



**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**

**(Eligibility : B. Sc. Zoology/Botany/Microbiology/Agri./  
Agri. Biotech./Environment Science)**

**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 be 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 interpret 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**

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

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

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

\* 1 Credit = 15hr

### 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
<b>Total Credits Semester-I</b>					<b>20</b>
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
<b>Total Credits Semester-II</b>					<b>20</b>
<b>Cumulative Credits Semester I + Semester II</b>					<b>40</b>



**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
<b>1. Biomolecules: Classification, Structure and Function</b>	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:	

		<ul style="list-style-type: none"> <li>a. Biochemistry</li> <li>b. Functions</li> </ul>	
	1.6	Proteins: <ul style="list-style-type: none"> <li>a. General properties of proteins</li> <li>b. Structure of amino acid</li> <li>c. Structure of proteins: Primary structure and its importance, Secondary structure-<math>\alpha</math>-helix, <math>\beta</math>-helix, Ramachandran plot, X ray diffraction, Tertiary structure: Myoglobin, Forces stabilizing, unfolding and refolding Quaternary structure- haemoglobin.</li> <li>d. Biological Roles</li> </ul>	
<b>2. Enzymes</b>	2.1	<ul style="list-style-type: none"> <li>a. Classification</li> <li>b. Types of enzymes</li> <li>c. Nomenclature</li> <li>d. Properties</li> </ul>	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)	
<b>3. Bioenergetics: - Metabolic Pathways and its energetics</b>	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: <ul style="list-style-type: none"> <li>a. Glycolysis</li> <li>b. TCA</li> <li>c. Glycogenesis, Glycogenolysis and Glyconeogenesis</li> </ul>	
	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.

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(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
<b>1. Overview of Chemical Nature of the Cell</b>	1.1	Carbon as backbone of biologically important molecules.	02
	1.2	Macromolecules and their role in the living systems.	
<b>2. Plasma Membrane</b>	2.1	Models of cell membranestructure	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	
<b>3. The Endomem</b>	3.1	Endoplasmic reticulum: Signal peptide hypothesis, protein folding, processing and secretion, lipid	07

<b>brane System and Peroxisomes</b>		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	
<b>4. Nucleus</b>	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	
<b>5. Mitochondria and Chloroplast</b>	5.1	Structure, Genetic system, Functions, Protein Import and biogenesis of mitochondria and chloroplast	03
<b>6. Extracellular Matrix, Cell-Cell Junction and Adhesion</b>	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	
<b>7. Cell Signaling and Transduction</b>	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	
<b>8. Cell Cycle and its regulation</b>	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	
<b>9. Cytoskeleton and Motor Proteins</b>	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	

<b>10. Cancer Biology</b>	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	
<b>11. Cell death mechanism</b>	11.1	Autophagy	04
	11.2	Apoptosis	
	11.3	Anoikis	
<b>12. Stem Cell Biology</b>	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. NewYork.
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.

**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 FolinCiocalteu Reagent	E	04
6	Estimation of vitamin 'C' by iodine method.	E	04
7	Estimation of amylase activity.	E	04
8	Estimation of protein by Lowry et.al method.	E	04

9	Determination of optimum pH of enzyme	E	04
10	Effect of substrate concentration, pH, temperature, inhibitor and activator on enzyme activity	E	08
11	Isolation of starch from corn (on the basis of density)	E	04
12	Isolation of cholesterol from egg yolk / human blood Or Determination of acid value of fat	E	04
13	Estimation of cholesterol by Zak's method.	E	04
14	Estimation of glycine by titrimetric method	E	04
E: Experiment, D: Demonstration			



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**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/ <i>Drosophila</i> 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			

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**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: 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
<b>Section A: Freshwater Zoology</b>			
<b>1. Types of Aquatic Environment</b>	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).	
<b>2: Physical Conditions of Water</b>	2.1	Movement of water, depth, viscosity, density, transparency turbidity and thermal stratification	04
<b>3: Chemical Conditions of Water</b>	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.	
<b>4: Physiological and protective adaptations of the following</b>	4.1	Protozoa, Rotifera, Crustaceans and Fishes.	02
<b>5: Diagnostic features and life cycle of temporary rainwater pool animals</b>	5.1	Fairy shrimps, Tadpole shrimps and Clam shrimps.	03
<b>6: Respiratory and locomotory adaptations</b>	6.1	Adaptations in freshwater insects and their larvae	03
<b>7: Adaptations in freshwater reptiles</b>	7.1	Terrapin and crocodiles	03
<b>8. Economic importance of fresh water animals</b>	8.1	Economic importance of freshwater molluscs	02
	8.2	Economic importance of reptiles	
<b>9. Aquatic habitat</b>	10.1	Productivity of water bodies and its importance	02
<b>10. Zooplanktons</b>	10.1	General characters of zooplankton with special emphasis on the characters used in taxonomy: Rotifera, Copepoda, Cladocera and Ostracoda	
<b>Section B: Ichthyology</b>			
<b>1. Classification and Diagnostic Characters (up to orders)</b>	1.1	Extant Cyclostomata, Chondrichthyes and Osteichthyes (9 major orders of fishes)	04
	1.2	Phylogeny of fishes	
<b>2. External morphology</b>	2.1	Body form, appendages, pigmentation, skin and scales	02
<b>3. Endoskeleton</b>	3.1	Skull	02
	3.2	Axial Skeleton	
	3.3	Appendicular skeleton.	
<b>4. Digestion</b>	4.1	Food and feeding habits	02
	4.2	Digestive system and its anatomical modifications.	
<b>5. Respiration</b>	5.1	Structure and functions of gills	04
	5.2	Adaptations for air breathing	
	5.3	Role of air bladder in respiration and buoyancy	
<b>7. Excretion and Osmoregulation</b>	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	
<b>8. Migration in fish</b>			<b>01</b>
<b>9. Reproduction</b>	9.1	Structure of gonads	03
	9.2	Gametogenic cycles	
	9.3	Spawning and parental care	
<b>10. Nervous System and Sense Organs</b>	10.1	Organization of the central and peripheral nervous systems.	03
	10.2	Eye, lateral line organs and chemoreceptors	
<b>11. Endocrine Organs</b>	11.1	Functions of the pituitary, thyroid, inter-renal and chromaffin tissues,	03
	11.2	Functions of ultimobranchial gland and corpuscles of Stannius	
<b>12. Fish Diseases</b>	12.1	Protozoan diseases in fish	03
	12.2	Fungal diseases in fish	
	12.3	Bacterial diseases in fish	

### REFERENCES:

1. Mellanby, H (1975). Animal life in freshwater, 6th Edn. Chapman-Hall.
2. Welch, P. S. (1935). Limnology.
3. Hutchinson, G. E., & Edmondson, Y. H. (1957). Treatise on limnology. Wiley.
4. Laws, E. A. (2000). Aquatic pollution: an introductory text. John Wiley & Sons.
5. Macan, T. T., & Worthington, E. B. (1951). Life in lakes and rivers.
6. Bal, D. V., & Rao, K. V. (1984). Marine fisheries. Tata McGraw Hill.
7. Bone, Q., N.B. Marshall and J. H. S. Blaxter (1995). Biology of Fishes, Edn.2, Blackie, Academic, Professional (Chapman and Hall), London.
8. Hoar, W.S. and D.J. Randall, (1969). Fish Physiology. Vols. I onwards, Academic Press, NewYork
9. Jayaram, K.C. (1981). The freshwater fishes of India. Pakistan, Bangladesh, Burma and Sri Lanka- A Handbook. Zool. Survey of India, Academic Press, NewYork.
10. Khanna, S.S. (1984). An Introduction to Fishes. Central Book Depot., Allahabad.

**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: 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
<b>Section-I: Genetics</b>			
<b>1. Gene Interactions and Deviations from Mendelian Inheritance</b>	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	
<b>2. Multiple alleles</b>	2.1	Coat colour in mice	02
<b>3. Linkage and crossing over</b>	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	
<b>4. Inheritance of</b>	4.1	QTL Mapping	04

<b>qualitative and quantitative traits</b>	4.2	Quantitative Genetics: Concepts of penetrance, expressivity and variance, Heritability	
	4.3	Genetic basis and influence of environment on quantitative inheritance	
<b>5. Principles of Population Genetics</b>	5.1	Genetic structure of populations –Gene pool, Genotype Frequency, Allelic frequency	04
	5.2	Hardy-Weinberg law and its application	
<b>6. Somatic Cell Genetics</b>	6.1	Its applications, Gene Therapy, Gene transfer technology	03
<b>7. Human genetics</b>	7.1	Dominant and recessive disorders,	05
	7.2	Pedigree Analysis	
	7.3	Physical and physiological traits	
<b>8. Gene Mutation</b>	8.1	Types, Causes and Detection	03
<b>9. Introduction to epigenetics</b>			<b>01</b>
<b>Section-II: Biostatistics</b>			
<b>1. Introduction to Biostatistics</b>	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	
<b>2. Data Classification</b>	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.	
<b>3. Measures of central tendency</b>	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	
<b>4. Measures of dispersion</b>	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	
<b>5. Correlation and Regression</b>	5.1	Bivariate data, concept of correlation, Types of Correlation, Scatterplot	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.	
<b>6. Probability and probability distribution</b>	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.	
<b>7. Test of hypothesis</b>	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.	

**REFERENCES:**

1. William S Klug and Michael R Cummings. Concepts of Genetics. Edn. IX. Prentice Hall Internatl, Inc., New York, 2008.
2. Trends in Genetics. Elsevier Publications, Amsterdam.
3. Lewin, B., Krebs, J., Kilpatrick, S. T., & Goldstein, E. S. (2011). Lewin's genes X. Jones & Bartlett Course.
4. Verma, P. S., & Agarwal, V. K. (2009). Genetics, (Multicolour Edition). S. Chand Publishing.
5. Russell, P. J. (2006). iGenetics: A Molecular Approach. ed. B. Cummings.
6. G. Vijayalakshmi and C. Sivapragasam. (2008) Research Methods –Tip and Techniques, MJP Publishers, Chennai. WWW.mjppublishers.com
7. Principles And Practice of Biostatistics : Dr J.V.Dixit
8. Antonisamy, B., Christopher, S., & Samuel, P. P. (2010). Biostatistics: principles and practice. Tata McGraw Hill Education.
9. Sokal, R. R., & Rohlf, F. J. (1987). Biostatistics. Francise & Co, New York.



**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 (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
<b>1. Microscopy</b>	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	
<b>2. Spectroscopy</b>		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	
<b>3. Centrifugation</b>	3.1	Principle & Basic Theory of Ultracentrifuge	04

	3.2	Differential and Density Gradient Centrifugation	
<b>4. Electrophoresis</b>	4.1	Introduction to Electrophoresis	04
	4.2	Native PAGE	
	4.3	SDS-PAGE	
	4.4	2D- Gel Electrophoresis	
<b>5. Principles and Applications of Chromatography</b>	5.1	Thin Layer Chromatography	10
	5.2	Adsorption Chromatography	
	5.3	Partition Chromatography.	
	5.4	GC-MS	
	5.5	HPLC	
	5.6	HPTLC	
<b>6. Advance Techniques in Biology</b>	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	
<b>7. Computer Application</b>	7.1	Databases and their applications	05
	7.2	Introduction to Bioinformatics	
<b>8. Cell Culture Techniques</b>	8.1	Introduction to cell culture	05
	8.2	Animal Cell culture	
	8.3	Potential use of cell cultures	
<b>9. Introduction to Nanotechnology</b>	9.1	Basic concepts of Nanotechnology	04
	9.2	Characterization techniques: FTIR & FESEM	
	9.3	Applications of Nanotechnology	

**REFERENCES:**

1. Binns, C. (2021). *Introduction to Nanoscience and Nanotechnology*. United States: Wiley.
2. *Nanotechnology and the Environment*. (2020). (n.p.): IntechOpen.
3. McMillan, V. E., & McMillan, V. (2012). *Writing papers in the biological sciences*. Macmillan.
4. Wilson, K., & Walker, J. (Eds.). (2010). *Principles and techniques of biochemistry and molecular biology*. Cambridge university press.
5. Lacey, A. J. (Ed.). (1999). *Light microscopy in biology: a practical approach* (Vol. 195). OUP Oxford.
6. Bozzola, J. J., & Russell, L. D. (1999). *Electron microscopy: principles and techniques for biologists*. Jones & Bartlett Course.
7. Kiernan, J. A. (1999). Histological and histochemical methods: theory and practice. *Shock*, 12(6), 479.
8. Sheppard Jr, N. F., Eden, M., & Kantor, G. (1994). 16th Annual International Conference of the IEEE Engineering in Medicine and Biology Society.
9. Ullmann, D. (1990). Day, RA, How to Write and Publish a Scientific Paper. Cambridge etc., Cambridge University Press 1988. XI, 211 pp.,£ 7.95 P/b. ISBN 0-521-36760-3.
10. Trelease, S. F. (1958). How to write scientific and technical papers.

**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
<b>1. Research Methodology</b>	1.1	Introduction to research methodology: Meaning of research and objectives of research	01
	1.2	Types, approaches and significance of research	01
	1.3	Research methods versus methodology	01
	1.4	Criteria of good research; Problems encountered by researchers in India.	01
<b>2. Defining the Research Problem</b>	2.1	Research problem and Selecting the problem	
	2.2	Necessity of defining the problem	01
	2.3	Technique involved in defining a problem	01

<b>3. Reviewing the literature</b>	3.1	Place of the literature review in research; Bringing clarity and focus to research problem	01
	3.2	Improving research methodology; Broadening knowledge base in research area and enabling contextual findings	02
	3.3	Review of the literature; Searching the existing literature; Reviewing the selected literature, Developing a theoretical framework	02
	3.4	Developing a conceptual framework; Writing about the literature reviewed	02
<b>4. Research Design</b>	4.1	Meaning of research design; Need for research design; Features of a good design	02
	4.2	Important concepts relating to research design, Different research designs,	02
	4.3	Basic principles of experimental designs and important experimental designs.	02
<b>5. Design of Sample Surveys</b>	5.1	Design of Sampling: Introduction and sample design	01
	5.2	Sampling and non-sampling errors; Sample survey versus census survey	02
	5.3	Types of sampling: Probability and Non-Probability	01
<b>6. Measurement and Scaling</b>	6.1	Qualitative and quantitative data; Classification of measurement scales; Goodness of measurement scales	03
	6.2	Sources of error in measurement; Techniques of developing measurement tools; Scaling techniques	03
	6.3	Multidimensional scaling	01
<b>7. Data Collection</b>	7.1	Introduction; Experiments and surveys; Collection of Primary and secondary data	02
	7.2	Selection of appropriate method for data collection; Case study method	02
<b>8. Testing of Hypotheses</b>	8.1	Hypothesis; Basic concepts of hypothesis testing	03
	8.2	Procedure for hypothesis testing	02

	8.3	Hypothesis testing for mean, proportion, variance; P-Value approach	04
	8.4	Limitations of the tests of hypothesis	
<b>9. Chi-square Test</b>	9.1	Test of difference of more than two proportions	02
	9.2	Test of independence of attributes	02
	9.3	Test of goodness of fit	01
	9.4	Cautions in using chi square tests	01
<b>10. Report Writing</b>	10.1	Types of reports; Different steps in report writing; Significance of report writing	04
	10.2	Layout of the research report	01
	10.3	Mechanics of writing a research report; Precautions for report writing	02
<b>11. Paper Writing</b>	11.1	Layout of a Research Paper	01
	11.2	When and where to publish?; Impact factor of journals	02
	11.3	Ethical issues related to publishing; Plagiarism and Self-Plagiarism	02

### 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.

**Examination Pattern / Evaluation Pattern****Teaching and Evaluation (for Major, Minor, AEC, VEC, IKS courses)**

<b>Course Credits</b>	<b>No. of Hours per Semester Theory/Practical</b>	<b>No. of Hours per Week Theory/Practical</b>	<b>Maximum Marks</b>	<b>CE 40 %</b>	<b>ESE 60%</b>
<b>1</b>	<b>15 / 30</b>	<b>1 / 2</b>	<b>25</b>	<b>10</b>	<b>15</b>
<b>2</b>	<b>30 / 60</b>	<b>2 / 4</b>	<b>50</b>	<b>20</b>	<b>30</b>
<b>3</b>	<b>45 / 90</b>	<b>4 / 6</b>	<b>75</b>	<b>30</b>	<b>45</b>
<b>4</b>	<b>60 / 120</b>	<b>4 / 8</b>	<b>100</b>	<b>40</b>	<b>60</b>

**Teaching and Evaluation (for VSC, SEC & CC courses)**

- Evaluation to be done by Internal & External Experts
- No descriptive end semester written examination
- Evaluation to be done at Department level preferably prior to commencement of Theory /Practical Examinations
- Evaluation to be done on the Skills gained by student