Anekant Education Society's

Tuljaram Chaturchand College

of Arts, Science & Commerce, Baramati

(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 (2023 Pattern)

(As Per NEP 2020)

To be implemented from Academic Year 2023-2024

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.

Anekant Education Society's
Tuljaram Chaturchand College
of Arts, Science & Commerce, Baramati
(Autonomous)

Board of Studies (BoS) in Zoology

From 2022-23 to 2024-25

Sr. No.	Name	Designation
1.	**Mr. Sandip P. Chordiya**	Chairman
2.	**Dr. Vitthal B. Nale**	Member
3.	**Dr. Deepali M. Sangale**	Member
4.	**Dr. Sunil N. Pokale**	Vice-Chancellor Nominee
5.	**Dr. Gulab D. Khedkar**	Expert from other University
6.	**Dr. Sanjay K. Gaikwad**	Expert from other University
7.	**Dr. Yogesh A. Karpe**	Industry Expert
8.	**Mr. Kishor U. More**	Invitee member
9.	**Mr. Mayur S. Shitole**	Invitee member
10.	**Mr. Bipin B. Jagtap**	Meritorious Alumni
11.	**Ms. Rutuja R. Chavan**	Student Representative
12.	**Mr. Subodh M. Nikam**	Student Representative
13.	**Mr. Shubham R. Ghadage**	Student Representative
14.	**Ms. Tamanna S. Tamboli**	Student Representative

Credit Distribution Structure for M.Sc. -2023-2024 (Zoology)

Year (2 Year PG)	Level	Sem. (2 Yr.)	Major		Research Methodology (RM)	OJT/FP	RP	Cum. Cr.	Degree
			Mandatory	Electives					
I	6.0	Sem-I	ZOO-501-MJM:Biochemistry & Bioenergetics (Credit 04) ZOO-502-MJM:Cell Biology (Credit 04) ZOO-503-MJM: Zoology Practical-I (Credit 02) ZOO-504-MJM:Zoology Practical-II (Credit 02)	ZOO-511-MJE: A. Biostatistics & Genetics ZOO-511-MJE: B. Biological Techniques (Credit 04)	ZOO-521-RM Research Methodology (Credit 04)	--	--	20	PG Diploma (after 3 Year Degree)
		Sem- II	ZOO-551-MJM: Molecular Biology (Credit 04) ZOO-552-MJM: Developmental Biology (Credit 04) ZOO-553-MJM: Zoology Practical-III (Credit 02) ZOO-554-MJM: Zoology Practical-IV (Credit 02)	ZOO-561-MJE: A. Entomology-I ZOO-561-MJE: B. Animal Physiology-I ZOO-561-MJE: C. Genetics-I (Credit 04)	--	ZOO-581-OJT/FP Credit 04	--	20	
Cum. Cr. For PG Diploma			**24**	**8**	**4**	**4**	**--**	**40**	

Course Structure for M.Sc. Zoology (2023 Pattern)

Sem	Course Type	Course Code	Course Name	Theory / Practical	Credits
I	Major Mandatory	ZOO-501-MJM	Biochemistry & Bioenergetics	Theory	04
	Major Mandatory	ZOO-502-MJM	Cell Biology	Theory	04
	Major Mandatory	ZOO-503-MJM	Zoology Practical-I	Practical	02
	Major Mandatory	ZOO-504-MJM	Zoology Practical-II	Practical	02
	Major Elective	ZOO-511-MJE (A)	Biostatistics & Genetics	Theory	04
		ZOO-511-MJE (B)	Biological Techniques		
	Research Methodology (RM)	ZOO-521-RM	Research Methodology	Theory	04
	Total Credits Semester-I				**20**
II	Major Mandatory	ZOO-551-MJM	Molecular Biology	Theory	04
	Major Mandatory	ZOO-552-MJM	Developmental Biology	Theory	04
	Major Mandatory	ZOO-553-MJM	Zoology Practical-III	Practical	02
	Major Mandatory	ZOO-554-MJM	Zoology Practical-IV	Theory	02
	Major Elective	ZOO-561-MJE (A)	Entomology-I	Theory	04
		ZOO-561-MJE (B)	Animal Physiology-I		
		ZOO-561-MJE (C)	Genetics-I		
	On Job Training (OJT)/Field Project (FP)	ZOO-581-OJT/FP	On Job Training/Field Project relevant to the major course.	Training / Project	04
	Total Credits Semester-II				**20**
	Cumulative Credits Semester I + Semester II				**40**

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2023)

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

Course Objectives:-

- Structures of biomolecules.
- Functions of biomolecules.
- Concept of enzymes kinetics.
- Role of enzymes.
- Metabolic pathways of carbohydrates, proteins, lipids and nucleic acids.
- Energetics of biomolecules.
- Mechanism of electron transport chain.

Course Outcomes:-

CO1: Recall the facts about structures of biomolecules.
CO2: Explain the functions of biomolecules.
CO3: Explain the concept of enzymes kinetics.
CO4: Compare the role of enzymes.
CO5: Explain the mechanism of metabolic pathways of carbohydrates, proteins, lipids and nucleic acids.
CO6: Compare the energetics of biomolecules.
CO7: Explain the mechanism of electron transport chain.

TOPICS:

Unit No.	Subunit No.	Details	Teaching Hours
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. Biochemistry b. Functions	
	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 c. 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

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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-MJM: Biochemistry and Bioenergetics
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	1	1	1	1	1	1
CO2	3	2	2	2	1	1	1	1	1	1
CO3	2	3	1	3	1	1	1	1	1	1
CO4	1	3	1	3	1	1	1	1	1	2
CO5	3	2	1	3	3	1	3	1	1	1
CO6	3	1	1	3	1	1	1	1	1	1
CO7	1	1	2	3	3	1	3	1	2	2

PO1: Comprehensive Knowledge and Understanding

CO1: Recall the facts about structures of biomolecules.

CO2: Explain the functions of biomolecules.

CO5: Explain the mechanism of metabolic pathways of carbohydrates, proteins, lipids and nucleic acids.

CO6: Compare the energetics of biomolecules. This course provides students with a foundational understanding of the structures, functions, and interactions of biomolecules, which are essential building blocks of life.

PO2: Practical, Professional, and Procedural Knowledge

CO3: Explain the concept of enzymes kinetics

CO4: Compare the role of enzymes. Understanding enzyme kinetics is relevant in various fields like medicine and biotechnology.

PO3: Entrepreneurial Mindset, Innovation, and Business Understanding

While the course doesn't directly address entrepreneurship, knowledge of biomolecules can be applied to develop innovative products in healthcare, biotechnology, and agriculture.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving

CO3: Explain the concept of enzymes kinetics.

CO4: Compare the role of enzymes.

CO5: Explain the mechanism of metabolic pathways of carbohydrates, proteins, lipids and nucleic acids.

CO6: Compare the energetics of biomolecules.

CO7: Explain the mechanism of electron transport chain. Understanding how biomolecules interact and function in metabolic pathways requires critical thinking and problem-solving skills.

PO5: Research, Analytical Reasoning, and Ethical Conduct

CO5: Explain the mechanism of metabolic pathways of carbohydrates, proteins, lipids and nucleic acids.

CO7: Explain the mechanism of electron transport chain. Understanding these complex pathways involves analyzing scientific data and concepts.

PO6: Communication, Collaboration, and Leadership

The course can encourage communication and collaboration through group projects or presentations on biomolecules and their functions.

PO7: Digital Proficiency and Technological Skills

CO5: Explain the mechanism of metabolic pathways of carbohydrates, proteins, lipids and nucleic acids.

CO7: Explain the mechanism of electron transport chain. Depending on the teaching methods, students might utilize digital resources or simulations to learn about metabolic pathways. However, the course might not have a strong focus on developing advanced technological skills.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy

Understanding the universality of biomolecules and metabolic pathways can foster appreciation for the interconnectedness of living organisms.

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices

CO7: Explain the mechanism of electron transport chain. Understanding cellular respiration, which involves the electron transport chain, is crucial for appreciating the importance of efficient energy utilization and its connection to environmental issues. Knowledge of biomolecules can be applied to understand environmental issues like biodegradation and develop sustainable solutions

PO10: Autonomy, Responsibility, and Accountability

By successfully navigating the course and its demands, students demonstrate a sense of autonomy and responsibility for their learning.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020 (w. e. f. June, 2023)

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

Course Objectives:-

- Structures of basic components of prokaryotic and eukaryotic cells.
- Cellular components and their functions.
- Mechanism of cell signaling.
- Cell division and regulation.
- Role of cell cytoskeleton.
- Mechanism of cell death.
- Role of stem cells in tissue repairing.

Course Outcomes:-

Student will be able to-

CO1: Compare the components of prokaryotic and eukaryotic cells.
CO2: Explain the role of cellular components.
CO3: Compare the mechanisms of cell signaling.
CO4: Explain the concept of cell division.
CO5: Recall the role of cytoskeleton.
CO6: Explain the mechanism of cell death.
CO7: Explain the importance of stem cells in tissue repairing.

TOPICS:

Unit No.	Subunit No.	Details	Teaching Hours

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	03
	4.2	Export and import of proteins	
	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.	04
	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 viruses, 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-MJM: Cell Biology
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	3	3	1	1	1	1
CO2	3	3	2	2	1	3	1	3	1	1
CO3	3	3	3	3	1	3	1	1	1	1
CO4	3	3	1	3	1	3	1	1	1	1
CO5	3	1	3	1	3	3	1	1	1	1
CO6	3	3	1	3	3	3	3	3	3	1
CO7	3	1	2	3	2	3	3	1	3	1

Program Outcome (PO)	Course Outcome (CO)	Justification
PO1: Comprehensive Knowledge and Understanding	CO1: Compare the components of prokaryotic and eukaryotic cells.	This CO builds upon foundational knowledge of biomolecules by comparing cellular structures and their components (PO1).
	CO2: Explain the role of cellular components.	Understanding the roles of various cellular components (e.g., organelles) deepens knowledge of cellular function (PO1).
	CO3: Compare the mechanisms of cell signaling.	CO3 delves into the communication processes within cells, adding another layer to comprehensive understanding of cellular behavior (PO1).
	CO4: Explain the concept of cell division.	Cell division is fundamental for growth and reproduction, understanding it contributes to overall knowledge of cellular processes (PO1).
	CO5: Recall the role of cytoskeleton.	The cytoskeleton plays a crucial role in cell structure and function. Recalling its role contributes to foundational knowledge (PO1).
	CO6: Explain the mechanism of cell death.	Cell death is a critical process in multicellular organisms. Understanding its mechanisms expands knowledge of cellular regulation (PO1).
	CO7: Explain the importance of stem cells in tissue repairing.	Stem cells have significant applications in regenerative medicine. Understanding their role contributes to broader knowledge of cellular function (PO1).
PO2: Practical, Professional, and Procedural Knowledge	(Indirect Correlation - CO1, CO2, CO3, CO4, CO6, CO7)	Knowledge of cell biology underpins various fields like medicine and biotechnology. It provides a foundation

		for practical applications (PO2).
PO3: Entrepreneurial Mindset, Innovation, and Business Understanding	(Indirect Correlation - CO3, CO6, CO7)	Understanding cell biology can be applied to develop innovative therapies and technologies related to cell manipulation and regeneration (PO3).
PO4: Specialized Skills, Critical Thinking, and Problem-Solving	CO3: Compare the mechanisms of cell signaling.	CO3 requires analyzing and comparing different cell signaling pathways, fostering critical thinking skills (PO4).
	CO4: Explain the concept of cell division.	Understanding the regulation and complexities of cell division involves problem-solving and critical thinking (PO4).
	CO6: Explain the mechanism of cell death.	Analyzing the mechanisms of programmed cell death requires critical thinking and problem-solving skills (PO4).
PO5: Research, Analytical Reasoning, and Ethical Conduct	(Indirect Correlation - CO1, CO2, CO3, CO4, CO6, CO7)	Cell biology is a foundation for various research areas in biology and medicine. Understanding cellular processes promotes analytical reasoning (PO5).
PO6: Communication, Collaboration, and Leadership	(Indirect Correlation)	The course can encourage communication and collaboration through group projects or presentations on cell biology topics (PO6).
PO7: Digital Proficiency and Technological Skills	(Indirect Correlation - CO1, CO2, CO6, CO7)	While the course doesn't directly focus on digital skills, some topics might utilize microscopy or cell biology software, potentially contributing to PO7.
PO8: Multicultural Competence, Inclusive Spirit, and Empathy	(Indirect Correlation - CO1, CO2)	Understanding the universality of cellular processes can foster appreciation for the interconnectedness of living organisms (PO8).
PO9: Value Inculcation, Environmental Awareness, and Ethical Practices	(Indirect Correlation - CO3, CO6, CO7)	Knowledge of cell biology can be applied to understand issues like stem cell research ethics and environmental impact of cellular processes (PO9).
PO10: Autonomy, Responsibility, and Accountability	(Indirect Correlation- All CO)	By successfully navigating the course and its demands, students demonstrate a sense of autonomy and responsibility for their learning (PO10).

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2023)

Name of the Program: M.Sc. Zoology
Program Code: PSZOO
Class: M. Sc. I
Semester: I
Course Type: Major (Mandatory) Practical
Course Code: ZOO-503-MJM
Course Name: Zoology Practical-I
Number of Credits: 02
Number of Teaching Hours: 60

Course Objectives:-

- Principle and working of instruments.
- Preparation of chemicals of different concentrations.
- Preparation of buffers of known pH.
- Estimation of inorganic phosphates and carbohydrates.
- Estimation of amino acids.
- Methodology for vitamin estimation.
- Effect of temperature, pH, activator and inhibitor on enzyme activity.

Course Outcomes:-

Student will be able to-

CO1: Explain principle and working of instruments.
CO2: Prepare chemicals of different concentrations.
CO3: Prepare buffers of known pH.
CO3: Estimate inorganic phosphates and carbohydrates with suitable method.
CO4: Estimate amino acid.
CO5: Explain the methodology for vitamin estimation.
CO6: Compare the effect of temperature, pH, activator and inhibitor on enzyme activity.

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			

Course Articulation Matrix of ZOO-503-MJM: Zoology Practical-I
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**1**	**2**	**2**	**3**	**3**	**1**	**1**	**1**	**1**
CO2	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**1**	**1**
CO3	**3**	**3**	**3**	**3**	**1**	**1**	**3**	**1**	**1**	**1**
CO4	**3**	**2**	**1**	**3**	**1**	**1**	**1**	**1**	**1**	**1**
CO5	**3**	**1**	**3**	**3**	**1**	**1**	**1**	**1**	**1**	**1**
CO6	**3**	**3**	**1**	**3**	**1**	**3**	**2**	**3**	**3**	**1**
CO7	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**1**	**3**	**1**

Program Outcome (PO)	Course Outcome (CO)	Justification
PO1: Comprehensive Knowledge and Understanding	CO1: Explain principle and working of instruments.	CO1 lays the foundation for understanding the principles and functions of various analytical instruments used in chemistry (PO1).
	CO2: Prepare chemicals of different concentrations.	Understanding concentration principles and calculations is crucial for preparing accurate solutions (PO1).
	CO3: Prepare buffers of known pH.	CO3 builds knowledge of buffers, their importance in maintaining pH, and preparation methods (PO1).
	CO4: Estimate inorganic phosphates and carbohydrates with suitable methods.	CO4 requires knowledge of specific methods for estimating different analytes, expanding chemical understanding (PO1).
	CO5: Estimate amino acid.	Similar to CO4, CO5 deepens knowledge by focusing on specific methods for amino acid estimation (PO1).

	CO6: Explain the methodology for vitamin estimation.	Understanding vitamin estimation methodologies adds to the student's overall chemical knowledge base (PO1).
PO2: Practical, Professional, and Procedural Knowledge	CO1: Explain principle and working of instruments.	CO1 provides foundational knowledge for operating analytical instruments used in professional settings (PO2).
	CO2: Prepare chemicals of different concentrations.	This CO equips students with a practical skill essential in laboratory settings (PO2).
	CO3: Prepare buffers of known pH.	Buffer preparation is a common lab procedure, and CO3 provides practical knowledge for this task (PO2).
	CO4: Estimate inorganic phosphates and carbohydrates with suitable methods.	CO4 equips students with practical analytical skills for estimating specific compounds (PO2).
	CO5: Estimate amino acid.	Similar to CO4, CO5 provides practical skills for amino acid estimation procedures (PO2).
	CO6: Explain the methodology for vitamin estimation.	CO6 familiarizes students with a valuable analytical technique for vitamin estimation (PO2).
PO3: Entrepreneurial Mindset, Innovation, and Business Understanding	(Indirect Correlation All CO)	The knowledge and skills gained in analytical chemistry can be applied to develop new analytical methods or products, fostering an entrepreneurial mindset (PO3).
PO4: Specialized Skills, Critical Thinking, and Problem-Solving	CO2: Prepare chemicals of different concentrations.	Preparing solutions requires calculations and problem-solving skills to achieve desired concentrations (PO4).
	CO3: Prepare buffers of known pH.	Buffer preparation involves calculations and adjustments based on desired pH, requiring critical thinking (PO4).
	CO4: Estimate inorganic phosphates and carbohydrates with suitable methods.	CO4 necessitates selecting appropriate methods and interpreting results, promoting critical thinking and problem-solving (PO4).
	CO5: Estimate amino acid.	Similar to CO4, CO5 requires critical thinking skills to choose methods and analyze data for amino acid estimation (PO4).
	CO6: Compare the effect of temperature, pH, activator and inhibitor on	CO6 involves analyzing and comparing the impact of various factors on enzyme activity, encouraging critical

	enzyme activity.	thinking and problem-solving (PO4).
PO5: Research, Analytical Reasoning, and Ethical Conduct	(Indirect Correlation - All COs)	All COs involve following protocols, analyzing data, and potentially troubleshooting issues, fostering analytical reasoning skills applicable to research (PO5).
PO6: Communication, Collaboration, and Leadership	(Indirect Correlation All CO)	The course can encourage communication and collaboration through group projects or presentations on analytical techniques and results (PO6).
PO7: Digital Proficiency and Technological Skills	(Indirect Correlation - CO1)	While not the primary focus, some analytical instruments might utilize software for data acquisition or analysis, potentially introducing basic digital skills (PO7).
PO8: Multicultural Competence, Inclusive Spirit, and Empathy	(Indirect Correlation All CO)	The principles of analytical chemistry are universal and applicable across cultures. Understanding these principles can foster appreciation for scientific inquiry (PO8).
PO9: Value Inculcation, Environmental Awareness, and Ethical Practices	(Indirect Correlation All CO)	Analytical chemistry plays a role in environmental monitoring and analysis. The course can introduce concepts of responsible chemical handling and ethical practices (PO9).
PO10: Autonomy, Responsibility, and Accountability	(Indirect Correlation All CO)	By successfully navigating the course and its demands, students demonstrate a sense of autonomy and

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2023)

Name of the Program: M.Sc. Zoology
Program Code: PSZOO
Class: M. Sc. I
Semester: I
Course Type: Major (Mandatory) Practical
Course Code: ZOO-504-MJM
Course Name: Zoology Practical-II
Number of Credits: 02
Number of Teaching Hours: 60

Course Objectives:-

- Use of stage and ocular micro-meter.
- Centrifugation for harvesting subcellular molecules.
- Detection of collagen in animal tissues.
- Methodology for DNA and RNA detection.
- Effect of chemicals on mitosis.
- Cell viability test.
- Study of metaphase chromosomes.

Course Outcomes:-

Student will be able to-

CO1: Use stage & ocular micro-meter and measure the cell size.
CO2: Perform the cell fractionation by centrifugal technique.
CO3: Detect the presence of collagen in animal tissues by appropriate staining method.
CO4: Detect the nucleic acids by appropriate staining method.
CO5: Interpret the effect of chemical on mitosis.
CO6: Performs appropriate test to check the cell viability.
CO7: Prepare the temporary slides to study metaphasic chromosomes.

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	Differential centrifugation for harvesting subcellular molecules	D	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	Aseptic technique and good cell culture practice.	D	04
7	Short term culture of whole blood and preparation of metaphase chromosomes.	E	04
8	Cell viability assay by Trypan blue exclusion.	E	04
9	MTT assay for cell viability.	E	04
10	Feulgen staining for DNA.	E	04

11	Study of effect of detergent / salt solution on membrane permeability	E	04
12	Study of cell organelles using electron micrographs (any 04)	D	04
13	Study of stages of mitosis using onion root tips.	E	04
14	Study of stages of meiosis using onion floral buds / grasshopper testes	E	04
15	Isolation of mitochondria from suitable material	E	04
E: Experiment, D: Demonstration			

Course Articulation Matrix of ZOO-504-MJM: Zoology Practical-II
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	**3**	**3**	**2**	**2**	**3**	**3**	**1**	**1**	**1**	**1**
CO2	**3**	**3**	**3**	**3**	**1**	**3**	**3**	**3**	**1**	**1**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**1**	**1**
CO4	**3**	**1**	**3**	**3**	**3**	**3**	**3**	**1**	**1**	**1**
CO5	**3**	**1**	**1**	**3**	**1**	**3**	**1**	**1**	**1**	**1**
CO6	**3**	**3**	**1**	**3**	**1**	**3**	**2**	**3**	**3**	**1**
CO7	**2**	**3**	**3**	**3**	**2**	**3**	**3**	**1**	**3**	**1**

Program Outcome (PO)	Course Outcome (CO)	Justification
PO1: Comprehensive Knowledge and Understanding	CO1: Use stage & ocular micrometer and measure the cell size.	CO1 reinforces understanding of cell size measurement techniques (PO1).
	CO2: Perform the cell fractionation by centrifugal technique.	CO2 builds knowledge of cell separation methods (PO1).
	CO3: Detect the presence of collagen in animal tissues by appropriate staining method.	CO3 expands knowledge of identifying specific biomolecules within tissues (PO1).
	CO4: Detect the nucleic acids by appropriate staining method.	Similar to CO3, CO4 deepens knowledge of identifying specific cellular components (PO1).
	CO5: Interpret the effect of chemical on mitosis.	CO5 requires understanding of mitosis and its response to external factors

		(PO1).
	CO6: Perform appropriate test to check the cell viability.	CO6 builds knowledge of cell viability assessment techniques (PO1).
	CO7: Prepare temporary slides to study metaphasic chromosomes.	CO7 reinforces understanding of chromosome observation methods (PO1).
PO2: Practical, Professional, and Procedural Knowledge	CO1: Use stage & ocular micrometer and measure the cell size.	CO1 equips students with a practical cell size measurement skill (PO2).
	CO2: Perform the cell fractionation by centrifugal technique.	CO2 provides hands-on experience with a cell separation technique (PO2).
	CO3: Detect the presence of collagen in animal tissues by appropriate staining method.	CO3 equips students with a practical technique for identifying collagen (PO2).
	CO4: Detect the nucleic acids by appropriate staining method.	Similar to CO3, CO4 provides a practical skill for identifying nucleic acids (PO2).
	CO5: Interpret the effect of chemical on mitosis.	While not directly procedural, CO5 involves applying knowledge to interpret experimental results (PO2).
	CO6: Perform appropriate test to check the cell viability.	CO6 equips students with a practical cell viability assessment skill (PO2).
	CO7: Prepare temporary slides to study metaphasic chromosomes.	CO7 provides practical experience in preparing slides for chromosome observation (PO2).
PO3: Entrepreneurial Mindset, Innovation, and Business Understanding	(Indirect Correlation - CO2, CO3, CO4, CO6)	The skills learned in cell fractionation, tissue staining, and cell viability testing could be applied in areas like developing diagnostic tools or biomaterial research

		(PO3).
PO4: Specialized Skills, Critical Thinking, and Problem-Solving	CO1: Use stage & ocular micrometer and measure the cell size.	CO1 requires careful observation and measurement techniques (PO4).
	CO2: Perform the cell fractionation by centrifugal technique.	CO2 involves selecting appropriate centrifugation conditions based on cell type (PO4).
	CO3: Detect the presence of collagen in animal tissues by appropriate staining method.	CO3 necessitates selecting the correct staining technique for collagen identification (PO4).
	CO4: Detect the nucleic acids by appropriate staining method.	Similar to CO3, CO4 requires selecting the right staining method for nucleic acids (PO4).
	CO5: Interpret the effect of chemical on mitosis.	CO5 involves analyzing data and interpreting the impact of chemicals on cell division (PO4).
	CO6: Perform appropriate test to check the cell viability.	Selecting the right cell viability test and interpreting results requires critical thinking (PO4).
	CO7: Prepare temporary slides to study metaphasic chromosomes.	CO7 involves careful preparation techniques and potentially troubleshooting issues with slide quality (PO4).
PO5: Research, Analytical Reasoning, and Ethical Conduct	(Indirect Correlation - All COs)	All COs (CO1, CO2, CO3, CO4, CO5, CO6, CO7) involve following protocols, collecting data, and potentially analyzing results, fostering research skills and analytical reasoning (PO5).
PO6: Communication, Collaboration, and Leadership	(Indirect Correlation)	The course can encourage communication and collaboration through lab reports, discussions of results, or group practical work (PO6).
PO7: Digital Proficiency	(Indirect Correlation -	While not the primary focus, some microscopes might utilize digital imaging

and Technological Skills	CO1)	software for capturing cell
PO8: Multicultural Competence, Inclusive Spirit, and Empathy	(Indirect Correlation All CO)	The principles of analytical chemistry are universal and applicable across cultures. Understanding these principles can foster appreciation for scientific inquiry (PO8).
PO9: Value Inculcation, Environmental Awareness, and Ethical Practices	(Indirect Correlation All CO)	Analytical chemistry plays a role in environmental monitoring and analysis. The course can introduce concepts of responsible chemical handling and ethical practices (PO9).
PO10: Autonomy, Responsibility, and Accountability	(Indirect Correlation All CO)	By successfully navigating the course and its demands, students demonstrate a sense of autonomy and

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2023)

Name of the Program: M.Sc. Zoology
Program Code: PSZOO
Class: M. Sc. I
Semester: I
Course Type: Major (Elective) Theory
Course Code: ZOO-511-MJE (A)
Course Name: Biostatistics and Genetics
Number of Credits: 04
Number of Teaching Hours: 60

Course Objectives:-

- Chemical basis of heredity.
- Principles of genetics and patterns of inheritance.
- Relative contribution of genes and environment to common disorders.
- Numerical data analysis.
- Representation of data.
- Correlation between variables for making conclusions.
- Importance of statistical tests for scientific communications.

Course Outcomes:-

Student will be able to-

CO1: Explain the chemical basis of heredity.
CO2: Recall the facts about patterns of inheritance.
CO3: Correlates the contribution of genes and environment in disorders.
CO4: Analyse numerical data.
CO5: Represent data by appropriate method.
CO6: Make conclusions by analysing correlation between the variables.
CO7: Explain the importance of statistics in scientific communications.

TOPICS:

Unit No.	Subunit No.	Details	Teaching Hours
Section-I: Genetics			
1. Gene Interactions and Deviations from Mendelian Inheritance	1.1	Introduction to Mendelian principles	04
	1.2	Incomplete and co-dominance	
	1.3	Dominant Epistasis & Recessive Epistasis	
	1.4	Duplicate Dominant Epistasis, Duplicate recessive epistasis	
2. Multiple alleles	2.1	Coat colour in mice	02
3. Linkage and crossing over	3.1	Linkage, linkage groups, types of crossing over	04
	3.2	Models of molecular basis of recombination	
	3.3	3-point test cross for diploids	
4. Inheritance of	4.1	QTL Mapping	04

qualitative and quantitative traits	4.2	Quantitative Genetics: Concepts of penetrance, expressivity and variance, Heritability	
	4.3	Genetic basis and influence of environment on quantitative inheritance	
5. Principles of Population Genetics	5.1	Genetic structure of populations – Gene pool, Genotype Frequency, Allelic frequency	04
	5.2	Hardy-Weinberg law and its application	
6. Somatic Cell Genetics	6.1	Its applications, Gene Therapy, Gene transfer technology	03
7. Human genetics	7.1	Dominant and recessive disorders,	05
	7.2	Pedigree Analysis	
	7.3	Physical and physiological traits	
8. Gene Mutation	8.1	Types, Causes and Detection	03
9. Introduction to epigenetics			**01**
Section-II: Biostatistics			
1. Introduction to Biostatistics	1.1	Applications and Uses of Statistics	02
	1.2	Definition of Population, sample, sample sizes, Different types of Samples in scientific experiments	
	1.3	Exercise and problems related to various sampling datasets	
2. Data Classification	2.1	Some important terms (Class frequency, class- limits, Class-width, class –mark)	03
	2.2	Frequency distribution, Cumulative frequency	
	2.3	Graphical representation of data (Histogram, Pie-Diagram, Ogive-curve.)	
	2.4	Exercise and Problems.	
3. Measures of central tendency	3.1	Concept of central tendency, Types of central tendency (Arithmetic mean, Median and mode) combined mean.	04
	3.2	Partition values (Quartiles, Deciles, and Percentiles)	
	3.3	Exercise and problems related to Mean mode median	
4. Measures of dispersion	4.1	Concept of dispersion, absolute and relative measure of dispersion	03
	4.2	Different measures of dispersion (Range, Quartile- Deviation, Variance and standard deviation, Coefficient of Variation) combined variance	
	4.3	Exercise and Problems	

5. Correlation and Regression	5.1	Bivariate data, concept of correlation, Types of Correlation, Scatter plot	05
	5.2	Karl Pearson's coefficient of correlation and its properties.	
	5.3	Concept of regression, linear regression, regression coefficients and its properties.	
	5.4	Exercise and problems.	
6. Probability and probability distribution	6.1	Some important terms (types of experiment, sample space and types of sample space, events and types of events.)	05
	6.2	Definition of probability (mathematical and classical) conditional probability.	
	6.3	Concept of random variable, univariate probability distribution and its mathematical expectation.	
	6.4	Some standard probability distributions (binomial, Poisson and normal) their probability distribution, mean, variance and properties of these distribution.	
	6.5	Exercise and Problems.	
7. Test of hypothesis	7.1	Some important terms (hypothesis, types of hypothesis, Test, Critical region, acceptance region, type I error, type II error, level of significance, p-value)	08
	7.2	Test for mean and equality of two population means, Test for proportion and equality of two population proportions.	
	7.3	Chi-square test for goodness of fit, Unpaired and paired 't' test,	
	7.4	F test for equality of two population variances.	
	7.5	Exercise and Problems.	

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Course Articulation Matrix of ZOO-511-MJE (A): Biostatistics and Genetics
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	2	2	3	3	1	1	3	1
CO2	3	3	3	1	1	3	2	1	3	1
CO3	1	3	1	3	3	3	3	3	3	1
CO4	1	3	1	3	1	3	1	1	3	1
CO5	2	3	3	3	1	3	1	1	3	1
CO6	2	3	3	3	1	3	1	1	3	1
CO7	2	2	1	3	2	3	1	1	3	1

Program Outcome (PO)	Course Outcome (CO)	Justification
PO1: Comprehensive Knowledge and Understanding	CO1: Explain the chemical basis of heredity.	CO1 builds knowledge of DNA as the genetic material (PO1).
	CO2: Recall the facts about patterns of inheritance.	CO2 strengthens understanding of Mendelian and non-Mendelian inheritance patterns (PO1).
	CO3: Correlates the contribution of genes and environment in disorders.	CO3 deepens knowledge of the interplay between genes and environment in causing diseases (PO1).
	CO4: Analyse numerical data.	CO4 introduces basic statistical analysis techniques used in biostatistics (PO1).
	CO5: Represent data by appropriate method.	CO5 equips students with knowledge of different data presentation methods (PO1).
	CO6: Make conclusions by analysing correlation between the variables.	CO6 builds understanding of analyzing relationships between variables in biological data (PO1).
	CO7: Explain the importance of statistics in scientific communications.	CO7 highlights the significance of statistics in interpreting and presenting scientific findings (PO1).
PO2: Practical, Professional, and Procedural Knowledge	(Indirect Correlation - CO4, CO5, CO6)	While the course may not involve extensive practical work, skills in data analysis (CO4, CO6) and data presentation (CO5) are valuable in various scientific professions (PO2).
PO3: Entrepreneurial Mindset, Innovation, and Business Understanding	(Indirect Correlation - CO1, CO3)	Knowledge of genetics (CO1) and gene-environment interactions (CO3) can be applied in areas like personalized medicine or genetic engineering (PO3).
PO4: Specialized Skills,	CO3: Correlates the	CO3 requires critical thinking to analyze the

Critical Thinking, and Problem-Solving	contribution of genes and environment in disorders.	complex relationship between genes and environmental factors (PO4).
	CO4: Analyse numerical data.	CO4 involves critical thinking skills to choose appropriate statistical methods for data analysis (PO4).
	CO5: Represent data by appropriate method.	Selecting the right data presentation method requires critical thinking about the data and audience (PO4).
	CO6: Make conclusions by analysing correlation between the variables.	CO6 necessitates critical thinking to interpret correlations between variables and draw evidence-based conclusions (PO4).
PO5: Research, Analytical Reasoning, and Ethical Conduct	CO4: Analyse numerical data.	CO4 equips students with skills to analyze data from biological research (PO5).
	CO5: Represent data by appropriate method.	Presenting research data effectively is an essential skill for scientific communication (PO5).
	CO6: Make conclusions by analysing correlation between the variables.	CO6 fosters analytical reasoning skills to draw conclusions from statistical analysis in research (PO5).
	(Indirect Correlation - CO1, CO2, CO3, CO7)	Understanding genetics (CO1, CO2, CO3) and the importance of statistics in research (CO7) contributes to ethical research practices (PO5).
PO6: Communication, Collaboration, and Leadership	(Indirect Correlation - All COs)	The course can encourage communication through presentations on genetic concepts, data analysis, or research findings (PO6).
PO7: Digital Proficiency and Technological Skills	CO4: Analyse numerical data.	CO4 might involve using statistical software for data analysis (PO7).
PO8: Multicultural Competence, Inclusive Spirit, and Empathy	(Indirect Correlation - CO1, CO3)	Understanding the universality of genetic principles (CO1) and the impact of genetics on all populations (CO3) can foster appreciation for human diversity (PO8).
PO9: Value Inculcation, Environmental Awareness, and Ethical Conduct	(Indirect Correlation - CO1, CO3)	Knowledge of genetics (CO1) has ethical implications, and CO3 can raise awareness of environmental factors influencing health (PO9).
PO10: Autonomy, Responsibility, and Accountability	(Indirect Correlation)	By successfully navigating the complexities of biostatistics and genetics, students demonstrate a sense of autonomy and responsibility in their learning (PO10).

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2023)

Name of the Program: M.Sc. Zoology
Program Code: PSZOO
Class: M. Sc. I
Semester: I
Course Type: Major (Elective) Theory
Course Code ZOO-511-MJE (B)
Course Name: Biological techniques
Number of Credits: 04
Number of Teaching Hours: 60

Course Objectives:-

- Advanced techniques in Life sciences.
- Principles and working of instruments.
- Techniques used in research.
- Databases and their applications.
- Cell culture technology.
- Importance of bioinformatics.
- Characterization of biomolecules.

Course Outcomes:-

Student will be able to-

CO1: Recall facts about techniques used in Life sciences.
CO2: Demonstrate the working of laboratory instruments.
CO3: Choose appropriate technique for research.
CO4: Analyse obtained data by using databases.
CO5: Compares different cell culture techniques.
CO6: Explains importance of bioinformatics
CO7: Characterizes biomolecules using appropriate techniques.

TOPICS:

Unit No.	Subunit No.	Details	Teaching Hours
1. Microscopy	1.1	Microscopy: Resolution and its limit, Improvement of resolution.	12
	1.2	Principles and Applications of: Phase Contrast, Fluorescence, Confocal, Transmission And Scanning Electron	
	1.3	Live Cell Imaging	
2. Spectroscopy	Principles of the following		10
	2.1	UV-Visible Spectroscopy	
	2.2	Atomic Absorption Spectroscopy	
	2.3	Molecular Spectroscopy	
	2.4	IR Spectroscopy	
	2.5	Circular Dichroism	
	2.6	MALDI-TOF	

3. Centrifugation	3.1	Principle & Basic Theory of Ultracentrifuge	4
	3.2	Differential and Density Gradient Centrifugation	
4. Electrophoresis	4.1	Introduction to Electrophoresis	5
	4.2	Native PAGE	
	4.3	SDS-PAGE	
	4.4	2D- Gel Electrophoresis	
5. Principles and Applications of Chromatography	5.1	Thin Layer Chromatography	6
	5.2	GC-MS	
	5.3	HPLC	
6. Blotting Techniques	6.1	Southern	6
	6.2	Western	
	6.3	Northern	
7. Advance Techniques in Biology	7.1	qRTPCR	13
	7.2	DNA fingerprinting	
	7.3	DNA Markers: RAPD, RFLP & AFLP	
	7.4	DNA microarray	
	7.5	DNA sequencing technology (Sanger and Next generation)	
	7.6	Protein sequencing	
	7.7	FRET analysis	
	7.8	Flow Cytometry	
8. Introduction to Nanotechnology	8.1	Basic concepts of Nanotechnology	04
	8.2	Characterization techniques: FTIR & FESEM	
	8.3	Applications of Nanotechnology	

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Course Articulation Matrix of ZOO-511-MJE (C): Biological Techniques
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	2	2	1	3	1	1	3	1
CO2	3	3	3	3	3	3	3	1	3	1
CO3	3	3	3	3	1	3	3	1	3	1
CO4	1	3	1	3	1	3	1	1	3	1
CO5	3	3	3	1	1	3	1	3	3	1
CO6	3	3	3	3	3	3	3	3	3	1
CO7	3	3	1	3	2	3	1	1	3	1

Program Outcome (PO)	Course Outcome (CO)	Justification
PO1: Comprehensive Knowledge and Understanding	CO1: Recall facts about techniques used in Life sciences.	CO1 builds foundational knowledge of various biological techniques (PO1).
	CO2: Demonstrate the working of laboratory instruments.	CO2 reinforces understanding of the principles and functions of biological laboratory instruments (PO1).
	CO3: Choose appropriate technique for research.	CO3 expands knowledge by applying understanding of different techniques to research design (PO1).
	CO4: Analyse obtained data by using databases.	CO4 introduces skills to analyze biological data using relevant databases (PO1).
	CO5: Compares different cell culture techniques.	CO5 deepens knowledge by comparing and contrasting various cell culture methods (PO1).
	CO6: Explains importance of bioinformatics.	CO6 builds understanding of the significance of bioinformatics in biological research (PO1).
	CO7: Characterizes biomolecules using appropriate techniques.	CO7 expands knowledge of diverse techniques used for biomolecule characterization (PO1).
PO2: Practical, Professional, and Procedural Knowledge	CO2: Demonstrate the working of laboratory instruments.	CO2 equips students with practical skills in operating common laboratory instruments (PO2).
	CO3: Choose appropriate technique for research.	Selecting the right technique for research is a crucial professional skill (PO2).

	CO5: Compares different cell culture techniques.	Understanding different cell culture methods is valuable for professional settings like cell biology research (PO2).
	CO7: Characterizes biomolecules using appropriate techniques.	CO7 provides hands-on experience with techniques for biomolecule characterization (PO2).
PO3: Entrepreneurial Mindset, Innovation, and Business Understanding	(Indirect Correlation - CO3, CO6, CO7)	The skills gained in selecting research techniques (CO3), understanding bioinformatics (CO6), and characterizing biomolecules (CO7) can be applied in areas like developing new diagnostic tools or biotechnologies (PO3).
PO4: Specialized Skills, Critical Thinking, and Problem-Solving	CO2: Demonstrate the working of laboratory instruments.	CO2 involves troubleshooting issues with laboratory instruments, requiring problem-solving skills (PO4).
	CO3: Choose appropriate technique for research.	Selecting the right technique necessitates critical thinking to consider research goals and sample characteristics (PO4).
	CO4: Analyse obtained data by using databases.	CO4 requires critical thinking skills to choose appropriate databases and interpret biological data (PO4).
	CO5: Compares different cell culture techniques.	CO5 involves critical thinking to evaluate the pros and cons of different cell culture methods for a specific application (PO4).
	CO6: Explains importance of bioinformatics.	CO6 necessitates critical thinking to understand how bioinformatics tools can be used to solve biological problems (PO4).
	CO7: Characterizes biomolecules using appropriate techniques.	CO7 requires problem-solving skills to troubleshoot issues that might arise during biomolecule characterization techniques (PO4).
PO5: Research, Analytical Reasoning, and Ethical Conduct	CO3: Choose appropriate technique for research.	Selecting the right technique is crucial for designing ethical and well-controlled research experiments (PO5).
	CO4: Analyse obtained data by using databases.	CO4 equips students with skills to analyze research data effectively (PO5).
	CO6: Explains importance of bioinformatics.	CO6 highlights the role of bioinformatics in responsible research data management and analysis (PO5).
	(Indirect Correlation - All COs)	Following protocols, performing experiments, and analyzing data in all COs (CO1, CO2, CO5, CO7) fosters research skills and analytical reasoning (PO5).
PO6: Communication, Collaboration, and Leadership PO7: Digital Proficiency and Technological Skills	(Indirect Correlation)	The course can encourage communication and collaboration through lab reports, discussions of results, or group work in practical sessions (PO6).
	CO4: Analyse obtained data by using databases.	CO4 requires proficiency in using biological databases for data analysis (PO7).
	(Indirect Correlation - CO6)	Understanding bioinformatics tools (CO6) can lead to further development of digital skills (PO7).

PO8: Multicultural Competence, Inclusive Spirit, and Empathy	(Indirect Correlation - CO1, CO3)	Understanding the universality of genetic principles (CO1) and the impact of genetics on all populations (CO3) can foster appreciation for human diversity (PO8).
PO9: Value Inculcation, Environmental Awareness, and Ethical Conduct	(Indirect Correlation - CO1, CO3)	Knowledge of genetics (CO1) has ethical implications, and CO3 can raise awareness of environmental factors influencing health (PO9).
PO10: Autonomy, Responsibility, and Accountability	(Indirect Correlation)	By successfully navigating the complexities of biostatistics and genetics, students demonstrate a sense of autonomy and responsibility in their learning (PO10).

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2023)

Name of the Program: M.Sc. Zoology
Program Code: PSZOO
Class: M. Sc. I
Semester: I
Course Type: Research Methodology (RM Theory)
Course Code: ZOO-521-RM
Course Name: Research Methodology
Number of Credits: 04
Number of Teaching Hours: 60

Course Objectives:-

- Overview of the research methodology.
- Technique of defining a research problem.
- Importance of literature review in research.
- Research designs and their characteristics.
- Sampling designs and methods of data collections.
- Parametric tests of hypotheses and Chi-square test.
- Art of writing research reports and research papers.

Course Outcomes:-

Student will be able to-

CO1: Explain concept of research methodology.
CO2: Define research problem.
CO3: Explain need of literature review in research.
CO4: Prepare research designs and explain their characteristics
CO5: Collect and present the data.
CO6: Analyse data by using appropriate tests.
CO7: Write research report and research paper.

Unit No.	Subunit No.	Details	Teaching Hours
1. Research methodology	1.1	Introduction to research methodology: meaning and objectives of research	05
	1.2	Types, approaches and significance of research	
	1.3	Criteria of good research; Problems encountered by researchers in India.	
2. Defining the research problem	2.1	Research problem and selecting the problem	03
	2.2	Necessity of defining the problem	
	2.3	Technique involved in defining a problem	
3. Reviewing the literature	3.1	Place of the literature review in research; Bringing clarity and focus to research problem	08
	3.2	Improving research methodology; Broadening knowledge base in research area and enabling contextual findings	

	3.3	Review of the literature; Searching the existing literature; Reviewing the selected literature, Developing a theoretical framework	
	3.4	Developing a conceptual framework; Writing about the literature reviewed	
4. Research design	4.1	Meaning and need of research design; Features of a good design	05
	4.2	Variables and its types	
	4.3	Basic principles of experimental designs	
5. Design of sample surveys	5.1	Introduction and sample design	04
	5.2	Sampling and non-sampling errors; Sample survey versus census survey	
	5.3	Types of sampling: probability and non-probability	
6. Descriptive statistics	6.1	Measures of central tendency: mean, mode and median	06
	6.2	Measures of variability: variance, standard deviation and standard error	
7. Data collection	7.1	Introduction; Experiments and surveys; collection of primary and secondary data	03
	7.2	Selection of appropriate method for data collection	
8. Hypothesis testing	8.1	Meaning and types of hypothesis	14
	8.2	Test for significance: parametric and non-parametric test.	
	8.3	P-Value approach; Types of errors	
	8.4	T-test: one sampled and two sampled	
	8.5	Chi-square test of goodness of fit	
	8.6	F-test for comparing variance	
9. Report writing	9.1	Types of reports; Different steps in report writing; Significance of report writing	07
	9.2	Layout of the research report	
	9.3	Mechanics of writing a research report; Precautions for report writing	
10. Paper writing	10.1	Layout of a research paper	05
	10.2	When and where to publish?; Impact factor of journals	
	10.3	Ethical issues related to publishing; Plagiarism and self-plagiarism	

REFERENCES:

1. Kothari, C. R. (2004). Research methodology: Methods and techniques. New Age International.
2. Kumar, R. (2018). Research methodology: A step-by-step guide for beginners. Sage.
3. Fink, A. (2019). Conducting research literature reviews: From the internet to paper. Sage publications.
4. Trochim, W. M., & Donnelly, J. P. (2001). Research methods knowledge base (Vol. 2). Macmillan Publishing Company, New York: Atomic Dog Pub.

Course Articulation Matrix of ZOO-521-RM: Research Methodology
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	1	3	1	3	1	1	3	1
CO2	1	3	1	3	1	3	1	1	3	1
CO3	1	1	1	3	1	3	3	3	3	1
CO4	3	3	1	3	1	3	1	3	3	1
CO5	1	3	3	3	1	3	1	1	3	1
CO6	1	3	1	3	3	3	1	1	3	1
CO7	1	2	3	3	2	3	3	1	3	2

Program Outcome (PO)	Course Outcome (CO)	Justification
PO1: Comprehensive Knowledge and Understanding	CO1: Explain concept of research methodology.	CO1 builds foundational knowledge of the research process and its key elements (PO1).
	CO2: Define research problem.	CO2 strengthens understanding of the importance of a well-defined research problem in any research project (PO1).
	CO3: Explain need of literature review in research.	CO3 deepens knowledge of how a comprehensive literature review informs research design and avoids redundancy (PO1).
	CO4: Prepare research designs and explain their characteristics.	CO4 introduces the various research designs and their specific characteristics (PO1).
	CO5: Collect and present the data.	CO5 equips students with knowledge of data collection methods and data presentation techniques (PO1).
	CO6: Analyse data by using appropriate tests.	CO6 builds understanding of how to choose and apply statistical tests for data analysis (PO1).
	CO7: Write research report and research paper.	CO7 strengthens knowledge of scientific writing formats for research reports and papers (PO1).

PO2: Practical, Professional, and Procedural Knowledge	(Indirect Correlation - CO4, CO5, CO6)	While the course might not involve extensive practical research, skills in choosing research designs (CO4), data collection (CO5), and data analysis (CO6) are valuable for various research-oriented professions (PO2).
PO3: Entrepreneurial Mindset, Innovation, and Business Understanding	(Indirect Correlation - All COs)	The skills learned in research methodology can be applied to areas like developing new products or services through well-defined research approaches (PO3).
PO4: Specialized Skills, Critical Thinking, and Problem-Solving	CO2: Define research problem.	CO2 requires critical thinking to refine and clearly define a research question or problem (PO4).
	CO3: Explain need of literature review in research.	CO3 involves critical thinking about how existing literature can inform and refine research questions (PO4).
	CO4: Prepare research designs and explain their characteristics.	Selecting the right research design necessitates critical thinking about research objectives and data collection methods (PO4).
	CO5: Collect and present the data.	Data collection methods often require critical thinking to adapt to specific research contexts (PO4).
	CO6: Analyse data by using appropriate tests.	CO6 necessitates critical thinking to choose the most suitable statistical tests for the collected data (PO4).
	CO7: Write research report and research paper.	Writing research reports and papers effectively requires critical thinking to organize information, analyze results, and draw conclusions (PO4).
PO5: Research, Analytical Reasoning, and Ethical Conduct	CO1: Explain concept of research methodology.	CO1 lays the foundation for understanding the research process and its ethical considerations (PO5).
	CO2: Define research problem.	Defining a clear research problem is crucial for conducting ethical research (PO5).
	CO3: Explain need of literature review in research.	A thorough literature review helps avoid plagiarism and ensures responsible research practices (PO5).
	CO4: Prepare research designs and research proposals.	Choosing appropriate research designs is essential for conducting ethical and feasible research (PO5).
	CO5: Collect and present the data.	Data collection methods should follow ethical guidelines, such as informed consent and data privacy (PO5).
	CO6: Analyse data by using appropriate tests.	Selecting appropriate statistical tests ensures accurate and unbiased data analysis (PO5).
	CO7: Write research report and research paper.	Writing research reports and papers ethically involves accurate data presentation, proper citation, and avoiding plagiarism (PO5).
PO6: Communication, Collaboration, and Leadership	(Indirect Correlation - CO7)	CO7 can encourage communication skills through writing research reports and potentially presenting research findings (PO6).
PO7: Digital Proficiency	(Indirect Correlation -	Students might use research databases and

and Technological Skills	All COs)	statistical software (CO3, CO6) during the course, fostering digital skills (PO7).
PO8: Multicultural Competence, Inclusive Spirit, and Empathy	(Indirect Correlation - CO3)	A comprehensive literature review in research (CO3) can involve considering diverse perspectives and research conducted in different cultures (PO8).
PO9: Value Inculcation, Environmental Awareness, and Ethical Conduct	(Indirect Correlation - CO1, CO3)	Knowledge of genetics (CO1) has ethical implications, and CO3 can raise awareness of environmental factors influencing health (PO9).
PO10: Autonomy, Responsibility, and Accountability	(Indirect Correlation)	By successfully navigating the complexities of biostatistics and genetics, students demonstrate a sense of autonomy and responsibility in their learning (PO10).