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
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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. Freshwater Zoology & Ichthyology ZOO-511-MJE: B. Biostatistics & Genetics ZOO-511-MJE: C. 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)	Freshwater Zoology & Ichthyology	Theory	04
		ZOO-511-MJE (B)	Biostatistics & Genetics		
		ZOO-511-MJE (C)	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: ZOO
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 Glyconeogenesis	
	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-MJM: Biochemistry and Bioenergetics
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

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

PO1: Disciplinary Knowledge:

CO1, CO2, CO3, CO4, CO5, CO6, CO7:

These COs directly assess students' understanding of key concepts and mechanisms in biochemistry, a core area of zoology. They require students to recall facts, explain functions, compare roles, and analyze mechanisms, demonstrating comprehensive knowledge of the discipline.

PO2: Critical Thinking and Problem Solving:

CO3, CO4, CO5, CO6, CO7: These COs require students to analyze enzyme kinetics, compare roles and energetics, and explain mechanisms. This involves critical thinking to identify relevant information, apply concepts to solve problems, and draw conclusions.

PO3: Social Competence:

CO5, CO6: These COs involve explaining complex biochemical concepts (CO5) and comparing energetics (CO6). This requires clear and concise communication, demonstrating effective social competence in presenting information.

PO4: Research-related skills and Scientific temper:

CO5, CO6, CO7: Explaining metabolic pathways (CO5), comparing energetics (CO6), and explaining electron transport chain (CO7) require students to analyze scientific literature, formulate research questions, and interpret data, demonstrating research skills and scientific temper.

PO5: Trans-disciplinary knowledge:

CO5, CO6: Comparing roles of enzymes (CO4) and energetics of biomolecules (CO6) requires students to integrate knowledge from different areas of biochemistry and apply it to broader contexts, demonstrating trans-disciplinary understanding.

PO6: Personal and professional competence:

CO1, CO2, CO3, CO4, CO5, CO6, CO7: All COs require independent learning, analysis, and explanation, demonstrating personal competence. Additionally, CO5 and CO6 involve comparing information, demonstrating the ability to work collaboratively.

PO7: Effective Citizenship and Ethics: Not directly assessed by these COs. However, understanding the impact of metabolic pathways on living organisms (CO5) could indirectly contribute to an awareness of ethical issues related to genetic engineering. Understanding the role of biomolecules in energy production and metabolism has ethical implications for human health and environmental sustainability.

PO8: Environment and Sustainability: Not directly assessed by these COs However, understanding the role of biomolecules in energy production (CO7) could indirectly contribute to an awareness of the need for sustainable energy sources. The electron transport chain plays a crucial role in cellular energy production, and understanding its mechanism can inform strategies for sustainable energy development.

PO9: Self-directed and Life-long learning:

All COs: All COs require independent learning, analysis, and critical thinking, which are essential skills for lifelong 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: ZOO
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 Endomem	3.1	Endoplasmic reticulum: Signal peptide hypothesis, protein folding, processing and secretion, lipid	07

brane System and Peroxisomes		synthesis	
	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

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2003). Molecular biology of the cell. Scandinavian Journal of Rheumatology, 32(2), 125-125.
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
CO1	**3**	**3**	**2**	**2**	**3**	**3**	**1**	**1**	**3**
CO2	**3**	**3**	**2**	**2**	**1**	**3**	**1**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**1**	**3**	**1**	**1**	**3**
CO4	**3**	**3**	**1**	**3**	**1**	**3**	**1**	**1**	**3**
CO5	**3**	**1**	**3**	**1**	**3**	**3**	**1**	**1**	**3**
CO6	**3**	**3**	**1**	**3**	**3**	**3**	**3**	**3**	**3**
CO7	**3**	**1**	**2**	**3**	**2**	**3**	**3**	**1**	**3**

PO1: Disciplinary Knowledge:
CO1, CO2, CO3, CO4, CO5, CO6, CO7:
These COs directly assess students' understanding of key concepts in cell biology, including cellular components, their roles, signaling mechanisms, division, cytoskeleton function, cell death, and stem cell significance in tissue repair.
PO2: Critical Thinking and Problem Solving:
CO1, CO2, CO3, CO4, CO6:
Comparing cellular components, analyzing signaling mechanisms, understanding cell division mechanisms, and evaluating the role of cell death all require critical thinking and problem-solving skills.
PO3: Social Competence:
CO3, CO5:
Explaining the mechanisms of cell signaling and the role of the cytoskeleton requires effective communication skills, both written and oral.
PO4: Research-related skills and Scientific temper:
CO3, CO4, CO6, CO7:
Analyzing signaling mechanisms, understanding cell division regulation, and exploring cell death mechanisms involve critical thinking, research skills, and an appreciation for scientific evidence and ethics.
PO5: Trans-disciplinary knowledge:
CO1, CO5, CO6:
Comparing prokaryotic and eukaryotic cells connects cell biology to other disciplines like microbiology and medicine, demonstrating trans-disciplinary understanding. The cytoskeleton's role in cell movement also connects to biomechanics.
PO6: Personal and professional competence:
CO1, CO2, CO3, CO4, CO5, CO6, CO7:
Mastering these COs requires independent learning, self-motivation, and the ability to work effectively with others to understand complex cellular processes.
PO7: Effective Citizenship and Ethics:
CO6, CO7:
Understanding the mechanisms of cell death and the potential of stem cells in tissue repair has ethical implications for human health and medical treatments.
PO8: Environment and Sustainability:
CO2, CO6:
Understanding the role of cellular components and mechanisms in maintaining cellular health and function is crucial for developing sustainable practices in areas like environmental toxicology and bioremediation.
PO9: Self-directed and Life-long learning:
CO1, CO2, CO3, CO4, CO5, CO6, CO7:
Mastering these COs provides a strong foundation for ongoing learning and exploration in the field of cell biology and related disciplines.

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

Name of the Program: M.Sc. Zoology
Program Code: ZOO
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
CO1	**3**	**1**	**2**	**2**	**3**	**3**	**1**	**1**	**3**
CO2	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**1**	**3**	**3**	**1**	**3**
CO4	**3**	**2**	**1**	**3**	**1**	**3**	**1**	**1**	**3**
CO5	**3**	**1**	**3**	**3**	**1**	**3**	**1**	**1**	**3**
CO6	**3**	**3**	**1**	**3**	**1**	**3**	**2**	**3**	**3**
CO7	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**1**	**3**

PO1: Disciplinary Knowledge:
CO1, CO2, CO3, CO4, CO5, CO6:
These COs directly assess students' understanding of key laboratory techniques and principles in biochemistry, including instrument operation, chemical preparation, buffer calibration, and enzyme assays.
PO2: Critical Thinking and Problem Solving:
CO2, CO3, CO6:
Preparing solutions of different concentrations and buffers of known pH requires solving basic mathematical problems and applying critical thinking to select appropriate methods and troubleshoot issues. Analyzing the effects of different factors on enzyme activity involves critical thinking and drawing conclusions from experimental data.
PO3: Social Competence:
CO1, CO5:
Explaining the principle and working of instruments and the methodology for vitamin estimation requires clear communication skills, both written and oral.
PO4: Research-related skills and Scientific temper:
CO2, CO3, CO4, CO5, CO6:
Performing biochemical assays, including preparing solutions, calibrating buffers, and conducting enzyme assays, involves following protocols, recording data accurately, and analyzing results with a scientific approach.

PO5: Trans-disciplinary knowledge:
CO1, CO2:
Understanding the principles and operation of various instruments connects biochemistry to other disciplines like physics and engineering, demonstrating trans-disciplinary understanding.
PO6: Personal and professional competence:
CO1, CO2, CO3, CO4, CO5, CO6:
Mastering these COs requires independent work in the lab, self-motivation to learn new techniques, and the ability to work effectively with others to conduct experiments and interpret data.
PO7: Effective Citizenship and Ethics:
CO2, CO3:
Preparing chemicals and buffers safely and responsibly demonstrates awareness of ethical considerations in scientific research and laboratory practices.
PO8: Environment and Sustainability:
CO1, CO3:
Understanding the impact of pH and other factors on enzyme activity and using environmentally friendly buffers can contribute to sustainable practices in laboratory research.
PO9: Self-directed and Life-long learning:
CO1, CO2, CO3, CO4, CO5, CO6:
Mastering these COs provides a strong foundation for independent learning and exploration in the field of biochemistry and related disciplines, including the ability to adapt to new techniques and technologies in the lab.

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

Name of the Program: M.Sc. Zoology
Program Code: ZOO
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
CO1	3	3	2	2	3	3	1	1	3
CO2	3	3	3	3	1	3	3	3	3
CO3	3	3	3	3	3	3	3	1	3
CO4	3	3	3	3	3	3	3	1	3
CO5	3	3	1	3	1	3	1	1	3
CO6	3	3	1	3	1	3	2	3	3
CO7	2	3	3	3	2	3	3	1	3

PO1: Disciplinary Knowledge:
CO1, CO2, CO3, CO4, CO5, CO6, CO7:
These COs directly assess students' understanding of key techniques and concepts in cell biology, including measuring cell size, cell fractionation, identifying specific biomolecules like collagen and nucleic acids, analyzing effects on cell processes like mitosis, and assessing cell viability.

PO2: Critical Thinking and Problem Solving:
CO1, CO2, CO3, CO4, CO5, CO6, CO7:
Selecting appropriate staining methods, interpreting microscope observations, analyzing chemical effects on cell division, and troubleshooting technical issues in laboratory procedures require critical thinking and problem-solving skills.

PO3: Social Competence:
CO2, CO3, CO4, CO7:
Collaborating with lab partners, sharing equipment and materials, and communicating observations and results effectively require good social and communication skills.

PO4: Research-related skills and Scientific temper:
CO1, CO2, CO3, CO4, CO5, CO6, CO7:
Designing experiments, collecting data, maintaining accurate records, and analyzing results with skepticism and objectivity involve research skills and scientific temper.

PO5: Trans-disciplinary knowledge:
CO1, CO3, CO4:
Measuring cell size connects cell biology to mathematics and physics, while identifying biomolecules like collagen and nucleic acids links it to molecular biology and chemistry.

PO6: Personal and professional competence:
CO1, CO2, CO3, CO4, CO5, CO6, CO7:
Mastering these COs requires independent learning, self-management, attention to detail, and the ability to work effectively with laboratory equipment and protocols, demonstrating good professional skills.
PO7: Effective Citizenship and Ethics:
CO2, CO3, CO4, CO7:
Handling chemicals and biological materials responsibly, following safety protocols, and minimizing waste generation demonstrate ethical awareness and environmental responsibility.
PO8: Environment and Sustainability:
CO2, CO6:
Utilizing centrifuge techniques efficiently and choosing cell viability tests with minimal environmental impact can contribute to sustainable practices in laboratory research.
PO9: Self-directed and Life-long learning:
CO1, CO2, CO3, CO4, CO5, CO6, CO7:
Mastering these COs equips students with the skills and knowledge to independently design and conduct cell biology experiments, fostering lifelong learning in the field.

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

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

Course Objectives:-

- Types of aquatic habitats.
- Physical & chemical properties of water.
- Aquatic adaptations of various animal groups.
- Economic importance of aquatic animals.
- Classification of fishes
- Anatomy of fishes.
- Fish disease.

Course Outcomes:-

Student will be able to-

CO1: Explain the types of aquatic habitats.
CO2: Interpret importance of physical & chemical properties of water for aquatic life.
CO3: Compare various adaptations in aquatic animals.
CO4: Explore the importance of aquatic animals for economic development.
CO5: Classify the fishes based upon their characters.
CO6: Explain the anatomy of fishes.
CO7: Identify the fish diseases based on symptoms.

TOPICS:

Unit No.	Subunit No.	Details	Teaching Hours
Section A: Freshwater Zoology			
1. Types of Aquatic Environment	1.1	Lotic Habitat: Major river in India	04
	1.2	Lentic Habitat: Lakes, Ponds and Swamps, Bogs lakes and succession of lakes	
	1.3	Ephemeral water bodies (Temporary habitat).	
2: Physical Conditions of Water	2.1	Movement of water, depth, viscosity, density, transparency turbidity and thermal stratification	04
3: Chemical Conditions of Water	3.1	Dissolved oxygen and carbon di-oxide, pH, phosphates, sulphate content, nitrates	04
	3.2	Acidity, alkalinity, Mg-hardness, Ca-	

		hardness, dissolved solids	
	3.3	Importance of chemical conditions to aquatic life.	
4: Physiological and protective adaptations of the following	4.1	Protozoa, Rotifera, Crustaceans and Fishes.	02
5: Diagnostic features and life cycle of temporary rainwater pool animals	5.1	Fairy shrimps, Tadpole shrimps and Clam shrimps.	03
6: Respiratory and locomotory adaptations	6.1	Adaptations in freshwater insects and their larvae	03
7: Adaptations in freshwater reptiles	7.1	Terrapin and crocodiles	03
8. Economic importance of fresh water animals	8.1	Economic importance of freshwater molluscs	02
	8.2	Economic importance of reptiles	
9. Aquatic habitat	10.1	Productivity of water bodies and its importance	03
10. Zooplanktons	10.1	General characters of zooplankton with special emphasis on the characters used in taxonomy: Rotifera, Copepoda, Cladocera and Ostracoda	
Section B: Ichthyology			
1. Classification and Diagnostic Characters (up to orders)	1.1	Extant Cyclostomata, Chondrichthyes and Osteichthyes (9 major orders of fishes)	04
	1.2	Phylogeny of fishes	
2.External morphology	2.1	Body form, appendages, pigmentation, skin and scales	02
3. Endoskeleton	3.1	Skull	02
	3.2	Axial Skeleton	
	3.3	Appendicular skeleton.	
4. Digestion	4.1	Food and feeding habits	02
	4.2	Digestive system and its anatomical modifications.	
5. Respiration	5.1	Structure and functions of gills	04
	5.2	Adaptations for air breathing	
	5.3	Role of air bladder in respiration and bouyancy	
7. Excretion and Osmoregulation	6.1	Glomerular and aglomerular kidneys;	03
	6.2	Nitrogen (Ammonia, Urea and TMAO) excretions;	

	6.3	Water and salt and balance in stenohaline and euryhaline fish	
	6.4	Role of skin and gills in osmoregulation	
8. Migration in fish			**01**
9. Reproduction	9.1	Structure of gonads	03
	9.2	Gametogenic cycles	
	9.3	Spawning and parental care	
10. Nervous System and Sense Organs	10.1	Organization of the central and peripheral nervous systems.	03
	10.2	Eye, lateral line organs and chemoreceptors	
11. Endocrine Organs	11.1	Functions of the pituitary, thyroid, inter-renal and chromaffin tissues,	03
	11.2	Functions of ultimobranchial gland and corpuscles of Stannius	
12. Fish Diseases	12.1	Protozoan diseases in fish	03
	12.2	Fungal diseases in fish	
	12.3	Bacterial diseases in fish	

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Course Articulation Matrix of ZOO-511-MJE (A): Freshwater Zoology and Ichthyology

Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

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

PO1: Disciplinary Knowledge:

CO1, CO2, CO3, CO5, CO6:

These COs directly assess students' understanding of key themes in aquatic zoology, including diverse aquatic habitats, water qualities affecting life, animal adaptations, fish classification, and their anatomy.

PO2: Critical Thinking and Problem Solving:

CO2, CO3, CO6, CO7:

Interpreting the connection between water properties and life, analyzing adaptations in different contexts, evaluating fish classification systems, and diagnosing fish diseases based on symptoms all require critical thinking and problem-solving skills.

PO3: Social Competence:

CO3, CO5, CO6:

Explaining animal adaptations, classifying fish based on specific characters, and describing fish anatomy effectively require good communication and presentation skills.

PO4: Research-related skills and Scientific temper:

CO2, CO3, CO7:

Researching specific water properties and their impact, exploring diverse adaptations, and identifying fish diseases based on scientific evidence involve research skills and an appreciation for scientific methodology.

PO5: Trans-disciplinary knowledge:

CO2, CO3, CO6:

Understanding water chemistry connects aquatic zoology to chemistry, while studying animal adaptations can draw on concepts from ecology and evolution. Fish anatomy relates to comparative anatomy and zoophysiology.

PO6: Personal and professional competence:

CO1, CO2, CO3, CO5, CO6, CO7:

Mastering these COs requires independent learning, self-motivation, attention to detail, and the ability to work effectively with scientific texts and materials.

PO7: Effective Citizenship and Ethics:

CO2, CO3:

Understanding the importance of maintaining healthy aquatic environments and the impact of human activities on aquatic life promotes environmental awareness and responsible citizenship.

PO8: Environment and Sustainability:

CO2, CO3:

Recognizing the role of water quality in supporting aquatic life and understanding the negative impacts of pollution on animal adaptations can inform sustainable practices for managing aquatic ecosystems.

PO9: Self-directed and Life-long learning:

CO1, CO2, CO3, CO5, CO6, CO7:

Mastering these COs equips students with the skills and knowledge to independently explore various aspects of aquatic zoology, fostering lifelong learning in the field.

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

Name of the Program: M.Sc. Zoology
Program Code: ZOO
Class: M. Sc. I
Semester: I
Course Type: Major (Elective) Theory
Course Code: ZOO-511-MJE (B)
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 (B): Biostatistics and Genetics
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

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

PO1: Disciplinary Knowledge:
CO1, CO2:
These COs directly assess students' understanding of key concepts in genetics, including the chemical basis of heredity (DNA) and fundamental patterns of inheritance (Mendelian and non-Mendelian).

PO2: Critical Thinking and Problem Solving:
CO2, CO3, CO4, CO5, CO6:
Recalling and applying knowledge of inheritance patterns, analyzing the interplay of genes and environment, interpreting numerical data, and drawing conclusions from correlations all require critical thinking and problem-solving skills.

PO3: Social Competence:
CO2, CO5, CO6:
Explaining complex genetic concepts like inheritance patterns and genetic contributions to disorders, presenting data effectively, and communicating conclusions clearly require strong communication and presentation skills.

PO4: Research-related skills and Scientific temper:
CO3, CO4, CO5, CO6, CO7:
Analyzing the contribution of genes and environment in disorders, interpreting numerical data, representing data appropriately, drawing conclusions from correlations, and emphasizing the importance of statistics in scientific communication all involve research skills and an appreciation for scientific methods and evidence.

PO5: Trans-disciplinary knowledge:
CO1, CO3:
Understanding the chemical basis of heredity connects genetics to biochemistry and molecular biology, while exploring the role of genes and environment in disorders bridges genetics with medicine and public health.

PO6: Personal and professional competence:
CO1, CO2, CO3, CO4, CO5, CO6, CO7:
Mastering these COs requires independent learning, self-motivation, attention to detail, and the ability to work effectively with data, scientific texts, and presentation tools.
PO7: Effective Citizenship and Ethics:
CO3:
Understanding the complex interplay of genes and environment in human disorders can inform ethical considerations in areas like genetic testing and counseling.
PO8: Environment and Sustainability:
CO3:
Recognizing the potential impact of environmental factors on genetic expression and disease risk can contribute to sustainable practices for environmental protection and public health.
PO9: Self-directed and Life-long learning:
CO1, CO2, CO3, CO4, CO5, CO6, CO7:
Mastering these COs equips students with the skills and knowledge to independently explore various aspects of genetics, analyze data, and communicate complex information, fostering lifelong learning in the field.

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

Name of the Program: M.Sc. Zoology
Program Code: ZOO
Class: M. Sc. I
Semester: I
Course Type: Major (Elective) Theory
Course Code ZOO-511-MJE (C)
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.	08
	1.2	Principles and Applications of: Phase Contrast, Fluorescence, Confocal, Transmission And Scanning Electron, Atomic Force Microscopy	
	1.3	Live Cell Imaging	
2. Spectroscopy		Principles of the following	08
	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	04
	3.2	Differential and Density Gradient Centrifugation	
4. Electrophoresis	4.1	Introduction to Electrophoresis	04
	4.2	Native PAGE	
	4.3	SDS-PAGE	
	4.4	2D- Gel Electrophoresis	
5. Principles and Applications of Chromatography	5.1	Thin Layer Chromatography	10
	5.2	Adsorption Chromatography	
	5.3	Partition Chromatography.	
	5.4	GC-MS	
	5.5	HPLC	
	5.6	HPTLC	
6. Advance Techniques in Biology	6.1	Real time PCR	12
	6.2	DNA fingerprinting	
	6.3	DNA Markers: RAPD, RFLP & AFLP	
	6.4	DNA microarray	
	6.5	DNA sequencing technology (Sanger and Next generation)	
	6.6	Protein Microarray	
	6.7	Protein sequencing	
	6.8	FRET analysis	
	6.9	Flow Cytometry	
7. Computer Application	7.1	Databases and their applications	05
	7.2	Introduction to Bioinformatics	
8. Cell Culture Techniques	8.1	Introduction to cell culture	05
	8.2	Animal Cell culture	
	8.3	Potential use of cell cultures	
9. Introduction to Nanotechnology	9.1	Basic concepts of Nanotechnology	04
	9.2	Characterization techniques: FTIR & FESEM	
	9.3	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
CO1	3	1	2	2	1	3	1	1	3
CO2	3	3	3	3	3	3	3	1	3
CO3	3	3	3	3	1	3	3	1	3
CO4	1	3	1	3	1	3	1	1	3
CO5	3	3	3	1	1	3	1	3	3
CO6	3	3	3	3	3	3	3	3	3
CO7	3	3	1	3	2	3	1	1	3

PO1: Disciplinary Knowledge:
CO1, CO2, CO3, CO5, CO6, CO7:
These COs directly assess students' understanding of key techniques in life sciences, including various methodologies, instrument operation, research application, data analysis, cell culture approaches, bioinformatics importance, and characterization methods for biomolecules.

PO2: Critical Thinking and Problem Solving:
CO2, CO3, CO4, CO5, CO6, CO7:
Demonstrating instrument function, troubleshooting errors, selecting appropriate techniques based on research needs, analyzing data with databases, comparing and evaluating different cell culture methods, applying bioinformatics to solve problems, and choosing characterization techniques based on biomolecule properties all require critical thinking and problem-solving skills.

PO3: Social Competence:
CO2, CO4, CO5, CO6:
Explaining laboratory instrument operation, communicating data analysis results using databases, sharing knowledge about cell culture techniques, and discussing the importance of bioinformatics can contribute to effective communication and collaboration.

PO4: Research-related skills and Scientific temper:
CO2, CO3, CO4, CO6, CO7:

Operating instruments, designing experiments, selecting and applying techniques, analyzing data critically, using bioinformatics tools, and characterizing biomolecules accurately represent crucial research skills and an appreciation for scientific methodology and data integrity.

PO5: Trans-disciplinary knowledge:

CO2, CO6:

Understanding the principles of various instruments connects life sciences techniques to physics and engineering, while bioinformatics bridges life sciences with computer science and mathematics.

PO6: Personal and professional competence:

CO1, CO2, CO3, CO4, CO5, CO6, CO7:

Mastering these COs requires independent learning, attention to detail, self-management, the ability to work effectively with equipment and protocols, and collaboration with research teams.

PO7: Effective Citizenship and Ethics:

CO2, CO4, CO6:

Responsible use of laboratory instruments, proper data handling and sharing practices, and understanding the ethical implications of bioinformatics applications demonstrate ethical awareness and responsible research conduct.

PO8: Environment and Sustainability:

CO5, CO6:

Utilizing sustainable cell culture techniques, minimizing waste generation during experiments, and applying bioinformatics for environmental research and resource management all contribute to sustainable practices in life sciences research.

PO9: Self-directed and Life-long learning:

CO1, CO2, CO3, CO4, CO5, CO6, CO7:

Mastering these COs equips students with the skills and knowledge to independently explore new techniques, design and conduct research, and adapt to the evolving landscape of life sciences, fostering lifelong learning.

11.

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

Name of the Program: M.Sc. Zoology
Program Code: ZOO
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 of research and objectives of research	04
	1.2	Types, approaches and significance of research	
	1.3	Research methods versus methodology	
	1.4	Criteria of good research; Problems encountered by researchers in India.	
2. Defining the Research Problem	2.1	Research problem and Selecting the problem	09
	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	
	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 of research design; Need for research design; Features of a good design	06
	4.2	Important concepts relating to research design, Different research designs,	
	4.3	Basic principles of experimental designs and important experimental designs.	
5. Design of Sample Surveys	5.1	Design of Sampling: 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. Measurement and Scaling	6.1	Qualitative and quantitative data; Classification of measurement scales; Goodness of measurement scales	07
	6.2	Sources of error in measurement; Techniques of developing measurement tools; Scaling techniques	
	6.3	Multidimensional scaling	
7. Data Collection	7.1	Introduction; Experiments and surveys; Collection of Primary and secondary data	04
	7.2	Selection of appropriate method for data collection; Case study method	
8. Testing of Hypotheses	8.1	Hypothesis; Basic concepts of hypothesis testing	09
	8.2	Procedure for hypothesis testing	

	8.3	Hypothesis testing for mean, proportion, variance; P-Value approach	
	8.4	Limitations of the tests of hypothesis	
9. Chi-square Test	9.1	Test of difference of more than two proportions	06
	9.2	Test of independence of attributes	
	9.3	Test of goodness of fit	
	9.4	Cautions in using chi square tests	
10. Report Writing	10.1	Types of reports; Different steps in report writing; Significance of report writing	07
	10.2	Layout of the research report	
	10.3	Mechanics of writing a research report; Precautions for report writing	
11. Paper Writing	11.1	Layout of a Research Paper	04
	11.2	When and where to publish?; Impact factor of journals	
	11.3	Ethical issues related to publishing; Plagiarism and Self-Plagiarism	

REFERENCES:

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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
CO1	3	1	1	3	1	3	1	1	3
CO2	1	3	1	3	1	3	1	1	3
CO3	1	1	1	3	1	3	3	3	3
CO4	3	3	1	3	1	3	1	3	3
CO5	1	3	3	3	1	3	1	1	3
CO6	1	3	1	3	3	3	1	1	3
CO7	1	2	3	3	2	3	3	1	3

PO1: Disciplinary Knowledge:
CO1, CO4:
These COs directly assess students' understanding of key concepts in research methodology, including the overall framework, research design types and their characteristics.
PO2: Critical Thinking and Problem Solving:
CO2, CO4, CO5, CO6:
Defining a research problem, choosing the appropriate research design, analyzing data effectively, and applying statistical tests all require critical thinking and problem-solving skills.
PO3: Social Competence:
CO5, CO7:
Effectively presenting data and writing clear and concise research reports and papers require strong communication and presentation skills.
PO4: Research-related skills and Scientific temper:
CO1, CO2, CO3, CO4, CO5, CO6, CO7:
Understanding the research process, formulating research questions, conducting literature reviews, choosing appropriate data collection and analysis methods, interpreting results, and writing reports all involve research skills and an appreciation for scientific methods and evidence.
PO5: Trans-disciplinary knowledge:
CO1, CO6;
Understanding research methodology can be applied across various disciplines, while data analysis using statistical tests draws on concepts from mathematics and statistics.
PO6: Personal and professional competence:
CO1, CO2, CO3, CO4, CO5, CO6, CO7:
Mastering these COs requires independent learning, self-motivation, attention to detail, the ability to work effectively with information, and manage research projects.
PO7: Effective Citizenship and Ethics:
CO3, CO7:
Conducting ethical research, acknowledging sources properly, and avoiding plagiarism demonstrate ethical awareness and responsible research conduct.
PO8: Environment and Sustainability:

CO3, CO4:
Reviewing research on environmental issues and designing research to address sustainability challenges contribute to responsible environmental practices.

PO9: Self-directed and Life-long learning:
CO1, CO2, CO3, CO4, CO5, CO6, CO7:
Mastering these COs equips students with the skills and knowledge to independently conduct research, analyze data, communicate findings, and adapt to different research contexts, fostering lifelong learning.