influences on behaviour, including examples like aggression and mating. • Genetic and environmental contributions to behaviour development. • Learning mechanisms: classical and operant conditioning, habituation, insight learning, and imprinting.	**15**

II	**Social Behaviour, Communication, and Chronobiology**	**2.1 Social Behaviour and Communication** • Communication methods: chemical (pheromones), auditory, visual, and tactile. • Species-specific communication (e.g., bird songs, pheromonal communication). • Social behaviours: altruism, kin selection, and inclusive fitness. • Social organization in animal societies: Examples in insects (honeybees, ants), birds, and mammals. **2.2 Reproductive Behaviour and Sexual Selection** • Mating systems: monogamy, polygamy, and courtship rituals. • Sexual dimorphism and mate choice; concepts of intra- and inter-sexual selection. • Reproductive strategies, including parental care and sperm competition. **2.3 Chronobiology and Biological Rhythms** • **Introduction to Chronobiology**: Significance of biological clocks in animals. • **Circadian and Circannual Rhythms**: Mechanisms and examples of daily and seasonal rhythms. • **Photoperiodism**: Role of light cycles in regulating behaviour and reproduction. • **Orientation and Navigation**: Use of internal clocks in migration patterns of birds, fish, and turtles. • **Zeitgebers and Synchronization**: Environmental cues, such as light and temperature, that influence biological rhythms.	**15**

	PRACTICALS	**2 credits**
1.	Observe and classify different behavioural patterns in selected animal species (e.g., grooming, feeding, and resting behaviours in a domesticated animal or invertebrate) and preparation of an ethogram to document observed behaviours.	
2.	Study of Perception of Environment -Study geotaxis behaviour in earthworms and phototaxis behaviour in insect larvae.	
3.	Communication in Invertebrates and Vertebrates - chemical, visual, and audio communication across species. Example: Study the wing-beat sound and courtship behaviour in Drosophila; duration intervals of courtship songs.	
4.	Study of Communication and Social Behaviour- aggregation and schooling behaviour in fishes, flocking behaviour in birds, or group behaviour in mammals (e.g., a troop of monkeys).	

5.	To study self-recognition or aggression behaviour in fish by observing reactions to mirror images.	
6.	Study food preference and optimal foraging behaviour in selected animals (e.g., ants or rodents).	
7.	Observe nest-making behaviour in local bird species and document nest structure and materials used.	
8.	To study chemotaxis (movement in response to a chemical stimulus) in invertebrates.	
9.	To study foraging behaviour and preference among ants.	
10.	To study courtship and mating behaviour in Aquatic Fish (e.g., Betta fish).	
11.	To study Host-parasite interactions e.g. cattle and egrets.	
12.	Study of Circadian Rhythms, migration and orientation behaviour in animals.	
13.	To observe cooperative behaviour in ants during tasks such as food transport.	
14.	To analyse feeding behaviour and aggression in social groups.	
15.	Field visit to nearby Coastal areas to observe marine life and the behaviour of marine animals.	

Learning Resources recommended:

1. Alcock, J. Animal Behaviour: An Evolutionary Approach (Sinauer Associates, Sunderland, Mass. USA)
2. Bradbury, J.W. & S.I. Vehrencamp. Principles of Animal Communication (Sinauer Associates)
3. Clutton-Brock, T.H. The Evolution of Parental Care (Princeton University Press, Princeton, NJ, USA)
4. Eibl-Eibesfeldt, I. Ethology: The Biology of Behaviour (Holt, Rinehart & Winston, New York)
5. Gould, J.L. The Mechanisms and Evolution of Behavior
6. Hauser, M. The Evolution of Communication (MIT Press, Cambridge, Mass. USA)
7. Hinde, R.A. Animal Behaviour: A Synthesis of Ethology and Comparative Psychology (McGraw Hill, New York)
8. Krebs, J.R. & N.B. Davies. Behavioural Ecology (Blackwell, Oxford, UK)
9. Wilson, E.O. Sociobiology: The New Synthesis (Harvard University Press, Cambridge, Mass. USA)

Evaluation Pattern:

(A) Internal Evaluation- 40 % **20 Marks**

Method	**Marks**
Class test	10
Assignment	10
Total	**20**

(B) External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- 30 Marks

1. The examination will have a duration of 1 hour and will carry a maximum of 30 marks.
2. There will be three questions, each carrying 10 marks. Each unit will have one question, and the third will cover the entire syllabus.
3. All questions will be compulsory, with internal choices provided within each question.
4. Questions may be divided into sub-questions (A and B), and marks will be allocated based on the topic's weightage.

Distribution of marks for descriptive external examination (30 marks)

All the Questions are compulsory

Time: 1 hour **Total marks: 30**

Question No.	Options	Unit	Marks
1.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1	10
2.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	2	10
3.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1&2	10

Practical Examination Pattern:

(A) Internal Examination 40 % 20 Marks

Heading	Practical
Journal	05
Lab Participation	05
Lab work/ Fieldwork	05
Viva-voce	05
Total	**20**

(B) External (Semester end practical examination) 60% 30 Marks

Particulars	Practical
Lab work	30
Total	**30**

PRACTICAL BOOK/JOURNAL

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Syllabus for (T. Y. B. Sc.) Autonomous from the year 2025-26

Name of the Course	**Endocrinology**
Course Code (refer to the student handbook)	25_USZOE608 and 25_USZOE609
Class	T.Y.B. Sc.
Semester	VI
No of Credits	4 (2+2)
Nature	Theory& Practical
Type (applicable to NEP only)	Elective
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: **Endocrinology**

CO1 – Learners will comprehend foundational principles of endocrinology, including the comparison of endocrine and nervous systems.
CO2 – Learners will become familiar with hormone chemistry, classification, and mechanisms of hormone action, including receptor types and signal pathways.
CO3 – Learners will understand the structure, function, and regulatory mechanisms of major endocrine glands such as the hypothalamus, pituitary, thyroid, and adrenal glands.
CO4 – Learners will explore advanced endocrine topics, including hormonal regulation of metabolism, reproduction, and growth.
CO5 – Learners will gain insight into endocrine disorders, their symptoms, and treatment, along with the role of hormones in stress responses and circadian rhythms.
CO6 – Learners will develop practical skills in measuring hormone levels and analyzing physiological responses associated with endocrine regulation and disorders.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Principles of Endocrinology and Hormone Function**	**1.1. Introduction to Endocrinology** • Definition, scope, and historical perspective of endocrinology • Comparison of endocrine and nervous systems **1.2 Hormone Chemistry and Classification** • Chemical nature of hormones: proteins, peptides, amines, and steroids • Classification of hormones based on solubility and site of action **1.3 Mechanisms of Hormone Action** • Hormone receptors: types and binding mechanisms • Signal transduction pathways: G-protein coupled receptors, tyrosine kinase receptors, and intracellular receptors **1.4 Hypothalamus and Pituitary Gland** • Structure, function, and hormone regulation • Hypothalamic hormones and pituitary hormones (anterior and posterior pituitary) **1.5 Thyroid and Parathyroid Glands** • Thyroid hormones: synthesis, regulation, and function • Role of parathyroid hormone in calcium homeostasis **1.6 Adrenal Gland** • Adrenal cortex and medulla: hormone synthesis and function • Regulation of corticosteroids and catecholamines	
II	**Advanced Topics in**	**2.1 Pancreas and Metabolism**	

	Endocrinology and Disorders	• Role of insulin, glucagon, and somatostatin in glucose metabolism • Hormonal regulation of blood sugar levels and energy homeostasis **2.2 Gonadal Hormones and Reproduction** • Male and female reproductive hormones: synthesis, function, and regulation • Role of hormones in puberty, menstrual cycle, and pregnancy **2.3 Pineal Gland and Circadian Rhythms** • Role of melatonin in regulating circadian rhythms and seasonal changes • Influence of environmental factors on the pineal gland **2.4 Hormones and Stress Response** • Role of adrenal hormones in stress adaptation • Effects of chronic stress on hormone levels and health **2.5 Endocrine Disorders** • Hyper- and hypofunction of endocrine glands (e.g., hypothyroidism, diabetes mellitus) • Common endocrine disorders and their symptoms, diagnosis, and treatment **2.6 Endocrine Regulation of Growth and Development** • Role of growth hormone and related growth factors • Hormonal regulation of developmental processes and ageing	

	PRACTICALS	**2 Credits**
1.	Histology of Endocrine Glands - Ovary, testis, pituitary, thyroid and adrenal gland	
2.	Measure hormone levels (e.g., cortisol or insulin) in blood or saliva samples using ELISA.	
3.	Measurement of blood glucose levels before and after meals and the Role of insulin and glucagon in glucose regulation	
4.	Estimation of Blood glucose level by glucose-oxidase-peroxidase method	
5.	Measurement of Blood Lipid Profile (Total Cholesterol, HDL, LDL, and Triglycerides)	
6.	Studying symptoms of hormone imbalances and physiological changes in endocrine disorders	
7.	Studying changes in hormone levels under stress conditions in model organisms and analysis of physiological parameters associated with stress	
8.	Estimation of Thyroid Hormones (T3 and T4)	
9.	Assay of Vitamin D Levels in Blood.	
10.	Salivary pH Test Before and After Eating (Influence of Cortisol)	

11.	Effect of Caffeine on Heart Rate (Daphnia Model)	
12.	Observing Menstrual Cycle Patterns (Simulated Hormone Variation)	
13.	Analyze the effect of physical activity on blood pressure before and after exercise to study the role of adrenaline and other stress hormones.	
14	Case Study Analysis on Hormone Replacement Therapy (HRT) to explore the effects of synthetic hormones on menopausal symptoms or endocrine disorders.	
15.	Case studies of various endocrine disorders	

Learning Resources recommended:

1. Hadley, M. E: Endocrinology. Pearson Education (Singapore)
2. C. D. Turner: General Endocrinology.
3. E. R. Martin: Endocrine Physiology Oxford University press
4. Gorbman A. and H.A. Bern: General and Comparative Endocrinology.
5. Bancroft, J.D. and Stevens A: Theory and practical histological techniques.
6. H. Laufer and R.C. H. Downer: Endocrinology of selected vertebrate types.

Evaluation Pattern:

(A) Internal Evaluation- 40 % **20 Marks**

Method	**Marks**
Class test	10
Assignment	10
Total	**20**

(B) External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- **30 Marks**

1. The examination will have a duration of 1 hour and will carry a maximum of 30 marks.
2. There will be three questions, each carrying 10 marks. Each unit will have one question, and the third will cover the entire syllabus.
3. All questions will be compulsory, with internal choices provided within each question.
4. Questions may be divided into sub-questions (A and B), and marks will be allocated based on the topic's weightage.

Distribution of marks for descriptive external examination (30 marks)

All the Questions are compulsory

Time: 1 hour **Total marks: 30**

Question No.	Options	Unit	Marks
1.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1	10
2.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	2	10
3.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1&2	10

Practical Examination Pattern:

(C) Internal Examination 40 % **20 Marks**

Heading	Practical
Journal	05
Lab Participation	05
Lab work/ Fieldwork	05
Viva-voce	05
Total	**20**

(D) External (Semester end practical examination) 60% **30 Marks**

Particulars	Practical
Lab work	30
Total	**30**

PRACTICAL BOOK/JOURNAL

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R.E. Society's

R. P. GOGATE COLLEGE OF ARTS & SCIENCE AND
R.V. JOGALEKAR COLLEGE OF COMMERCE (AUTONOMOUS),
RATNAGIRI

NAAC accredited 'A' Grade (4th Cycle)
Ratnagiri-415612 (Maharashtra-India)

T.Y. B. Sc. SYLLABUS FOR

ZOOLOGY

Vocational Skill Course (VSC)

Department of Zoology Under NEP 2020

Framed According to the National Education Policy (NEP 2020)

To be implemented from Academic Year: 2025-2026

PREAMBLE:

It is with great enthusiasm that I present the syllabus for the T.Y.B.Sc. Major Elective Courses in Zoology under the Choice-Based Credit System (CBCS) are to be implemented from the academic year 2025-2026. This syllabus reflects the department's commitment to fostering academic excellence, holistic education, and skill-based learning.

The elective courses, such as Human Osteology, Developmental Biology, Ethology, and Endocrinology, are meticulously curated to equip students with advanced knowledge in their chosen areas of specialization. These courses emphasize an interdisciplinary approach, blending theoretical concepts with practical applications to ensure a robust learning experience.

In line with contemporary scientific developments and industry demands, this syllabus highlights critical aspects of employability, entrepreneurship, and research readiness. Through hands-on laboratory experiments, field-based studies, and exposure to current trends, the students are empowered to bridge the gap between academic knowledge and real-world challenges.

As the Head of the Department of Zoology, I take immense pride in presenting a curriculum that not only prepares our students for professional success but also nurtures their curiosity and passion for life sciences. I extend my heartfelt gratitude to the faculty, advisory members, and academic contributors for their dedicated efforts in developing this comprehensive syllabus.

Together, let us inspire our students to explore, innovate, and contribute meaningfully to the field of Zoology and beyond.

Chairperson,
BOS in Zoology,
Gogate Jogalekar College,
Ratnagiri.

Syllabus for T. Y. B. Sc. Course: ZOOLOGY
Credit-Based Semester and Grading System
(To be implemented from the Academic Year 2025-2026)

SEMESTER – V

COURSE CODE	UNIT	TOPIC	CREDITS
25_USZOV510	I	Foundations of Animal Behavior and Control Mechanisms	02
	II	Pest Management and Control Strategies	
25_USZOV511		Entomology and Pest Management Practical	02
Total Number of Credits and Workload			**04**

SEMESTER – VI

COURSE CODE	UNIT	TOPIC	CREDITS
25_USZOV611	I	Introduction to Sustainable Aquaculture Practices	**02**
	II	Sustainable Aquaculture Practices and Management	
25_USZOV612		Sustainable Aquaculture Practical	**02**
Total Number of Credits and Workload			**04**

Syllabus for (T. Y. B. Sc.) Autonomous from the year 2025-26

Name of the Course	**Entomology and pest management**
Course Code (refer to the student handbook)	25_USZOV510 and 25_USZOV510
Class	T.Y.B. Sc.
Semester	V
No of Credits	4
Nature	Theory & Practical
Type (applicable to NEP only)	VSC
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: **Entomology and Pest management**

CO1 - Learners will understand the foundational principles of entomology, including insect classification and the distinguishing features of major insect orders.

CO2 - Learners will gain knowledge of insect morphology, exploring the external structures and sensory systems that define various insect species.

CO3 - Learners will develop an understanding of insect physiology, with insights into their digestive, circulatory, respiratory, and nervous systems.

CO4 - Learners will comprehend the ecological roles of insects, recognizing their importance as pollinators, decomposers, and predators within ecosystems.

CO5 - Learners will identify the economic significance of insects, distinguishing between beneficial insects and those that are harmful as pests and disease vectors.

CO6 - Learners will acquire foundational knowledge in pest management, including the principles of integrated pest management (IPM) and methods for sustainable pest control.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Fundamentals of Entomology**	**1.1 Introduction to Entomology** • Definition, scope, and significance of entomology • Classification of insects and characteristics of major insect orders **1.2 Insect Morphology** • External structure: head, thorax, and abdomen • Insect sensory systems: eyes, antennae, and receptors **1.3 Insect Physiology** • Digestive, circulatory, respiratory, and nervous systems in insects • Mechanisms of insect reproduction and development (metamorphosis types) **1.4 Insect Ecology** • Role of insects in ecosystems: pollinators, decomposers, and predators • Insect-plant interactions and co-evolution **1.5 Economic Importance of Insects** • Beneficial insects: pollinators, biocontrol agents, and products (e.g., silk, honey) • Harmful insects: pests of crops, vectors of disease **1.6 Insect Behaviour** • Basics of insect behaviour: foraging, mating, and defence mechanisms • Communication in insects (e.g., pheromones, sound production)	
II	**Pest Management**	**2.1 Introduction to Pest Management** • Concepts and principles of pest management	

	and Control Strategies	• Types of pests: agricultural, stored-product, and household pests **2.2 Integrated Pest Management (IPM)** • Definition and components of IPM • IPM methods: cultural, biological, mechanical, and chemical control **2.3 Biological Control of Insect Pests** • Use of natural enemies: predators, parasitoids, and pathogens • Examples of successful biological control programs **2.4 Chemical Control and Insecticides** • Types of insecticides and modes of action • Environmental and health impacts of insecticide use **2.5 Biotechnological Approaches in Pest Control** • Use of genetic engineering and pheromones in pest management • Development and role of pest-resistant crops **2.6 Pest Management in Stored Products** • Common stored-product pests and control measures • Methods of storage and pest prevention	

	PRACTICAL	**2 Credits**
1.	**Insect Collection and Identification** • Collection techniques for different insect groups • Identification of insects using taxonomic keys	
2.	**Study of Insect Morphology** • Dissection and study of insect parts: mouthparts, wings, and legs • Observation of sensory organs (antennae, compound eyes) under a microscope	
3.	**Preparation of Insect Specimens** • Mounting, pinning, and labelling techniques for insect specimens • Preserving specimens for educational and research purposes	
4.	**Observation of Insect Behaviour** • Studying insect behaviour related to foraging, mating, and defence • Recording and interpreting observations of insect activity	
5.	**Pollinator Observation and Documentation** • Observe and document insect pollinators in a local area. • Discuss the role of different insect species in pollination.	
6.	**Study of Economic Importance: Honeybee and Silk Moth** • Study the life cycles and economic benefits of the honeybee and silk moth. • Discuss the processes of honey and silk production.	

7.	**Experiment on Light Attraction in Insects** • Set up a simple light trap in a dark room or outdoor area. • Observe and record which insects are attracted to light sources and discuss their behaviour.	
8.	**Field Studies of Pests and Damage Assessment** • Field identification of common agricultural pests • Assessing pest-induced damage to crops and plants	
9.	**Integrated Pest Management (IPM) Case Study** • Designing an IPM plan for a specific crop pest • Analysis of the advantages and challenges of IPM	
10.	**Use of Biological Control Agents** • Observation of parasitoid-pest interactions in laboratory settings • Evaluation of biocontrol agent efficacy on selected pests	
11.	**Examination of Insecticides and Modes of Action** • Study different types of insecticides and discuss their mode of action on insects. • Discuss the environmental and health impacts through a literature review or presentation.	
12.	**Stored-Product Pest Detection and Prevention Methods** • Identification of stored-product pests in food samples • Experimenting with methods to control and prevent pest infestation	
13.	**Studying Anti-Predator Mechanisms in Insects** • Observe insects with camouflage or other defence mechanisms (e.g., stick insects, ladybugs). • Discuss how these adaptations protect from predators.	
14.	**Insecticide Efficacy Test** • Conduct a small-scale experiment using natural insect repellents (e.g., neem, garlic) on a target insect species. • Compare the efficacy of natural repellents to synthetic insecticides.	
15.	**Documentation and Presentation of Pest Control Techniques** • Prepare a presentation on various pest control techniques used in agriculture. • Compare traditional and modern techniques and discuss their effectiveness and limitations.	

Learning Resources recommended:

1. Essentials of Entomology by John B. Free: A great introductory text covering the basics of insect biology and behaviour.
2. The Insects: An Outline of Entomology by P.J. Gullan and P.S. Cranston: Offers comprehensive coverage of insect biology, ecology, and physiology.
3. Insect Physiology and Biochemistry by James L. Nation: An in-depth look at insect physiology, including digestion, reproduction, and metabolic processes.
4. The Principles of Insect Physiology by V.B. Wigglesworth: A foundational text that explores various physiological functions in insects.

5. The Science of Entomology by William S. Romoser and John G. Stoffolano: Covers the anatomy, physiology, and development of insects with a focus on applications in medical and agricultural entomology.
6. Integrated Pest Management: Principles and Practice by Dharam P. Abrol: Focuses on the principles and modern practices in pest management, ideal for practical applications.
7. Principles of Insect Morphology by R.E. Snodgrass: Provides detailed explanations of insect anatomy and adaptations, useful for both morphology and physiology topics.
8. Principles of Insect Pest Management by G.S. Dhaliwal and R. Arora: Introduces the basics of pest management with a focus on integrated pest management techniques.
9. Insect Pest Management by David Dent and Richard H. Binks: This book presents practical applications and methodologies for pest control in agriculture.
10. Insect Pest Management and Ecological Research by Gimme H. Walter: Examines ecological principles in pest management, with case studies on biological control and IPM.

Evaluation Pattern:

(A) Internal Evaluation- 40 % **20 Marks**

Method	**Marks**
Class test	10
Assignment	10
Total	**20**

(B) External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- **30 Marks**

1. The examination will have a duration of 1 hour and will carry a maximum of 30 marks.
2. There will be three questions, each carrying 10 marks. Each unit will have one question, and the third will cover the entire syllabus.
3. All questions will be compulsory, with internal choices provided within each question.
4. Questions may be divided into sub-questions (A and B), and marks will be allocated based on the topic's weightage.

Distribution of marks for descriptive external examination (30 marks)

All the Questions are compulsory

Time: 1 hour **Total marks: 30**

Question No.	Options	Unit	Marks
1.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1	10
2.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	2	10
3.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1&2	10

Practical Examination Pattern:

(A) Internal Examination 40 % **20 Marks**

Heading	Practical
Journal	05
Lab Participation	05
Lab work/ Fieldwork	05
Viva-voce	05
Total	**20**

(B) External (Semester end practical examination) 60% **30 Marks**

Particulars	Practical
Lab work	30
Total	**30**

PRACTICAL BOOK/JOURNAL

Students must present a duly certified journal to be eligible for the practical examination; otherwise, they will not be permitted to participate. If a journal and/or report is lost, a Lost Certificate must be obtained from the Head/Coordinator/Department In-charge. Failure to do so will result in the student being unable to participate in the practical examination.

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Syllabus for (T. Y. B. Sc.) Autonomous from the year 2025-26

Name of the Course	**Sustainable Aquaculture Practices**
Course Code (refer to the student handbook)	25_USZOV610 and 25_USZOV611
Class	T.Y.B. Sc.
Semester	VI
No of Credits	4
Nature	Theory & Practical
Type (applicable to NEP only)	VSC
Highlight revision specific to employability/ entrepreneurship/ skill development (if any) 100 words	

Nomenclature: **Sustainable Aquaculture practices**

CO1 - Learners will understand the foundational principles of entomology, including insect classification and the distinguishing features of major insect orders.
CO2 - Learners will gain knowledge of insect morphology, exploring the external structures and sensory systems that define various insect species.
CO3 - Learners will develop an understanding of insect physiology, with insights into their digestive, circulatory, respiratory, and nervous systems.
CO4 - Learners will comprehend the ecological roles of insects, recognising their importance as pollinators, decomposers, and predators within ecosystems.
CO5 - Learners will identify the economic significance of insects, distinguishing between beneficial insects and those that are harmful as pests and disease vectors.
CO6 - Learners will acquire foundational knowledge in pest management, including integrated pest management (IPM) principles and methods for sustainable pest control.

Curriculum:

Unit	Title	Learning Points	No of Lectures
I	**Introduction to Sustainable Aquaculture Practices**	**1.1 Introduction to Aquaculture** • Definition, scope, and significance of aquaculture. • Types of aquaculture systems: freshwater, brackish, and marine. • Overview of traditional vs. sustainable aquaculture practices. **1.2 Sustainability in Aquaculture** • Concept of sustainability and its importance in aquaculture. • Environmental, economic, and social dimensions of sustainable practices. • Challenges in maintaining sustainability in aquaculture. **1.3 Aquaculture System Design** • Key components of aquaculture systems: ponds, tanks, and recirculating systems. • Designing sustainable systems to minimize environmental impact. • Water management techniques to reduce waste and conserve resources. **1.4 Water Quality Management** • Importance of water quality in sustainable aquaculture. • Parameters to monitor: pH, dissolved oxygen, temperature, ammonia, and nitrates. • Methods for maintaining optimal water quality in aquaculture systems. **1.5 Species Selection and Diversity** • Choosing sustainable species for aquaculture (tilapia, carp, catfish, etc.). • Role of native species in sustainable aquaculture.	**15**

		• Multi-species systems and polyculture for enhancing productivity. **1.6 Feed and Nutrition** • Overview of fish feed and its environmental impact. • Sustainable feeding practices and use of alternative feed sources. • Importance of balanced nutrition in promoting growth and reducing waste. **1.7 Case Studies on Sustainable Aquaculture Models** • Successful sustainable aquaculture practices around the world. • Examples of small-scale, eco-friendly aquaculture systems.	
II	**Sustainable Aquaculture Practices and Management**	**2.1 Waste Management and Recycling in Aquaculture** • Types of waste produced in aquaculture and its impacts. • Waste recycling and management techniques, including biofilters and integrated systems. • Introduction to aquaponics as a sustainable aquaculture practice. **2.2 Integrated Multi-Trophic Aquaculture (IMTA)** • Concept and principles of IMTA systems. • Benefits of combining species with different trophic levels. • Design and maintenance of IMTA systems for sustainability. **2.3 Health Management and Disease Control** • Common diseases in aquaculture and their prevention. • Sustainable practices for disease control, including natural treatments and biosecurity. • Role of probiotics and biofilters in maintaining healthy aquaculture systems. **2.4 Use of Technology in Sustainable Aquaculture** • Role of sensors, automation, and data management in monitoring aquaculture systems. • Overview of innovations like artificial intelligence and IoT in sustainable practices. • Case studies on the impact of technology in improving sustainability. **2.5 Legal and Regulatory Aspects** • Overview of regulatory frameworks governing sustainable aquaculture. • Guidelines for environmental compliance and certifications (e.g., ASC, MSC). • Importance of ethical and legal standards in aquaculture operations.	**15**

		2.7 Socioeconomic Impact of Sustainable Aquaculture • Role of sustainable aquaculture in food security and local economies. • Opportunities and challenges for small-scale fish farmers. • Contribution of sustainable aquaculture to community development. **2.7 Future Trends in Sustainable Aquaculture** • Innovations and emerging practices for sustainability in aquaculture. • Prospects of plant-based feeds, lab-grown fish, and other sustainable options. • Discussion on the future of global aquaculture and the role of sustainability.	

	PRACTICAL	**2 Credits**
1.	**To measure and analyse essential water quality parameters that impact fish health.** • Test for pH, temperature, dissolved oxygen (DO), ammonia, and nitrate levels. • Assess turbidity and monitor water clarity.	
2.	**To understand the design and functioning of a small-scale, sustainable aquaculture system.** • Construct and set up a simple aquaculture tank with biofilters. • Learn water circulation techniques and how to manage water inflow and outflow.	
3.	**To understand sustainable feed composition and prepare cost-effective feed.** • Analyse the nutritional content of common fish feed ingredients (protein, fats, and carbohydrates). • Prepare feed pellets using alternative, eco-friendly ingredients.	
4.	**Developing an Aquaponics System for Waste Management** • Set up an aquaponics system with fish and plants. • Monitor plant growth and assess how fish waste supports nutrient cycling for plants.	
5.	**To identify common diseases and apply basic treatment and prevention techniques.** • Identify common pathogens under a microscope (e.g., bacterial, fungal). • Implement preventive techniques like biosecurity practices and mild organic treatments.	
6.	**Insect-Based Protein as Alternative Feed Source** • Prepare fish feed by incorporating mealworms or other insect proteins. • Conduct a feeding trial and observe fish response.	

7.	**Biofilter Construction and Testing** • Construct a simple biofilter using activated charcoal, gravel, and sponge layers. • Test the biofilters effectiveness by measuring ammonia and nitrate levels in water before and after filtration.	
8.	**Comparative Study of Different Fish Species for Aquaculture Viability** • Select a few hardy, low-maintenance fish species. • Compare growth rates, feed conversion efficiency, and survival rates under similar conditions.	
9.	**Fish Health Monitoring through Simple Diagnostic Tests** • Perform basic examinations such as checking for lesions, body colouration, and gill clarity. • Use safe, diluted iodine or methylene blue solutions to assess gill health.	
10.	**Case Study and Report on Sustainable Aquaculture Practices** • Conduct a field visit (if possible) or study a case from a successful aquaculture practice. • Prepare a report focusing on sustainability aspects, challenges, and solutions.	
11.	**Practical Project: Design Your Sustainable Aquaculture Model** • Design a complete model, including fish species selection, feed plan, and waste management. • Present the model design, explaining sustainability features and expected outcomes.	

Learning Resources recommended:

1. "Aquaculture: Principles and Practices" by T.V.R. Pillay and M.N. Kutty
2. "Ecological Aquaculture: The Evolution of the Blue Revolution" by Barry A. Costa-Pierce
3. "Introduction to Aquaculture" by Matthew Landau
4. "Freshwater Aquaculture: A Handbook for Small Scale Fish Culture in North America" by William McLarney
5. "Aquaponic Gardening: A Step-By-Step Guide to Raising Vegetables and Fish Together" by Sylvia Bernstein
6. “Aquaculture and Fisheries Biotechnology: Genetic Approaches" by Rex A. Dunham
7. "Aquaculture: Farming Aquatic Animals and Plants" by John S. Lucas and Paul C. Southgate
8. "Biology of Aquaculture" by Andrew J. Lawrence and Krzysztof Jan M. Jankowski
9. "Marine Aquaculture: Effects on Biodiversity and Animal Health" by Gene S. Helfman
10. "Aquaculture Production Systems" by James H. Tidwell
11. "Principles of Sustainable Aquaculture: Promoting Social, Economic and Environmental Resilience" by Stuart W. Bunting
12. "Fish Disease: Diagnosis and Treatment" by Edward J. Noga

Evaluation Pattern:

(A) Internal Evaluation- 40 % **20 Marks**

Method	Marks
Class test	10
Assignment	10
Total	**20**

(B) External Evaluation - 60%

Semester End Evaluation (Paper Pattern)- **30 Marks**

1. The examination will have a duration of 1 hour and will carry a maximum of 30 marks.
2. There will be three questions, each carrying 10 marks. Each unit will have one question, and the third will cover the entire syllabus.
3. All questions will be compulsory, with internal choices provided within each question.
4. Questions may be divided into sub-questions (A and B), and marks will be allocated based on the topic's weightage.

Distribution of marks for descriptive external examination (30 marks)

All the Questions are compulsory

Time: 1 hour **Total marks: 30**

Question No.	Options	Unit	Marks
1.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1	10
2.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	2	10
3.	A) Answer any one of the following questions (6 marks each) B) Answer any one of the following questions (4 marks each)	1&2	10

Practical Examination Pattern:

(C) Internal Examination 40 % **20 Marks**

Heading	Practical
Journal	05
Lab Participation	05
Lab work/ Fieldwork	05
Viva-voce	05
Total	**20**

(D) External (Semester end practical examination) 60% 30 Marks

Particulars	Practical
Lab work	30
Total	**30**

PRACTICAL BOOK/JOURNAL

Students must present a duly certified journal to be eligible for the practical examination; otherwise, they will not be permitted to participate. If a journal and/or report is lost, a Lost Certificate must be obtained from the Head/Coordinator/Department In-charge. Failure to do so will result in the student being unable to participate in the practical examination.

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