Anekant Education Society's

Tuljaram Chaturchand College

of Arts, Science & Commerce, Baramati

(NAAC A^{++} Accredited & Empowered Autonomous)

Two Year M.Sc. Degree Program in Zoology

(Faculty of Science & Technology)

CBCS Syllabus

M.Sc. (Zoology) Semester -I

For P.G. Department of Zoology

Tuljaram Chaturchand College of Arts, Science & Commerce, Baramati

Choice Based Credit System Syllabus (2026 Pattern)

(As Per NEP 2020)

To be implemented from Academic Year 2026-27

Title of the Programme: M. Sc. (Zoology)

Preamble

AES's Tuljaram Chaturchand College has made the decision to change the syllabus of across various faculties from June, 2023 by incorporating the guidelines and provisions outlined in the National Education Policy (NEP), 2020. The NEP envisions making education more holistic and effective and to lay emphasis on the integration of general (academic) education, vocational education and experiential Course. The NEP introduces holistic and multidisciplinary education that would help to develop intellectual, scientific, social, physical, emotional, ethical and moral capacities of the students. The NEP 2020 envisages flexible curricular structures and Course based outcome approach for the development of the students. By establishing a nationally accepted and internationally comparable credit structure and courses framework, the NEP 2020 aims to promote educational excellence, facilitate seamless academic mobility, and enhance the global competitiveness of Indian students. It fosters a system where educational achievements can be recognized and valued not only within the country but also in the international arena, expanding opportunities and opening doors for students to pursue their aspirations on a global scale.

In response to the rapid advancements in science and technology and the evolving approaches in various domains of Zoology and related subjects, the Board of Studies in Zoology at Tuljaram Chaturchand College, Baramati - Pune, has developed the curriculum for the first semester of **M. Sc. Zoology,** which goes beyond traditional academic boundaries. The syllabus is aligned with the NEP 2020 guidelines to ensure that students receive an education that prepares them for the challenges and opportunities of the 21st century. This syllabus has been designed under the framework of the Choice Based Credit System (CBCS), taking into consideration the guidelines set forth by the National Education Policy (NEP) 2020, LOCF (UGC), NCrF, NHEQF, Prof. R.D. Kulkarni's Report, Government of Maharashtra's General Resolution dated 20th April and 16th May 2023, and the Circular issued by SPPU, Pune on 31st May 2023.

After completion of M.Sc. in Zoology, enrolled students will acquire complete disciplinary knowledge as well as allied branches of Zoology. At the end of programme, students may possess expertise which will provide them competitive advantage in pursuing higher studies within India or abroad; and seek jobs in academia, civil administration, research or industries. Students will be able to define and explain major concepts in the biological sciences. They will be able to correctly use biological instrumentation and proper laboratory techniques; to communicate biological knowledge in oral and written form; to

identify the relationship between structure and function at all levels: molecular, cellular, tissue, organ, system and organismal.

Students should be able to identify, classify and differentiate diverse non-chordates and chordates based on their basic morphological, anatomical biochemical and molecular characters. They will also be able to describe economic, ecological and medical significance of various animals in human life. This programme will create a curiosity and awareness among students to explore the animal diversity and take up wild life photography or wild life exploration as a career option. The procedural knowledge about identification and classification of animals will provide students professional advantages in seeking the jobs in fields of teaching, research and taxonomy in various private & public organizations; including Zoological Survey of India and National Parks/Sanctuaries. Students will be able to apply the scientific methods to answer questions in biology by formulating testable hypotheses, gathering data that address these hypotheses, and analysing those data to assess the degree to which their scientific work supports their hypotheses. Students will be able to present scientific hypotheses and data both orally and in writing in the conventional formats that are in practice. Students will be able to access the primary literature, identify relevant works for a particular topic, and evaluate the scientific content of these works. Acquired practical skills in biotechnology, biostatistics, bioinformatics and molecular biology can be used to pursue career as a scientist in drug development industry in India or abroad. The students will be acquiring basic experimental skills in various techniques in the fields of genetics; molecular biology; biotechnology; entomology, physiology, qualitative and quantitative microscopy; and analytical biochemistry. These methodologies will provide an extra edge to our students, who wish to undertake higher studies. Students will be able to use the evidence of comparative biology to explain how the theory of evolution offers the only scientific explanation for the unity and diversity of life on earth. They will be able to use specific examples to explicate how descent with modification has shaped animal morphology, physiology, life history, and behaviour. Students will be able to explain how organisms function at the level of the gene, genome, cell, tissue, organ and organ-system. Drawing upon this knowledge, they will be able to give specific examples of the physiological adaptations, development, reproduction and behaviour of different animals. Students will be able to analyse the ecological relationships of life on earth by tracing energy and nutrient flows through the ecosystems. They will be able to establish the relationship between the physical features of the environment and the structure of populations, communities, and ecosystems. Students undertaking skill enhancement courses like aquaculture, sericulture and apiculture

will inculcate skills involved in rearing fish, bees and silk moth which would help them to generate self-employment making them successful entrepreneurs. Acquired skills in diagnostic testing, haematology, histopathology, staining procedures etc. used in clinical and research laboratories will make them eligible to work in diagnostic or research laboratories. M.Sc. Zoology candidates will find opportunities in public services departments, NGOs, environmental agencies, universities, colleges, biotechnological, pharmaceutical, environmental / ecological fields. There are numerous career opportunities for candidates completing their M.Sc. Zoology in public and private sector. Candidates may find jobs as Animal Behaviourist, Conservationist, Wildlife Biologist, Zoo Curator, Wildlife Educator, Zoology teacher, Forensic experts, Lab technicians, Veterinarians, etc.

Overall, revising the Zoology syllabus in accordance with the NEP 2020 ensures that students receive an education that is relevant, comprehensive, and prepares them to navigate the dynamic and interconnected world of today. It equips them with the knowledge, skills, and competencies needed to contribute meaningfully to society and pursue their academic and professional goals in a rapidly changing global landscape.

Programme Specific Outcomes (PSOs)

PSO1. Disciplinary Knowledge: Understand the basic concepts of various branches of Zoology like Entomology, Physiology, Genetics, Cell Biology, Taxonomy, Biochemistry & Bioenergetics, Molecular Biology, Embryology, Developmental Biology, Immunology, Ecology, Ichthyology, Fresh Water Zoology, and Applied Zoology.

PSO2. Critical thinking and problem solving: Analyse the relationships of animals with abiotic factors and different biotic factors like plants and microbes. They will able to identify the species based on molecular taxonomy.

PSO3. Individual and Teamwork: Sets up the experiments and performs the same as per laboratory standards in different fields of Zoology like Taxonomy, Physiology, Ecology, Cell biology, Genetics, Applied Zoology, Clinical science, tools and techniques of Zoology, Toxicology, Entomology, Nematology, Sericulture, Biochemistry, Ichthyology, Animal biotechnology, Immunology, Physiology and research methodology.

PSO4. Research related skills and scientific temper: Propose hypothesis, formulate tests, use various modern instruments for biological analysis, data collection and field surveys and interprets the data and find answers.

PSO5. Critical Thinking: Recognizes the relationships between structure and functions at different levels of biological organization (e.g., molecules, cells, organs, organisms, populations, and species) for animals.

PSO6. Development of Observation Skills: Distinguishes different ecosystems (e.g., terrestrial, freshwater, marine) based on biological, chemical, and physical features; Correlates the morphology, physiology, behaviour with the properties of habitat.

PSO7. Ethics and Effective Citizenship: Contributes the knowledge for sustainable development and nation building.

PSO8. Management Skills: Exhibits management skills in applied branches of Zoology like Apiculture, Sericulture, Aquaculture and Agriculture.

PSO9. Environmental Ethics and Sustainability: Explains the broad understanding of ecosystems, biodiversity and their conservation.

PSO10. Identification of critical problems and issues: Detect the causes and consequences of biodiversity depletion.

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Tuljaram Chaturchand College

of Arts, Science & Commerce, Baramati

(NAAC A++ Accredited & Empowered Autonomous)

Board of Studies (BoS) in Zoology

From 2025-26 to 2027-28

Sr. No.	Name of Member	Designation
1.	**Dr. Chordiya Sandip Popatlal**	**Chairperson**
2.	**Dr. Nale Vitthal Baban**	Member
3.	**Dr. Manoorkar Poojawati**	Member
4.	**Dr. Sangale Deepali Maruti**	Member
5.	**Mr. More Kishor U.**	Member
6.	**Dr. Jadhav Sameer Sadashiv**	Member
7.	**Mr. Kare Samadhan**	Member
8.	**Mr. Awaghade Yugandhar**	Member
9.	**Dr. Ravindra D. Chaudhari**	Vice-Chancellor Nominee Subject Expert from SPPU, Pune
10.	**Dr. Gaikwad Sanjay K.**	Subject Expert from Outside the Parent University
11.	**Dr. Deshmukh A. A.**	Subject Expert from Outside the Parent University
12.	**Dr. Karpe Yogesh**	Representative from Industry/Corporate Sector/Allied areas
13.	**Ms. Kumbhar Kamal**	Member of the College Alumni
14.	**Ms. Sakshi Sawant**	UG Student
15.	**Ms. Sanika Nikhale**	PG Student

Credit distribution structure for Two Years PG as per National Education Policy (2026 Pattern)
(M.Sc.)

PG Program for First Year														
Level	**Sem.**	**Major (MD)**	**Major (Ele)**				**RM**	**OJT**	**RP**					**Cum.Cr.**
6.0	I	10(T)+4 (P) / 14(T)	2(T)+2 (T/P) / 4(T)	--	--	---	4 (RM) (T)	--	--	--	--	--	--	**22**
	II	10(T)+4 (P) / 14(T)	2(T)+2 (T/P) / 4(T)	--	0	---	0	4 (OJT)		0	0	0	0	**22**
Cum. Cr. For PG Diploma		**28**	**8**				**4**	**4**						**44**
Exit option : PG Diploma (44 Credits) after Three Year UG Degree														
PG Program for Second Year														
6.5	III	10(T)+4(P) / 14(T)	2(T)+2 (T/P) / 4(T)						4 (RP)		0	0	0	**22**
	IV	10(T)+2(P) / 12(T)	2(T)+2 (T/P) / 4(T)						6 (RP)		0	0	0	**22**
Cum. Cr. For PG Degree		**26**	**8**						**10**					**44**
Cum. Cr. For 2 Yr. PG Degree		**54**	**16**				**4**	**4**	**10**					**88**
Exit option : PG Degree (88 Credits) after Three Year UG Degree														

Abbreviations: Yr.: Year; Sem.: Semester; MD : Mandatory, Ele : Electives, OJT: On Job Training: Internship/ Apprenticeship; FP: Field projects; RM: Research Methodology; Research Project: RP; Cumulative Credits: Cum. Cr., T : Theory, P : Practical

Anekant Education Society's

Tuljaram Chaturchand college of Arts, Science and commerce, Baramati,

Empowered Autonomous, NAAC A ++

Department of Zoology

Course and Credit structure for

M.Sc. –I Zoology NEP-2020 (2026 Pattern)

Level	Sem	Course Type	Course Code	Title of Course	Theory / Practical	No. of Credits
6.0	I	Major (Mandatory)	ZOO-501-MRM	Biochemistry and Bioenergetics	Theory	4
			ZOO-502-MRM	Cell Biology	Theory	4
			ZOO-503-MRM	Biological Techniques	Theory	2
			ZOO-504-MRM	Biochemistry and Bioenergetics Lab	Practical	2
			ZOO-505-MRM	Cell Biology and Biological Techniques Lab	Practical	2
		Major (Elective)	ZOO-506-MJE(A)	Ichthyology	Theory (Any One)	2
			ZOO-506-MJE(B)	Endocrinology		
			ZOO-507-MJE(A)	Practicals in Ichthyology	Practical (Any One)	2
			ZOO-507-MJE(B)	Practicals in Endocrinology		
		Research Methodology	ZOO-508-RM	Research Methodology	Theory	4
					Total Credits Sem-I	**22**
6.0	II	Major (Mandatory)	ZOO-551-MRM	Molecular Biology	Theory	4
			ZOO-552-MRM	Developmental Biology	Theory	4
			ZOO-553-MRM	Ecology	Theory	2
			ZOO-554-MRM	Molecular Biology Lab	Practical	2
			ZOO-555-MRM	Developmental Biology and Ecology Lab	Practical	2
		Major (Elective)	ZOO-556-MJE(A)	Entomology-I	Theory (Any One)	2
			ZOO-556-MJE(B)	Genetics-I		
			ZOO-557-MJE(A)	Practicals in Entomology-I	Practical (Any One)	2
			ZOO-557-MJE(B)	Practicals in Genetics-I		
		On Job Training (OJT)	ZOO-558-OJT	On Job Training	Practical	4
					Total Credits Sem-II	**22**
Cumulative Credits for PG Diploma – I and II						**22+22 =44**

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2026)

Name of the Program: M.Sc. Zoology
Program Code: PSZO
Class: M. Sc. I
Semester: I
Course Type: Major (Mandatory) Theory
Course Code: ZOO-501-MRM
Course Name: Biochemistry and Bioenergetics
Number of Credits: 04
Number of Teaching hours: 60

Course Objectives:

- To understand the chemical nature, classification, structure, and biological functions of biomolecules.
- To explain enzyme properties, kinetics, and mechanisms of enzyme regulation and inhibition.
- To introduce the principles of bioenergetics and thermodynamics in biological systems.
- To describe major metabolic pathways and their regulation in living organisms.
- To understand carbohydrate, lipid, and protein metabolism and their physiological significance.
- To explain electron transport chain and oxidative phosphorylation mechanisms.
- To develop conceptual understanding of metabolic integration and energy balance in cells.

Course Outcomes:

After successful completion of this course, students will be able to:
CO1: Explain the structure and functions of biomolecules including carbohydrates, lipids, proteins, vitamins, and coenzymes.
CO2: Describe enzyme classification, kinetics, inhibition, and regulatory mechanisms.
CO3: Apply thermodynamic concepts to biological energy transformations.
CO4: Illustrate carbohydrate metabolic pathways and their regulation.
CO5: Explain lipid metabolism including β-oxidation and fatty acid synthesis.
CO6: Describe oxidative phosphorylation and electron transport processes.
CO7: Integrate metabolic pathways and explain their physiological significance.

TOPICS:

UNIT	SUB UNITS	SYLLABUS	NO. OF LECTURES
1. Biomolecules: Classification, Structure and Function	1.1	Stabilizing Interactions in Biomolecules	20
	1.2	a. Water: Structure and Function b. pH and Buffers c. Biological Buffer System	
	1.3	Carbohydrates: a. Classification of Carbohydrates b. Structure, general properties and functions	
	1.4	Lipids: a. Classification b. Structure and function c. Major subclasses.	
	1.5	Vitamins and coenzymes: a. Source b. Biochemistry c. Functions d. Deficiency	

	1.6	Proteins: a. General properties of proteins b. Structure of amino acid c. Structure of proteins: Primary structure and its importance, Secondary structure- alpha-helix, beta-helix, Ramachandran plot, X ray diffraction, Tertiary structure: Myoglobin, Forces stabilizing, unfolding and refolding Quaternary structure- haemoglobin. d. Biological Roles	
2. Enzymes	2.1	a. Classification b. Types of enzymes c. Nomenclature d. Properties	10
	2.2	Enzyme Kinetics -One Substrate Reaction Michaelis-Menten Equation, Lineweaver-Burk plot	
	2.3	Specific Activity	
	2.4	Factors affecting enzyme activity	
	2.5	Enzyme inhibition	
	2.6	Allosteric Enzymes Isozymes (LDH)	
3. Bioenergetics: - Metabolic Pathways and its energetics	3.1	Internal energy, enthalpy, entropy, concept of free energy, redox potentials, high energy compounds, structure and function of ATP.	30
	3.2	Concepts of metabolism: Metabolic Pathways- Catabolic and anabolic, Regulation of metabolic pathways.	
	3.3	Carbohydrate metabolisms: a. Glycolysis b. TCA Glycogenesis, Glycogenolysis and Gluconeogenesis	
	3.4	Electron transport chain and Oxidative phosphorylation.	
	3.5	Lipid metabolism: Introduction, Biosynthesis of Palmitic acid, Beta oxidation of fatty acid	

REFERENCES

1. *Voet, D., & Voet, J. G. (2010). Biochemistry. John Wiley & Sons.*
2. Berg Jeremy, Tymoczko John, Stryer Lubert (2007), *Biochemistry.*Publisher: W. H. Freeman, New York.
3. *Calculations, B. (1997) Segel Irvin H. Publisher: John Wiley and Sons, New York, 34.*
4. *Trevor, P. (2004). Enzymes: Biochemistry, Biotechnology and Clinical Chemistry. Horwood Series in Chemical Science.*
5. Murray, R. K., Granner, D. K., & Rodwell, V. W. (2010). Harper's illustrated Biochemistry.
6. *Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). Lehninger principles of biochemistry. Macmillan.*

Course Articulation Matrix of ZOO-501-MRM- Biochemistry and Bioenergetics
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	2	1	1	1	1
CO2	3	3	2	3	1	1	1	1
CO3	2	3	2	2	1	1	1	1
CO4	3	3	2	3	1	1	1	1
CO5	3	2	2	2	1	1	1	1
CO6	3	2	2	2	1	1	1	1
CO7	3	3	2	3	1	1	2	2

PO1: Advanced Disciplinary Knowledge & Originality
The course outcomes (CO1–CO7) provide in-depth disciplinary knowledge in biochemistry and bioenergetics, including biomolecular structure, enzymology, metabolic pathways, and energy transformation processes. This knowledge base enables students to develop originality in understanding and applying biochemical concepts in academic and research contexts.

PO2: Research, Analysis, and Complexity
CO2, CO3, CO6, and CO7 emphasize analytical understanding of enzyme kinetics, thermodynamics, oxidative phosphorylation, and metabolic integration. These outcomes foster critical analysis and interpretation of complex biological systems, preparing students to engage in biochemical research and advanced scientific investigations.

PO3: Problem Solving in New Contexts

Through CO3–CO7, students learn to apply biochemical principles to novel biological and physiological contexts. Understanding energy transformations and metabolic regulation enables students to solve biochemical and biomedical problems in unfamiliar or interdisciplinary scenarios.

PO4: Technical Mastery and Scientific Reasoning

CO2–CO6 require mastery of biochemical principles such as enzyme kinetics, metabolic regulation, and electron transport mechanisms. These outcomes strengthen scientific reasoning and technical competence necessary for laboratory experiments, data interpretation, and advanced biochemical applications.

PO5: Integrated Communication

CO1–CO7 encourage students to articulate biochemical concepts, metabolic pathways, and energy processes clearly in written and oral formats. Students develop the ability to communicate scientific knowledge effectively to peers, instructors, and interdisciplinary audiences.

PO6: Ethical, Social, and Professional Judgment

Understanding biochemical processes and their physiological significance (CO7) supports ethical and professional judgment in biomedical research, healthcare, and biotechnology. Students become aware of the implications of biochemical knowledge in health, industry, and society.

PO7: Autonomous and Lifelong Learning

The course promotes independent learning by requiring students to integrate biochemical concepts (CO7) and apply foundational knowledge (CO1–CO6). This fosters self-directed learning and encourages continuous professional development in rapidly evolving biochemical and life science fields.

PO8: Employability, Innovation, and Entrepreneurship

The biochemical knowledge and analytical skills gained through CO1–CO7 prepare students for careers in biotechnology, pharmaceuticals, research, diagnostics, and academia. The course also encourages innovative thinking in metabolic engineering, drug development, and biotechnological applications, enhancing employability and entrepreneurial potential.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2026)

Name of the Program: M.Sc. Zoology
Program Code: PSZO
Class: M. Sc. I
Semester: I
Course Type: Major (Mandatory) Theory
Course Code: ZOO-502-MRM
Course Name: Cell Biology
Number of Credits: 04
Number of Teaching hours: 60

Course Objectives:-

- To introduce the chemical composition and macromolecular organization of cells.
- To explain plasma membrane structure and transport mechanisms.
- To understand the endomembrane system and intracellular trafficking.
- To describe nuclear organization and genetic regulation mechanisms.
- To explain mitochondria, chloroplasts, and cellular energy metabolism.
- To understand cytoskeleton, cell signaling, and cell cycle regulation.
- To understand the mechanism of cancer development, cell death & application of stem cell

Course Outcomes:-

After successful completion of this course, students will be able to:
CO1: describe chemical and molecular organization of cells.
CO2: explain membrane structure, transport, and membrane potential mechanisms.
CO3: illustrate structure and functions of ER, Golgi, lysosomes, and peroxisomes.
CO4: explain nuclear structure and nucleo-cytoplasmic transport.
CO5: describe mitochondria and chloroplast biogenesis and functions.
CO6: explain cell signaling pathways, cytoskeleton functions, and cell cycle control.
CO7: evaluate mechanisms of cancer development, programmed cell death, and stem cell applications.

TOPICS:

UNIT	SUB UNITS	SYLLABUS	NO. OF LECTURES
1. Overview of Chemical Nature of the Cell	1.1	Carbon as backbone of biologically important molecules.	02
	1.2	Macromolecules and their role in the living systems.	
2. Plasma membrane	2.1	Models of cell membrane structure	06
	2.2	Membrane Transport: Carrier proteins (uniporters, symporters and antiporters), Active and passive transport, Voltage and transmitter gated ion channels.	
	2.3	Membrane potential and synaptic transmission	
3. The Endomembrane System and Peroxisomes	3.1	Endoplasmic reticulum: Signal peptide hypothesis, protein folding, processing and secretion, lipid synthesis	07
	3.2	Golgi complex: Protein glycosylation and proteolytic processing	
	3.3	Lysosomes: Structure, Role in intracellular digestion and Apoptosis, Lysosomal Storage Diseases	
	3.4	Peroxisomes and Glyoxysomes : Structure and functions	
	3.5	Intracellular Transport and protein trafficking	
4. Nucleus	4.1	Ultrastructure, Nuclear pore complex	

	4.2	Export and import of proteins	03
	4.3	Nucleolus, Nuclear lamina and its role in Cell Division	
5. Mitochondria and Chloroplast	5.1	Structure, Genetic system, Functions, Protein Import and biogenesis of mitochondria and chloroplast	03
6. Extracellular Matrix, Cell-Cell Junction and Adhesion	6.1	Polarity proteins	05
	6.2	Cell junctions: tight junction, claudins, desmosome, hemidesmosome, gap junctions and Plasmodesmata	
	6.3	Cell adhesion molecules: cadherins, integrins and selectins	
	6.4	Extracellular matrix of animal and plant cell	
7. Cell Signaling and Transduction	7.1	General structure of cellular receptors	07
	7.2	Second messengers in cell signaling: Types and their role	
	7.3	G-Protein Coupled Receptors and its associated pathway	
	7.4	Receptor tyrosine kinases and its associated pathway	
8. Cell Cycle and its regulation	8.1	Check points of cell cycle.	03
	8.2	Regulation of Cyclin and Cyclin dependent kinases (Cdk), Check points- role of Rb and p53	
	8.3	Inhibitors of cell cycle	
9. Cytoskeleton and Motor Proteins	9.1	Microtubules: Structure, MTOC's and functions of microtubules	07
	9.2	Intermediate filaments: Structure, types and functions of intermediate filaments.	
	9.3	Microfilaments: Actin polymerization, role in cell movement.	
	9.4	Dynein, Kinesin and Myosin	
	9.5	Inhibitors of cytoskeleton organization	
10. Cancer Biology	10.1	Characteristics of Cancer Cell	07
	10.2	Tumor viruses: Hepatitis B virus, Adenoviruses, SV40, Papillomaviruses and Retroviruses	
	10.3	Oncogene and Tumor suppresser gene	
	10.4	Diagnosis, Screening and treatment of cancer	
11. Cell death mechanism	11.1	Autophagy	04
	11.2	Apoptosis	
	11.3	Anoikis	
12. Stem Cell Biology	12.1	Concept, types, self-renewal, pluripotency, differentiation	05
	12.2	Use of stem cells in tissue repair	

REFERENCES

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2. Lodish, H., D. Baltimore, A. Berk, L. Zipursky, M. Matsudaira and J. Darnell. (1995). Molecular Cell Biology, Eds. 3, Scientific American and W. H. Freeman. New York.
3. Robertis, D. (1987). Cell and molecular biology.
4. Becker, W. M. (2005). The world of the cell.
5. Cooper, G. M., & Hausman, R. E. (2016). The Cell: A Molecular Approach.

Course Articulation Matrix of ZOO-502-MRM- Cell Biology
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	2	1	1	1	1
CO2	3	3	2	3	1	1	1	1
CO3	3	2	2	2	1	1	1	1
CO4	3	2	2	2	1	1	1	1
CO5	3	2	2	3	1	1	1	1
CO6	3	3	2	3	1	1	1	1
CO7	3	3	2	3	1	2	2	1

PO1: Advanced Disciplinary Knowledge & Originality
CO1–CO7 provide advanced disciplinary knowledge of cellular organization, membrane dynamics, organelle functions, nuclear biology, bioenergetics, signaling pathways, and cancer biology. This foundational and advanced understanding enables students to develop originality in cellular and molecular biology concepts and applications.

PO2: Research, Analysis, and Complexity
CO2, CO6, and CO7 emphasize complex cellular mechanisms such as membrane transport, signal transduction, cell cycle regulation, and cancer development. These outcomes foster analytical and research-oriented thinking, enabling students to interpret and evaluate complex biological processes and experimental data.

PO3: Problem Solving in New Contexts
CO3–CO7 equip students with knowledge of organelle functions, biogenesis, and cellular regulation, enabling them to apply cellular biology principles to novel problems in biotechnology, medicine, and research, such as disease mechanisms and therapeutic strategies.

PO4: Technical Mastery and Scientific Reasoning
CO1–CO6 develop scientific reasoning and technical mastery by requiring students to understand molecular structures, membrane transport mechanisms, organelle biogenesis, and cellular signaling. This strengthens their ability to interpret experimental observations and apply scientific logic in laboratory and research settings.

PO5: Integrated Communication
CO1–CO7 require students to explain and illustrate cellular structures and functions, enabling them to communicate complex biological concepts effectively in written, graphical, and oral forms to scientific and interdisciplinary audiences.

PO6: Ethical, Social, and Professional Judgment
CO7 addresses cancer biology, programmed cell death, and stem cell applications, which have significant ethical, social, and professional implications. Understanding these topics helps students develop responsible judgment in biomedical research, healthcare, and biotechnology practices.

PO7: Autonomous and Lifelong Learning
The course encourages students to integrate knowledge across cellular processes (CO1–CO7) and explore emerging topics such as stem cell biology and cancer research. This promotes self-directed learning and lifelong professional development in life sciences.

PO8: Employability, Innovation, and Entrepreneurship
Knowledge of cellular structure, organelle function, signaling pathways, and disease mechanisms prepares students for careers in biotechnology, pharmaceuticals, biomedical research, diagnostics, and academia. The course also supports innovation in cell-based therapies and biotechnological applications, enhancing employability and entrepreneurial skills.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2026)

Name of the Program: M.Sc. Zoology
Program Code: PSZO
Class: M. Sc. I
Semester: I
Course Type: Major (Mandatory) Theory
Course Code: ZOO-503-MRM
Course Name: Biological Techniques
Number of Credits: 02
Number of Teaching hours: 30

Course Objectives:-

- To introduce principles and applications of microscopy techniques.
- To understand spectroscopic and analytical methods in biology.
- To explain centrifugation and electrophoretic techniques.
- To introduce chromatographic techniques and their applications.
- To understand modern molecular biology techniques including DNA markers and sequencing.
- To introduce bioinformatics and database applications.
- To familiarize students with nanotechnology concepts in biological sciences.

Course Outcomes:-

After successful completion of this course, students will be able to:
CO1: explain principles and applications of light and advanced microscopy.
CO2: describe spectroscopic techniques used in biological research.
CO3: apply centrifugation and electrophoresis for biomolecule separation.
CO4: explain chromatographic techniques for biological analysis.
CO5: describe molecular techniques including DNA markers, sequencing, and microarrays.
CO6: use biological databases and basic bioinformatics tools.
CO7: explain principles and applications of nanotechnology in biology.

TOPICS:

UNIT	SUB UNIT	SYLLABUS	NO. OF LECTURES
1. Microscopy	1.1	Microscopy: Resolution and its limit, Improvement of resolution.	05
	1.2	Principles and Applications of: Phase Contrast, Fluorescence, Confocal microscope	
2. Spectroscopy	Principles of the following		06
	2.1	UV-Visible Spectroscopy	
	2.2	Atomic Absorption Spectroscopy	
	2.3	Molecular Spectroscopy	
	2.4	IR Spectroscopy	
	2.5	Circular Dichroism	
	2.6	Mass Spectroscopy	
3. Centrifugation	3.1	Differential and Density Gradient Centrifugation	03
4. Electrophoresis	4.1	SDS-PAGE	03
	4.2	2D- Gel Electrophoresis	
5. Principle and Applications of Chromatography	5.1	Thin Layer Chromatography	04
	5.2	GC-MS	
	5.3	HPLC	
6. Advance	6.1	DNA Markers: RAPD, RFLP & AFLP	05

Techniques in Biology	6.2	DNA microarray	
	6.3	DNA sequencing technology (Sanger and Next generation)	
7. Computer Application	7.1	Databases and their applications	02
	7.2	Introduction to Bioinformatics	
8. Introduction to Nanotechnology	8.1	Basic concepts of Nanotechnology	02
	8.2	Applications of Nanotechnology	

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Course Articulation Matrix of ZOO-503-MRM Biological Techniques
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	1	3	1	1	1	1
CO2	2	2	1	3	1	1	1	1
CO3	2	3	2	3	1	1	1	1
CO4	2	3	2	3	1	1	1	1
CO5	2	3	2	3	1	1	1	1
CO6	2	2	2	2	1	1	2	2
CO7	1	1	1	2	1	1	1	2

PO1: Advanced Disciplinary Knowledge & Originality
CO1–CO7 provide advanced knowledge of microscopy, spectroscopy, centrifugation, chromatography, molecular biology techniques, bioinformatics, and nanotechnology. This equips students with strong disciplinary knowledge and encourages originality in understanding and applying modern biological research tools.

PO2: Research, Analysis, and Complexity
CO2–CO6 involve analytical and research-oriented techniques such as spectroscopy, electrophoresis, sequencing, and bioinformatics. These outcomes foster critical analysis, data interpretation, and understanding of complex biological systems and research methodologies.

PO3: Problem Solving in New Contexts
CO3–CO7 enable students to apply experimental and computational techniques to novel biological problems, such as biomolecule characterization, genetic analysis, and nanobiotechnology applications. This enhances problem-solving abilities in interdisciplinary and real-world contexts.

PO4: Technical Mastery and Scientific Reasoning
CO1–CO6 develop technical competence in advanced laboratory and analytical techniques, while CO7 introduces nanotechnology applications in biology. These outcomes strengthen scientific reasoning, experimental design, and technical mastery required in modern biological research and industry.

PO5: Integrated Communication
CO1–CO7 require students to interpret experimental results, analyze biological data, and explain advanced techniques. This develops the ability to communicate scientific concepts, methodologies, and findings effectively in written, oral, and graphical formats.

PO6: Ethical, Social, and Professional Judgment
CO5–CO7 include applications such as genetic analysis and nanotechnology, which have ethical and societal implications. Understanding these technologies promotes ethical awareness and professional responsibility in research, healthcare, and biotechnology sectors.

PO7: Autonomous and Lifelong Learning
The course encourages students to explore emerging tools such as sequencing, microarrays, and bioinformatics databases (CO5–CO6), promoting self-directed learning and continuous professional development in rapidly evolving biological sciences.

PO8: Employability, Innovation, and Entrepreneurship
Training in advanced biological techniques and nanotechnology (CO1–CO7) prepares students for careers in biotechnology, pharmaceuticals, research laboratories, diagnostics, and bioinformatics industries. These outcomes foster innovation and entrepreneurial potential in biological research and technology development.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2026)

Name of the Program: M.Sc. Zoology
Program Code: PSZO
Class: M. Sc. I
Semester: I
Course Type: Major (Mandatory) Practical
Course Code: ZOO-504-MRM
Course Name: Biochemistry and Bioenergetics Lab
Number of Credits: 02
Number of Teaching hours: 60

Course Objectives:-

- To develop skills in preparation of standard solutions and buffers.
- To estimate biomolecules using biochemical assays.
- To analyze enzyme activity and factors affecting enzyme kinetics.
- To isolate biomolecules from biological samples.
- To determine biochemical parameters in biological samples.
- To develop analytical and quantitative laboratory skills.
- To promote scientific documentation and interpretation of experimental data.

Course Outcomes:-

After successful completion of this course, students will be able to:
CO1: prepare standard solutions and buffers accurately.
CO2: perform biochemical estimations of sugars, proteins, vitamins, and lipids.
CO3: determine enzyme activity and optimum reaction conditions.
CO4: isolate biomolecules such as starch and cholesterol.
CO5: analyze biochemical parameters using titrimetric and colorimetric methods.
CO6: interpret experimental data using statistical and analytical approaches.
CO7: maintain laboratory records and follow biosafety and ethical practices.

PRACTICALS:

Sr. No	Title of the Practical	E/D	Teaching Hours
1	Preparation of standard Acid and Alkali solutions and acid-base titration	E	04
2	Preparation of Buffers of known pH and molarity Measurement of pH of Various samples and their buffering capacity	E	04
3	Estimation of inorganic phosphates from plasma	E	04
4	Estimation of Sugar (Glucose) by GOD-POD Method	E	04
5	Estimation of Tyrosine by Folin Ciocalteu Reagent	E	04
6	Estimation of vitamin ‘C’ by iodine method	E	04
7	Estimation of amylase activity	E	04
8	Estimation of protein by Lowry et.al method	E	04
9	Determination of optimum pH of enzyme	E	04
10	Effect of substrate concentration, pH, temperature, inhibitor and activator on enzyme activity	E	08
11	Isolation of starch from corn (on the basis of density)	E	04
12	Isolation of cholesterol from egg yolk / human blood or Determination of acid value of fat	E	04

13	Estimation of cholesterol by Zak's method	E	04
14	Estimation of glycine by titrimetric method	E	04
E: Experiment, D: Demonstration			

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Course Articulation Matrix of ZOO-504-MRM- Biochemistry and Bioenergetics Lab
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	1	3	1	1	1	1
CO2	2	2	1	3	1	1	1	1
CO3	2	3	2	3	1	1	1	1
CO4	2	2	1	3	1	1	1	1
CO5	2	2	2	3	1	1	1	1
CO6	1	2	2	2	1	1	2	1
CO7	1	1	1	2	1	2	1	1

PO1: Advanced Disciplinary Knowledge & Originality
CO1–CO5 provide foundational and advanced knowledge of biochemical laboratory techniques, including solution preparation, biomolecule estimation, enzyme assays, and biomolecule isolation. This strengthens students' disciplinary understanding of biochemical principles and laboratory methodologies, fostering originality in experimental approaches.

PO2: Research, Analysis, and Complexity
CO2, CO3, CO5, and CO6 emphasize biochemical analysis, enzyme kinetics, titrimetric and colorimetric estimations, and data interpretation. These outcomes promote analytical thinking, quantitative reasoning, and understanding of complex biochemical experimental data, preparing students for research activities.

PO3: Problem Solving in New Contexts
CO1–CO6 enable students to apply biochemical techniques and analytical methods to solve experimental and real-world biological problems, such as optimizing enzyme reactions, quantifying biomolecules, and interpreting biochemical data in diverse research and diagnostic contexts.

PO4: Technical Mastery and Scientific Reasoning
CO1–CO5 develop technical competence in laboratory techniques such as buffer preparation, biochemical assays, biomolecule isolation, and analytical measurements. CO6 further strengthens scientific reasoning through statistical analysis and interpretation of experimental results.

PO5: Integrated Communication
CO6 and CO7 require students to interpret experimental results, maintain laboratory records, and document findings systematically. This enhances their ability to communicate scientific data and experimental outcomes effectively in written and oral formats.

PO6: Ethical, Social, and Professional Judgment
CO7 emphasizes biosafety practices, ethical laboratory conduct, and proper record maintenance. These outcomes cultivate professional responsibility, ethical awareness, and adherence to safety standards in biochemical research and industrial laboratories.

PO7: Autonomous and Lifelong Learning
The course encourages independent experimentation, data analysis, and interpretation (CO1–CO6), promoting self-directed learning and continuous skill development in biochemical techniques and research methodologies.

PO8: Employability, Innovation, and Entrepreneurship
Hands-on training in biochemical estimations, enzyme assays, biomolecule isolation, and analytical techniques (CO1–CO6) prepares students for careers in research laboratories, biotechnology industries, pharmaceuticals, diagnostics, and academia. The course also supports innovation in biochemical research and industrial applications.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2026)

Name of the Program: M.Sc. Zoology
Program Code: PSZO
Class: M. Sc. I
Semester: I
Course Type: Major (Mandatory) Practical
Course Code: ZOO-505-MRM
Course Name: Cell Biology and Biological techniques Lab
Number of Credits: 02
Number of Teaching hours: 60

Course Objectives:-

- To develop skills in microscopic measurement and staining techniques.
- To study cell division and chromosomal structures.
- To isolate cellular organelles using centrifugation techniques.
- To perform spectrophotometric analysis of biomolecules.
- To understand chromatographic separation techniques.
- To demonstrate advanced biological techniques and instrumentation.
- To provide exposure to biotechnology laboratories and research environments.

Course Outcomes:-

After successful completion of this course, students will be able to:
CO1: measure cell size and perform cell viability assays.
CO2: demonstrate mitosis, chromosome preparation, and DNA staining.
CO3: isolate nuclei and chloroplasts using differential centrifugation.
CO4: determine biomolecule concentration using spectrophotometry.
CO5: separate biomolecules using chromatography.
CO6: explain advanced techniques such as 2D electrophoresis and nanoparticle characterization.
CO7: prepare scientific reports and follow laboratory safety practices.

PRACTICALS:

Sr. No	Title of the Practical	E/D	Teaching Hours
1	Measurements of cell size using stage micro-meter and ocular micro-meter	E	04
2	Cell viability assay by Trypan blue exclusion	E	04
3	Effect of Colchicine treatment on Mitosis from any suitable material	E	04
4	Demonstration of collagen by Van Gieson's Stain in Liver / Tissue Sections / *Drosophila* larvae	E	04
5	Differential staining for DNA and RNA in human cheek epithelial cells	E	04
6	Preparation of metaphase chromosomes	E	04
7	Feulgen staining for DNA detection	E	04
8	Calculation of Relative Centrifugal Force (RCF)	E	04
9	Isolation of nuclei from liver / plant tissue	E / D	04
10	Isolation of Chloroplasts from Spinach Leaves by Differential Centrifugation	E	04
11	Determination of λmax of Potassium Permanganate using UV–Visible Spectrophotometer	E	04

12	Determination of DNA Concentration using UV Spectrophotometer (A260/A280 ratio)	E	04
13	Simulation based demonstration of 2D Gel Electrophoresis	D	04
14	Separation of amino acids by paper chromatography	E	08
15	Study of characterization techniques of Nanoparticles	D	04
16	Visit to a Biotechnology lab and submission of the report	-	-
E: Experiment, D: Demonstration			

REFERENCES

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2. Shivaraja, Y. M., Ganesh, M. K., & Hemavathi, A. (2008). *Laboratory manual for practical biochemistry*. New Delhi, India: Jaypee Brothers Medical Publishers.
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Course Articulation Matrix of ZOO-505-MRM- Cell Biology and Biological Techniques Lab
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	1	3	1	1	1	1
CO2	2	2	1	3	1	1	1	1
CO3	2	3	2	3	1	1	1	1
CO4	2	2	2	3	1	1	1	1
CO5	2	2	2	3	1	1	1	1
CO6	1	2	1	2	1	1	1	2
CO7	1	1	1	2	2	2	1	1

PO1: Advanced Disciplinary Knowledge & Originality
CO1–CO6 provide comprehensive disciplinary knowledge of cell measurement, viability assays, mitosis, chromosome preparation, organelle isolation, spectrophotometry, chromatography, and advanced analytical techniques. This strengthens students' understanding of cellular and molecular biology practical methodologies and promotes originality in experimental design and interpretation.

PO2: Research, Analysis, and Complexity
CO2–CO6 emphasize experimental analysis, biomolecule quantification, organelle isolation, and advanced analytical techniques such as electrophoresis and nanoparticle characterization. These outcomes foster analytical thinking, quantitative data interpretation, and understanding of complex biological experiments, preparing students for research-oriented studies.

PO3: Problem Solving in New Contexts
CO1–CO6 equip students with practical skills to address experimental and biological problems, such as assessing cell viability, quantifying biomolecules, and characterizing biological samples. This enables students to apply laboratory techniques in new research, biomedical, and biotechnological contexts.

PO4: Technical Mastery and Scientific Reasoning
CO1–CO6 develop technical competence in microscopy, staining, centrifugation, spectrophotometry, chromatography, and advanced analytical methods. These outcomes strengthen scientific reasoning, experimental planning, and interpretation of laboratory results in cell biology and biological techniques.

PO5: Integrated Communication
CO7 requires students to prepare scientific reports and document experimental observations systematically. This enhances their ability to communicate scientific data, experimental findings, and interpretations effectively in written and oral formats.

PO6: Ethical, Social, and Professional Judgment
CO7 emphasizes laboratory safety, biosafety guidelines, and ethical scientific practices. Understanding and following these practices cultivate professional responsibility, ethical awareness, and adherence to regulatory standards in biological research laboratories.

PO7: Autonomous and Lifelong Learning
The course promotes independent experimentation, observation, and interpretation of experimental results (CO1–CO6), encouraging self-directed learning and continuous skill enhancement in laboratory techniques and emerging biological technologies.

PO8: Employability, Innovation, and Entrepreneurship
Hands-on training in cell biology techniques, biomolecule analysis, and advanced characterization methods (CO1–CO6) prepares students for careers in research laboratories, biotechnology industries, diagnostics, pharmaceuticals, and academia. The course also fosters innovation in experimental biology and biotechnological applications, enhancing employability and entrepreneurial skills.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2026)

Name of the Program: M.Sc. Zoology
Program Code: PSZO
Class: M. Sc. I
Semester: I
Course Type: Major (Elective) Theory
Course Code: ZOO-506-MJE (A)
Course Name: Ichthyology
Number of Credits: 02
Number of Teaching hours: 30

Course Objectives:-

- To classify fishes and understand phylogenetic relationships.
- To study external morphology and skeletal organization of fishes.
- To understand feeding and digestive adaptations.
- To explain respiratory and buoyancy mechanisms.
- To understand excretion and osmoregulation in fishes.
- To study reproductive and nervous systems in fishes.
- To relate fish biology to ecological and economic importance.

Course Outcomes:-

After successful completion of this course, students will be able to:
CO1: classify fishes and explain evolutionary relationships.
CO2: describe external morphology and skeletal structures.
CO3: analyze feeding habits and digestive system modifications.
CO4: explain respiratory mechanisms and air bladder function.
CO5: describe excretory and osmoregulatory adaptations.
CO6: explain reproductive and nervous system organization.
CO7: evaluate ecological and economic significance of fishes.

TOPICS:

UNIT	SUB UNIT	SYLLABUS	NO. OF LECTURES
1. Classification and Diagnostic Characters (up to orders)	1.1	Extant Cyclostomata, Chondrichthyes and Osteichthyes (9 major orders of fishes)	**4 L**
	1.2	Phylogeny of fishes	
2.External morphology	2.1	Body form, appendages, pigmentation, skin and scales	**3 L**
3. Endoskeleton	3.1	Skull	**4 L**
	3.2	Axial Skeleton	
	3.3	Appendicular skeleton.	
4. Digestion	4.1	Food and feeding habits	**4 L**
	4.2	Digestive system and its anatomical modifications	
5. Respiration	5.1	Structure and functions of gills	**5 L**
	5.2	Adaptations for air breathing	
	5.3	Role of air bladder in respiration and buoyancy	
6. Excretion and Osmoregulation	6.1	Glomerular and aglomerular kidneys	**4 L**
	6.2	Nitrogen (Ammonia, Urea and TMAO)	

		excretions	
7. Reproduction	7.1	Male reproductive system	**4 L**
	7.2	Female reproductive system	
8. Nervous system	8.1	Central nervous system of fish	**2 L**

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Course Articulation Matrix of ZOO-506-MJE (A) Ichthyology
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	1	2	1	1	1	1
CO2	2	2	1	3	1	1	1	1
CO3	3	2	2	3	1	1	1	1
CO4	1	2	1	3	1	1	1	1
CO5	1	3	2	2	1	1	1	1
CO6	2	2	3	2	1	1	1	1
CO7	2	1	1	2	1	1	2	3

PO1: Advanced Disciplinary Knowledge & Originality
CO1–CO7 provide advanced disciplinary knowledge on fish classification, evolutionary relationships, morphology, physiology, ecology, and economic importance. This comprehensive understanding strengthens students' conceptual knowledge of ichthyology and encourages originality in evolutionary and biological studies of fishes.

PO2: Research, Analysis, and Complexity
CO1, CO3, CO4, CO5, and CO7 involve analysis of evolutionary trends, physiological adaptations, ecological roles, and economic significance of fishes. These outcomes develop analytical skills and the ability to understand complex biological and ecological systems, preparing students for research and scientific investigations.

PO3: Problem Solving in New Contexts
CO3–CO7 equip students with knowledge of functional adaptations and ecological roles of fishes, enabling them to address problems in fisheries biology, aquaculture, conservation, and environmental management in diverse and novel contexts.

PO4: Technical Mastery and Scientific Reasoning
CO2–CO6 strengthen scientific reasoning by explaining structural and functional adaptations in fishes, including skeletal systems, digestion, respiration, osmoregulation, reproduction, and nervous systems. This enhances students' ability to interpret biological structures and physiological processes using scientific logic.

PO5: Integrated Communication
CO1–CO7 require students to describe, analyze, and evaluate biological concepts related to fishes. This develops their ability to communicate scientific information effectively through diagrams, written descriptions, and oral presentations in academic and professional settings.

PO6: Ethical, Social, and Professional Judgment
CO7 highlights the ecological and economic significance of fishes, including conservation, fisheries management, and sustainable utilization. This fosters ethical awareness, social responsibility, and professional judgment regarding biodiversity conservation and sustainable aquatic resource management.

PO7: Autonomous and Lifelong Learning
The course encourages students to integrate knowledge of fish biology, ecology, and evolution (CO1–CO7) and explore current developments in fisheries science and aquatic biology. This promotes self-directed learning and lifelong professional development in biological and environmental sciences.

PO8: Employability, Innovation, and Entrepreneurship
Knowledge of fish classification, physiology, ecology, and economic importance (CO1–CO7) prepares students for careers in fisheries, aquaculture, environmental science, marine biology, research institutions, and biodiversity conservation agencies. The course also supports innovation and entrepreneurship in aquaculture and fishery-based industries.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2026)

Name of the Program: M.Sc. Zoology
Program Code: PSZO
Class: M. Sc. I
Semester: I
Course Type: Major (Elective) Theory
Course Code: ZOO-506-MJE (B)
Course Name: Endocrinology
Number of Credits: 02
Number of Teaching hours: 30

Course Objectives:-

- To understand hormones as chemical messengers and endocrine communication.
- To explain hormone receptors and signal transduction mechanisms.
- To describe hypothalamic and pituitary hormone regulation.
- To explain hormonal control of metabolism and osmoregulation.
- To understand hormonal regulation in invertebrates and vertebrates.
- To explain endocrine mechanisms in development and metamorphosis.
- To relate endocrine functions to physiological and environmental adaptations.

Course Outcomes:-

After successful completion of this course, students will be able to:
CO1: explain endocrine communication and hormone chemistry.
CO2: describe receptor mechanisms and hormone action pathways.
CO3: explain hypothalamic–pituitary axis regulation.
CO4: describe hormonal control of metabolism and osmoregulation.
CO5: explain endocrine regulation in crustaceans and amphibians.
CO6: describe hormonal control of insect development and metamorphosis.
CO7: correlate endocrine mechanisms with physiological adaptations.

TOPICS:

UNIT	SUB UNIT	SYLLABUS	NO. OF LECTURES
1. Chemical Communication	1.1	Hormones as chemical messenger	3 L
	1.2	Chemistry of Invertebrate and vertebrate hormones	
	1.3	Neurosecretion, neurohemal and endocrine organs	
2. Hormone Receptors	2.1	Receptors on the plasma membrane, cytoplasm & nucleus	3 L
	2.2	Mechanism of hormone action- signal transduction cascade	
3. Hypothalamic Hypophysiotropins			2 L
4. Master gland hormones	4.1	Adenohypophysial Hormones	3 L
	4.2	Neurohypophysial Hormones	
5. Control of Chromatophores	5.1	Role of Pituitary and Pineal gland	2 L
6. Hormonal Regulation of metabolism	6.1	Regulation of Carbohydrates, Protein &Lipid metabolism	3 L
	6.2	Pancreatic Hormones and Glucocorticoids	
7. Osmoregulatory	7.1	Role of ADH, mineralocorticoids, renin-	2 L

Hormones		angiotensin in osmoregulation	
8. Gastrointestinal Hormones			2 L
9. Control of calcium and Phosphate Metabolism			2 L
10. Endocrine Mechanism in Crustacean	10.1	X & Y organs	3 L
	10.2	Regulation of heartbeat, osmoregulation and reproduction	
11. Hormonal Control in Amphibia	11.1	Yolk synthesis, secretion & uptake	3 L
	11.2	Larval Development and Metamorphosis	
12. Hormonal Regulation in Insect	12.1	Larval development and metamorphosis	2 L

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Course Articulation Matrix of ZOO-506-MJE (B) - Endocrinology
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	3	1	1	1	1
CO2	2	3	2	3	1	1	1	1
CO3	2	3	2	3	1	1	1	1
CO4	2	2	3	3	1	1	1	1
CO5	3	2	1	2	1	1	1	1
CO6	2	2	3	2	1	1	1	1
CO7	2	1	1	2	1	3	2	1

PO1: Advanced Disciplinary Knowledge & Originality
CO1–CO7 provide advanced disciplinary knowledge of endocrine communication, hormone chemistry, receptor mechanisms, neuroendocrine regulation, and comparative endocrine systems in vertebrates and invertebrates. This comprehensive understanding strengthens students' conceptual knowledge and encourages originality in physiological and endocrine research.

PO2: Research, Analysis, and Complexity
CO2, CO3, CO4, and CO7 involve complex hormonal signaling pathways, regulatory feedback mechanisms, and physiological adaptations. These outcomes develop analytical skills and the ability to interpret complex endocrine systems and research data, preparing students for advanced studies and research.

PO3: Problem Solving in New Contexts
CO4–CO7 equip students with knowledge of hormonal regulation in metabolism, osmoregulation, development, and adaptation. This enables students to apply endocrine principles to novel problems in physiology, medicine, biotechnology, and environmental biology.

PO4: Technical Mastery and Scientific Reasoning

CO1–CO6 strengthen scientific reasoning by explaining hormone chemistry, receptor interactions, endocrine control systems, and developmental regulation. This enhances students' ability to understand physiological mechanisms and apply scientific logic in experimental and clinical contexts.

PO5: Integrated Communication
CO1–CO7 require students to explain and correlate endocrine mechanisms and physiological responses, enabling them to communicate complex biological concepts clearly through written, graphical, and oral presentations in academic and professional environments.

PO6: Ethical, Social, and Professional Judgment
Understanding endocrine regulation in health, development, and environmental adaptation (CO4–CO7) supports ethical and professional judgment in biomedical research, endocrinology, environmental science, and biotechnology, particularly in areas such as hormone therapy and endocrine disruptors.

PO7: Autonomous and Lifelong Learning
The course encourages students to integrate knowledge of endocrine mechanisms across taxa (CO1–CO7) and explore emerging research in endocrinology and physiology. This promotes self-directed learning and lifelong professional development in biological and health sciences.

PO8: Employability, Innovation, and Entrepreneurship
Knowledge of hormonal regulation, developmental endocrinology, and physiological adaptations (CO1–CO7) prepares students for careers in biomedical research, healthcare, pharmaceuticals, veterinary science, biotechnology, and environmental biology. The course also supports innovation in hormone-based therapies and biotechnological applications, enhancing employability and entrepreneurial potential.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2026)

Name of the Program: M.Sc. Zoology
Program Code: PSZO
Class: M. Sc. I
Semester: I
Course Type: Major (Elective) Practical
Course Code: ZOO-507-MJE (A)
Course Name: Practicals in Ichthyology
Number of Credits: 02
Number of Teaching hours: 60

Course Objectives:-

- To develop practical skills in identification and classification of fishes using taxonomic keys.
- To study external morphology and morphometric characteristics of fishes.
- To understand anatomical adaptations of digestive, reproductive and nervous systems in fishes.
- To study fish scales, chromatophores, and tail fin structures through laboratory techniques.
- To analyze length-weight relationships and physiological indices in fishes.
- To understand adaptations related to respiration, feeding, and habitat in fishes.
- To provide field exposure through visits to fish farms, markets, or aquaria for understanding applied ichthyology.

Course Outcomes:-

After successful completion of this course, students will be able to:
CO1: identify and classify fishes using diagnostic taxonomic keys.
CO2: describe external morphology and perform morphometric measurements of fishes.
CO3: analyze anatomical structures of digestive, reproductive and nervous systems in fishes.
CO4: prepare and examine fish scales, chromatophores, and fin structures microscopically.
CO5: calculate length-weight relationships and physiological indices such as condition factor and gonado-somatic index.
CO6: explain adaptive features of fishes in relation to feeding, respiration, and habitat.
CO7: evaluate practical applications of ichthyology in aquaculture, fisheries, and conservation.

PRACTICALS:

Sr. No	Title of the Practical	E/D	Teaching Hours
1	Study of external characters of any locally available fish	E	04
2	Study of morphometric measurements of any locally available fish	E	04
3	Identification of fish with the help of diagnostic key	E	04
4	Temporary preparation of cycloid and placoid scale from fishes	E	04
5	Preparation of permanent slides of fish scales	E	04
6	Study of fish chromatophores	E / D	04
7	Study of fish tail fins	D	04
8	Study of length-weight relationship and conditions factor of fish	E	04
9	Study of gonosomatic and hepatosomatic indices of fish	E	04
10	Study of adaptations of fishes (adhesive organs, accessory respiratory organs, stomachless fishes and spiral valve)	D	04
11	Dissection and morphology observation of digestive system of carp/catfish/*Tilapia*	E / D	04

12	Dissection and morphology observation of reproductive system of carp/catfish/*Tilapia*	E / D	04
13	Dissection and morphology observation of central nervous system of carp/catfish/*Tilapia*	E / D	04
14	Identification of nitrogenous waste product in fish	E	04
15	Satiation index (e.g. Gambusia-mosquito larvae system)	E / D	04
16	Visit to fish farm/fish market or any aquarium to study breeding *behaviour* of gourami, Siamese fighter, swordtail/tilapia & submission of report	-	-
E: Experiment, D: Demonstration			

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Course Articulation Matrix of ZOO-507-MJE (A) - Practicals in Ichthyology
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	2	1	1	1	1
CO2	2	2	1	2	1	1	1	1
CO3	2	2	2	2	1	1	1	1
CO4	2	2	1	2	1	1	1	1
CO5	2	2	2	2	1	1	1	1
CO6	2	2	2	2	1	1	1	1
CO7	1	1	1	1	1	1	2	3

PO1: Advanced Disciplinary Knowledge & Originality
CO1–CO7 provide comprehensive disciplinary knowledge of fish taxonomy, morphology, anatomy, physiology, morphometrics, and applied ichthyology. This strengthens students' conceptual and practical understanding of ichthyology and encourages originality in taxonomic identification and biological interpretation of fishes.

PO2: Research, Analysis, and Complexity
CO2, CO3, CO5, and CO6 involve analytical measurements, anatomical analysis, calculation of physiological indices, and interpretation of adaptive features. These outcomes develop analytical and research-oriented skills required to understand complex biological and ecological patterns in fish biology.

PO3: Problem Solving in New Contexts
CO5–CO7 equip students with quantitative and applied skills to address problems in fisheries science, aquaculture, and conservation biology. Students learn to apply morphometric and physiological data to solve real-world problems related to fish health, growth assessment, and resource management.

PO4: Technical Mastery and Scientific Reasoning

CO1–CO5 develop technical competence in taxonomic identification, morphometric analysis, anatomical dissection, microscopic preparation, and statistical calculations. These outcomes strengthen scientific reasoning and technical mastery required for laboratory, field, and research applications in ichthyology.

PO5: Integrated Communication
CO1–CO7 require students to record morphometric data, interpret anatomical observations, and explain adaptive and applied aspects of fish biology. This enhances their ability to communicate scientific findings effectively through practical records, reports, and presentations.

PO6: Ethical, Social, and Professional Judgment
CO7 emphasizes practical applications in aquaculture, fisheries, and conservation, fostering ethical awareness and professional responsibility toward sustainable utilization and conservation of aquatic biodiversity and fishery resources.

PO7: Autonomous and Lifelong Learning
The course encourages independent taxonomic identification, data analysis, and interpretation of adaptive features (CO1–CO6), promoting self-directed learning and lifelong professional development in fisheries science and aquatic biology.

PO8: Employability, Innovation, and Entrepreneurship
Hands-on training in fish identification, morphometrics, anatomical analysis, and applied fisheries biology (CO1–CO7) prepares students for careers in aquaculture, fisheries management, biodiversity conservation, research institutions, and fishery-based industries. The course also supports innovation and entrepreneurship in aquaculture and sustainable fisheries practices.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2026)

Name of the Program: M.Sc. Zoology
Program Code: PSZO
Class: M. Sc. I
Semester: I
Course Type: Major (Elective) Practical
Course Code: ZOO-507-MJE (B)
Course Name: Practicals in Endocrinology
Number of Credits: 02
Number of Teaching hours: 60

Course Objectives:-

- To develop understanding of endocrine organs through histological and anatomical studies.
- To study neuroendocrine structures and hormonal control mechanisms in animals.
- To perform experiments demonstrating hormonal regulation of physiological processes.
- To analyze effects of endocrine manipulations such as ablation and hormone administration.
- To understand hormonal control of development and metamorphosis in animals.
- To study comparative endocrinology in invertebrates and vertebrates through practical experiments.
- To develop experimental skills, data recording, and interpretation in endocrine research.

Course Outcomes:-

After completion of this course, students will be able to:
CO1: identify and describe histology and anatomy of endocrine glands and neuroendocrine organs.
CO2: demonstrate hormonal effects on physiological processes such as heart rate and metabolism.
CO3: perform endocrine manipulation experiments such as gonadectomy, pancreatectomy, and eyestalk ablation.
CO4: analyze hormonal control of chromatophores, blood sugar regulation, and osmoregulation.
CO5: explain hormonal regulation of metamorphosis in amphibians and insects
CO6: compare endocrine mechanisms between invertebrates and vertebrates.
CO7: record, analyze, and interpret experimental data following ethical and biosafety guidelines.

PRACTICALS:

Sr. No	Title of the Practical	E/D	Teaching Hours
1	Study of histology of endocrine structures with the help of chart and permanent slides	D	04
2	Study of neurohemal organs	D	04
3	Staging of fish Chromatophores and effect of adrenaline and acetylcholine *in-vivo*	E	04
4	Dissection of fish pituitary gland	E / D	04
5	Study of retrocerebral complex of the cockroach	E	04
6	Study of effect of eye stalk ablation on blood sugar regulation in the crab haemolymph	E	08
7	Study of effect of eye stalk ablation on chloride content in the crab haemolymph	E	08
8	To perform gonadectomy in the mouse / rat	E / D	04
9	To perform pancreatectomy in the mouse / rat	E / D	04
10	Effect of thyroid hormone on amphibian metamorphosis	E / D	08
11	Study of metamorphosis in insect with suitable organism	E / D	08
12	To study the effect of adrenaline on heart beat rate in *Daphnia*	E	04
E: Experiment, D: Demonstration			

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2. Sharma, P. D. (2012). Elementary endocrinology. New Delhi, India: Rastogi Publications.
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Course Articulation Matrix of ZOO-507-MJE (B)- Practicals in Endocrinology
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	2	1	1	1	1
CO2	2	2	2	2	1	1	1	1
CO3	2	3	2	3	1	1	1	1
CO4	2	2	2	2	1	1	1	1
CO5	2	2	2	2	1	1	1	1
CO6	2	2	2	2	1	1	1	1
CO7	1	1	1	1	1	2	1	1

PO1: Advanced Disciplinary Knowledge & Originality
CO1–CO6 provide comprehensive disciplinary knowledge of endocrine gland histology, neuroendocrine organs, hormonal physiology, comparative endocrinology, and developmental regulation. This strengthens students' conceptual and practical understanding of endocrine systems and promotes originality in physiological and endocrinological research.

PO2: Research, Analysis, and Complexity
CO2–CO6 involve experimental analysis of hormonal effects, endocrine manipulations, physiological regulation, and comparative endocrine mechanisms. These outcomes develop analytical and research-oriented skills, enabling students to interpret complex hormonal control systems and experimental data.

PO3: Problem Solving in New Contexts
CO2–CO6 equip students with experimental and analytical skills to address problems in physiology, endocrinology, and biomedical research, such as metabolic regulation, developmental control, and osmoregulatory mechanisms in diverse biological contexts.

PO4: Technical Mastery and Scientific Reasoning
CO1–CO5 develop technical competence in histological identification, endocrine manipulation experiments, physiological assays, and comparative endocrine analysis. These outcomes strengthen scientific reasoning, experimental design, and interpretation of endocrine physiology experiments.

PO5: Integrated Communication
CO7 requires students to record, analyze, and interpret experimental data systematically. This enhances their ability to communicate scientific findings effectively through practical records, reports, and presentations in academic and professional environments.

PO6: Ethical, Social, and Professional Judgment

CO3 and CO7 emphasize ethical handling of experimental animals, biosafety practices, and responsible research conduct. Understanding these aspects cultivates professional responsibility, ethical awareness, and adherence to regulatory guidelines in physiological and endocrinological research.

PO7: Autonomous and Lifelong Learning
The course encourages independent experimentation, data analysis, and comparative interpretation of endocrine mechanisms (CO1–CO6), promoting self-directed learning and lifelong professional development in endocrinology and physiological sciences.

PO8: Employability, Innovation, and Entrepreneurship
Hands-on training in endocrine histology, physiological experiments, endocrine manipulation, and comparative endocrinology (CO1–CO7) prepares students for careers in biomedical research, pharmaceuticals, veterinary science, biotechnology, environmental biology, and academia. The course also supports innovation in hormone-based research and biotechnological applications, enhancing employability and entrepreneurial skills.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2026)

Name of the Program: M.Sc. Zoology
Program Code: PSZO
Class: M. Sc. I
Semester: I
Course Type: Research Methodology (RM) Theory
Course Code: ZOO-508-RM
Course Name: Research Methodology
Number of Credits: 04
Number of Teaching hours: 60

Course Objectives:-

- To introduce the concepts, types, and significance of research in biological sciences.
- To develop skills in identifying and formulating research problems and hypotheses.
- To train students in reviewing scientific literature and designing research studies.
- To provide knowledge of experimental design, sampling methods, and data collection techniques.
- To introduce basic biostatistical concepts and data analysis methods.
- To develop skills in scientific report writing and research paper preparation.
- To inculcate research ethics, plagiarism awareness, and responsible research practices.

Course Outcomes:-

After successful completion of this course, students will be able to:
CO1: explain the concepts, types, and objectives of research in biological sciences.
CO2: identify research problems and formulate research questions and hypotheses.
CO3: conduct literature review and design appropriate research methodologies.
CO4: apply experimental design, sampling techniques, and data collection methods.
CO5: analyze biological data using statistical tools and interpret results.
CO6: prepare scientific research reports and research papers in standard formats.
CO7: demonstrate ethical research practices, including plagiarism prevention and publication ethics.

TOPICS:

UNIT	SUB UNIT	SYLLABUS	NO. OF LECTURES
1. Research methodology	1.1	Introduction to research methodology: meaning and objectives of research	04
	1.2	Types, approaches and significance of research	
	1.3	Characteristics of good research; Problems encountered by researchers in India	
2. Defining the research problem	2.1	Research problem and selection of research problem	03
	2.2	Necessity of defining the research problem	
	2.3	Techniques involved in defining a research problem	
3. Reviewing the literature	3.1	Purpose of literature review: understanding existing research and refining the research problem	05
	3.2	Use of literature to plan research methods and understand research background	
	3.3	Searching and reading scientific research papers	
	3.4	Writing and organizing the literature review	
4. Research design	4.1	Concept and importance of research design; Planning research work	04
	4.2	Variables used in biological research and their types	

	4.3	Basic principles of planning biological experiments	
5. Design of sample surveys	5.1	Concept and importance of sampling; Sample design in research	03
	5.2	Sampling and non-sampling errors; Sample survey versus census survey	
	5.3	Types of sampling: probability and non-probability	
6. Introduction to biostatistics	6.1	Applications and uses of statistics in biological research	03
	6.2	Population and sample; Sample size and types of samples used in scientific experiments	
	6.3	Exercises and problems related to sampling datasets	
7. Data collection	7.1	Methods of data collection: experiments and surveys; Primary and secondary data	03
	7.2	Selection of appropriate method for data collection	
8. Data classification and presentation	8.1	Classification of data; Terms used in grouped data	04
	8.2	Frequency distribution and cumulative frequency distribution	
	8.3	Graphical representation of data	
	8.4	Exercises and problems	
9. Measures of central tendency	9.1	Mean, median and mode	04
	9.2	Quartiles, deciles and percentiles	
	9.3	Exercises and problems	
10. Measures of dispersion	10.1	Concept of dispersion	04
	10.2	Range, quartile deviation, variance, standard deviation, coefficient of variation	
	10.3	Exercises and problems	
11. Correlation and regression	11.1	Concept of correlation and scatter diagram	06
	11.2	Karl Pearson's coefficient of correlation	
	11.3	Regression and regression coefficients	
	11.4	Exercises and problems	
12. Probability and probability distribution	12.1	Probability concepts and random variables	05
	12.2	Binomial, Poisson and normal distribution	
	12.3	Exercises and problems	
13. Test of hypothesis	13.1	Hypothesis, level of significance and errors	06
	13.2	t-test, chi-square test and F-test	
	13.3	Exercises and problems	
14. Report writing	14.1	Types and structure of research reports	03
	14.2	Mechanics and precautions in report writing	
15. Paper writing	15.1	Structure of research paper	03
	15.2	Publication ethics, plagiarism and self-plagiarism	

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Course Articulation Matrix of ZOO-508-RM – Research Methodology
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	1	1	1	1	1	1
CO2	2	3	2	1	1	1	1	1
CO3	2	3	2	1	1	1	1	1
CO4	2	3	2	1	1	1	1	1
CO5	1	3	2	1	1	1	1	1
CO6	1	2	1	1	2	1	1	1
CO7	1	1	1	1	1	3	2	1

PO1: Advanced Disciplinary Knowledge & Originality
CO1–CO3 provide foundational and advanced knowledge of research concepts, problem identification, hypothesis formulation, and research design in biological sciences. This strengthens students' understanding of scientific inquiry and fosters originality in developing research ideas and scientific investigations.

PO2: Research, Analysis, and Complexity
CO2–CO5 emphasize research problem formulation, experimental design, sampling methods, and statistical data analysis. These outcomes develop analytical and critical thinking skills and enable students to handle complex biological research problems and interpret scientific data effectively.

PO3: Problem Solving in New Contexts
CO2–CO5 equip students with the ability to identify research problems, design experiments, and analyze data, enabling them to solve biological research problems in new and interdisciplinary contexts such as biotechnology, environmental science, and biomedical research.

PO4: Technical Mastery and Scientific Reasoning
CO3–CO5 develop technical competence in research methodology, experimental design, sampling strategies, and statistical analysis. These outcomes strengthen scientific reasoning and methodological rigor required for conducting reliable and reproducible biological research.

PO5: Integrated Communication
CO6 focuses on preparing scientific research reports and research papers in standard formats. This enhances students' ability to communicate scientific findings effectively through structured reports, publications, and presentations in academic and professional settings.

PO6: Ethical, Social, and Professional Judgment

CO7 emphasizes ethical research practices, plagiarism prevention, and publication ethics. These outcomes cultivate ethical awareness, social responsibility, and professional integrity in scientific research and scholarly communication.

PO7: Autonomous and Lifelong Learning
The course encourages students to independently review literature, design research methodologies, and analyze data (CO2–CO5), promoting self-directed learning and lifelong professional development in research and scientific inquiry.

PO8: Employability, Innovation, and Entrepreneurship
Training in research methodology, data analysis, and scientific writing (CO1–CO6) prepares students for careers in research institutions, academia, biotechnology industries, healthcare, and policy organizations. The course also fosters innovation by enabling students to design original research projects and contribute to scientific advancements.