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 -III

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 2024-2025

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

Preamble

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

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

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

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

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

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

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

Programme Specific Outcomes (PSOs)

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

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

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

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

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

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

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

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

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

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

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

Board of Studies (BoS) in Zoology

From 2022-23 to 2024-25

Sr. No.	Name	Designation
1.	**Dr. 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.	**Mr. Subodh M. Nikam**	Student Representative
12.	**Ms. Sana J. Sayyad**	Student Representative

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

Sem	Course Category	Course Code	Course Title	Theory / Practical	Credits
III	Major mandatory	ZOO-601-MJM	Histology, Histo-chemistry & Reproductive Physiology of Mammals	**T**	4
	Major mandatory	ZOO-602-MJM	Systematics & Economic Zoology	**T**	4
	Major mandatory	ZOO-603-MJM	Zoology Practical-V	**P**	2
	Major mandatory	ZOO-604-MJM	Zoology Practical-VI	**P**	2
	Major Elective	ZOO-611-MJE (A)	Ichthyology	**T**	2
		ZOO-611-MJE (B)	Comparative Animal Physiology	**T**	2
	Major Elective	ZOO-612-MJE (A)	Ichthyology Lab	**P**	2
	Major Elective	ZOO-612-MJE (B)	Comparative Animal Physiology Lab	**P**	2
	Research project	ZOO-621-RP	Research Project	**P**	4
				Total Credits (Semester-III)	**20**
IV	Major mandatory	ZOO-651-MJM	Parasitology & Immunology	**T**	4
	Major mandatory	ZOO-652-MJM	Physiology, Biochemistry & Ecology of Insects	**T**	4
	Major mandatory	ZOO-653-MJM	Zoology Practical-VII	**P**	2
	Major Elective	ZOO-661-MJE (A)	Entomology-II	**P**	2
		ZOO-661-MJE (B)	Animal Physiology-II	**T**	2
		ZOO-661-MJE (C)	Genetics-II	**T**	2
	Major Elective	ZOO-662-MJE (A)	Entomology-II Lab	**P**	2
		ZOO-662-MJE (B)	Animal Physiology-II Lab	**P**	2
		ZOO-662-MJE (C)	Genetics-II Lab	**P**	2
	Research Project	ZOO-681-RP	Research Project	**P**	6
				Total Credits (Semester-IV)	**20**
				Cumulative Credits (Semester-III & IV)	**40**

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2024)

Name of the Program: M.Sc. Zoology
Program Code: ZOO
Class: M. Sc. II
Semester: III
Course Type: Major (Mandatory) Theory
Course Code: ZOO-601-MJM
Course Name: Histology, Histochemistry and Reproductive Physiology of Mammals
Number of Credits: 04
Number of Teaching hours: 60

Course Objectives:

- To understand the different types of tissue, methods of microscopy, tissue preservation, and the limits of magnification and resolution.
- To understand the structural organization the various types of muscles.
- Explain the scientific basis of tissue preparation and be able to apply that understanding to the practice of the subjects such as making films, spread and counting
- To understand the concept of mammalian reproduction
- Identify and describe the anatomical structures of the male and female reproductive systems and explain their respective functions
- To understand the concept of pregnancy, parturition, and lactation and causes of reproductive dysfunction, treatment and artificial control of reproduction
- Understand the process of spermatogenesis, including the roles of Sertoli cells, Leydig cells, and the blood-testis barrier
- Describe the hormonal regulation and feedback mechanism of sexual cycles, including puberty, oestrus, and menstrual cycle

Course Outcomes:

After completion of this course, students will be able to

CO1: understand the general principles of histochemistry
CO2: gather hazardous materials information and will recognize and respond properly to potential hazards of handling chemicals and chemical waste
CO3: explore career opportunities and participate in career and graduate school planning through organization and activities
CO4: describe the concept of mammalian reproduction by explaining the anatomical structures and functions of both male and female reproductive systems.
CO5: describe the changes that occur in the reproductive system over the lifetime of an individual.
CO6: identify the major hormones involved in reproduction and describe their role in regulating reproduction in males and females.
CO7: describe the processes that can lead to dysfunction of the reproductive system and treatment for reproductive dysfunction such as artificial insemination and In vitro fertilization

TOPICS:

UNIT	SUB UNITS	SYLLABUS	NO. OF LECTURES
1. Fundamentals of histology:			04
	1.1	Scope and importance of Histology and Histochemistry	
	1.2	Epithelial, connective, muscular, nervous and other specialized tissues	
2. Techniques in histology:			10
	2.1	Procurement of tissue samples and fixation	
	2.2	Fixatives: Types of fixatives and its effects on tissue	
	2.3	Processing of fixed tissue samples: Dehydration, clearing,	

		infiltration, embedding and block making	
	2.4	Principles, design and functioning: Automated microtomes, ultra-microtome and cryostat; Problems and troubleshooting	
	2.5	Staining: Histochemical and immunohistologial methods	
	2.6	Mordants and mordanting, temporary and permanent preparations, whole mount preparation	
3. Fundamentals of histochemical techniques:			06
	3.1	Detection of glycogen, neutral and acid mucopolysaccharides and basic proteins	
	3.2	Detection of nonspecific esterases, specific and nonspecific lipid	
	3.3	Detection of acid and alkaline phosphatase	
4. Histology of mammalian tissue:			07
	4.1	Histological organization of stomach, intestine, lung, kidney, spleen, thymus, bone and bone marrow	
5. Reproductive Systems:			06
	5.1	Anatomy of male and female reproductive system, accessory organs and their function	
	5.2	Spermatogenesis and blood-testis barriers	
	5.3	Sexual dimorphisms	
6. Reproductive patterns:			03
	6.1	Environmental factors and breeding	
	6.2	Continuous and seasonal breeders	
7. Sexual cycles:			05
	7.1	Puberty, oestrous and menstrual cycles	
	7.2	Ovarian event: Follicular phase	
8. Hormonal regulation:			07
	8.1	Hypothalamus –pituitary and gonad axis; other hormones	
	8.2	Hypothalamic GnRH, pituitary gonadotropins, testicular hormones, testosterone derivatives and inhibin	
	8.3	Ovarian hormones: Oestrogen and progesterone; Feedback relationships	
	8.4	Role of hormones in pregnancy	
	8.5	Feedback mechanism in hormone secretion	
9. Gamete transportation and pregnancy:			03
	9.1	Conception, blastocyst formation, implantation and delayed implantation	
10. Parturition: Birth process and its neuroendocrine control; Puerperium			03
11. Lactation: Mammary glands, milk synthesis and secretion; Hormonal regulation and suckling reflex			03
12. Reproductive dysfunctions, treatment, and contraception			03
	12.1	Reproductive dysfunctions	
	12.2	Artificial insemination and in-vitro fertilization	
	12.3	Methods of contraception in male and female	

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2. Austin, C. R., Austin, C. R., & Short, R. V. (Eds.). (1985). Reproduction in mammals: volume 4, reproductive fitness. Cambridge University Press.
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Course Articulation Matrix of ZOO-601-MJM Histology, Histochemistry and Reproductive Physiology of Mammals
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

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

PO1: Comprehensive Knowledge and Understanding
CO1 describe the concept of general principles of histochemistry and CO2 mammalian reproduction by explaining the anatomical structures and functions of both male and female reproductive systems.PO1 encompasses a broad understanding of mammalian reproduction, including anatomical structures, functions.

PO2: Practical, Professional, and Procedural Knowledge
CO7 describe the processes that can lead to dysfunction of the reproductive system and treatment for reproductive dysfunction. CO6, explain concepts of pregnancy, parturition, and lactation, including the physiological changes and hormonal regulations associated with each stage require practical knowledge of diagnosing and treating reproductive dysfunctions and understanding the procedures involved in pregnancy, parturition, and lactation.

PO3: Entrepreneurial Mindset, Innovation, and Business Understanding
CO3 and CO6 involves mapping understanding reproductive health can indirectly contribute to innovations in healthcare businesses or services. CO4 understand the general principles of Histochemistry (Applying knowledge to diagnose and understand human diseases).

PO4: Specialized Skills, Critical Thinking, and Problem-Solving
CO5 identify the major hormones involved in reproduction and describe their role in regulating reproduction in males and females.CO6 describe the hormonal regulation of sexual cycles, including the onset of puberty, the oestrous cycle in non-primate mammals, and the menstrual cycle in primates.CO7 explain the process of spermatogenesis, detailing the roles of Sertoli cells, Leydig cells, and the blood-testis barrier, as well as the stages of spermiogenesis.

PO5: Research, Analytical Reasoning, and Ethical Conduct
CO2 and CO4 involves, research in histological structure of various tissues, reproductive biology related to reproductive dysfunction and treatment often involves ethical considerations.

PO6: Communication, Collaboration, and Leadership
CO7 Involves direct mapping with reproductive system topics. However, effective communication and collaboration may be necessary in reproductive health education or research teams.

PO7: Digital Proficiency and Technological Skills
CO1, CO2 and CO7 deals digital tools and technologies may be used in research or medical diagnostics related to histochemistry of tissue and reproduction technology in vitro fertilization and treatment for reproductive dysfunction

PO8: Multicultural Competence, Inclusive Spirit, and Empathy
CO6 involves awareness about the reproductive dysfunction and its treatment along with control consists of understanding reproductive health in diverse populations requires cultural competence and empathy.

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices
CO5, CO4 involves considerations in reproductive health care and environmental impacts of reproductive technologies are relevant.

PO10: Autonomy, Responsibility, and Accountability
CO6, CO7 direct concern with responsibility of reproductive system topics includes understanding reproductive health empowers individuals to take responsibility for their reproductive choices.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2024)

Name of the Program: M.Sc. Zoology
Program Code: ZOO
Class: M. Sc. II
Semester: III
Course Type: Major (Mandatory) Theory
Course Code: ZOO-602-MJM
Course Name: Systematics & Economic Zoology
Number of Credits: 04
Number of Teaching hours: 60

Course Objectives:-

- Develop a comprehensive understanding of fundamental concepts in systematics, including symmetry, coelom, metamerism, and taxonomic characters.
- Gain proficiency in various methodologies used in systematics, such as ecotaxonomy, molecular systematics, and numerical taxonomy.
- Acquire practical skills in taxonomic collections, including specimen collection, preservation, curation, and identification.
- Gain insights into principles and rules of zoological nomenclature, including the International Code of Zoological Nomenclature (ICZN).
- Explore the diversity of life kingdoms, focusing on Monera, Protista, and Animalia, and their characteristics.
- Investigate the role of various organisms in agriculture, such as protozoa in soil ecosystems and beneficial insects.
- Gain insights into different economic enterprises related to animals, including sponge culture, coral reef utilization, vermiculture, aquaculture, and the dairy industry, while considering ethical and sustainable practices.

Course Outcomes:

After completion of this course, students will be able to-:

CO1: Demonstrate a thorough understanding of fundamental concepts in systematics, including the principles of symmetry, coelom, metamerism, and taxonomic characters.
CO2: Apply various methodologies in systematics, such as ecotaxonomy, molecular systematics, and numerical taxonomy, to analyze and classify organisms effectively.
CO3: Apply practical skills in taxonomic collections, including specimen collection, preservation, curation, and accurate identification of specimens.
CO4: Demonstrate knowledge and application of principles and rules of zoological nomenclature, including adherence to the International Code of Zoological Nomenclature (ICZN).
CO5: Describe and compare the diversity of life kingdoms, with a focus on Monera, Protista, and Animalia, including their characteristics and evolutionary significance.
CO6: Evaluate and discuss the ecological roles of organisms in agriculture, such as protozoa in soil ecosystems and beneficial insects in pest control and pollination.
CO7: Analyze and assess different economic enterprises related to animals, including sponge culture, coral reef utilization, vermiculture, aquaculture, and the dairy industry, while considering ethical and sustainable practices for resource management and conservation.

TOPICS:

UNIT	SUB UNITS	SYLLABUS	NO. OF LECTURES
1. Fundamental of Systematics:			**15**
	1.1	Symmetry: Asymmetry, radial symmetry, bilateral symmetry and spherical symmetry	
	1.2	Coelom: Introduction, origin, evolution and functions of coelom	
	1.3	Metamerism: Origin and evolution of metamerism, significance of metamerism; Origin of Metazoa	

	1.4	Biological classification, hierarchy of categories and higher taxa	
	1.5	Taxonomic characters and keys	
	1.6	Species concepts	
2. Methodologies in Systematics:			**05**
	2.1	Ecotaxomony, behavioural taxonomy, cytotaxonomy, biochemical taxonomy, numerical taxonomy	
	2.2	Molecular Systematics: DNA fingerprinting & Molecular markers for detection of polymorphism	
3. Taxonomic collections, methods & data recording			**04**
	3.1	Collecting ways and data collection	
	3.2	Preservation of collected material and curating	
	3.3	Methods of identification and problems encountered in identification	
4. Zoological Nomenclature			**03**
	4.1	International code of Zoological Nomenclature (ICZN).	
	4.2	Operative principles and important rules of nomenclature	
	4.3	Important Latin words & abbreviations and Linnaean Signs	
5. Kingdoms of Life:			**03**
	5.1	General outline of kingdoms including Monera & Protista	
	5.2	Broad outline & diversity in kingdom Animalia	
6. Protozoa and agriculture			**03**
	6.1	**Soil protozoans:** a. Fungal-dominated soils b. Bacterial-dominated soils **Role in agriculture-** 1. Mineralizing nutrients 2. Regulating bacteria population 3. Fungi controlling	
7. Sponge Culture			**01**
	7.1	Methods of sponge culture	
	7.2	Economic importance	
8. Coral reef			**03**
	8.1	Concept of coral reef	
	8.2	Formation of coral reefs	
	8.3	Types of coral reefs	
	8.4	Use of corals in medicine, jewellery and ecotourism	
9. Vermiculture			**05**
	9.1	Introduction to vermiculture	
	9.2	Important species	
	9.3	Small and large scale vermiculture and precautions	
	9.4	Products	
10. Insects and human			**04**
	10.1	**Beneficial insects and harmful insects**	
11. Aquaculture:			**08**
	11.1	**Fresh water fish farming** 11.1.1 Types of ponds 11.1.2 Culture methods 11.1.3 Fish feed- artificial and live 11.1.4 Fish byproducts	
	11.2	**Pearl culture**	

		6.2.1 Introduction to pearl culture 6.2.2 Morphology and biology of *Lamellidans* spp. 6.2.3 Formulation and preparation of artificial feeds 6.2.4 Implantation techniques, post-operative care, marketing and economic importance	
12. Dairy industry			**04**
	12.1	Global and Indian status	
	12.2	Cattle breeds- Indigenous and exotic	
	12.3	Milk processing techniques	
	12.4	Milk products	
13. Ethics and sustainable use of animals as an economic enterprise			

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Course Articulation Matrix of ZOO-602-MJM: Systematics & Economic Zoology
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

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

PO1: Comprehensive Knowledge and Understanding
All COs mapped with PO1 because; PO1 emphasizes comprehensive knowledge and understanding, which is fundamental across various domains.

PO2: Practical, Professional, and Procedural Knowledge
All COs mapped with PO2 because; it emphasizes practical, professional, and procedural knowledge, which are essential skills across diverse fields of study.

PO3: Entrepreneurial Mindset, Innovation, and Business Understanding
All COs mapped with PO3 because; the field of systematics and zoology requires innovative thinking and entrepreneurial skills. Knowledge of taxonomic collections and nomenclature (CO3 and CO4) is vital for establishing and running businesses related to biodiversity conservation, agriculture, and aquaculture.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving
All COs mapped with PO4 because; systematics and zoology require a range of specialized skills for classification, analysis, and problem-solving. Understanding fundamental concepts (CO1), applying methodologies (CO2), and practical skills in taxonomic collections (CO3) necessitate critical thinking to analyze complex data and solve taxonomic puzzles.

PO5: Research, Analytical Reasoning, and Ethical Conduct
All COs mapped with PO5 because; the field of systematics and zoology requires a strong emphasis on research, analytical skills, and ethical conduct. CO1 involves understanding fundamental concepts, which often requires research to explore existing knowledge and analyze various theories and hypotheses. CO2 involves applying different methodologies, which necessitates analytical reasoning to interpret data and draw meaningful conclusions.

PO6: Communication, Collaboration, and Leadership
All COs mapped with PO6 due to the importance of communication, collaboration, and leadership skills in advancing knowledge and practices in systematics and zoology. CO4 necessitates clear communication and collaboration when adhering to zoological nomenclature principles to ensure consistency and clarity in scientific communication. CO5 involves collaborating with peers to discuss and compare the diversity of life kingdoms and their characteristics.

PO7: Digital Proficiency and Technological Skills
All COs mapped with PO7 because; digital proficiency and technological skills, as modern advancements in technology play a crucial role in the field of systematics and zoology. CO1 involves utilizing digital tools and technologies to access and analyze vast amounts of data related to organism classification and taxonomy. CO2 requires proficiency in using various software and computational tools for molecular systematics and numerical taxonomy.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy
All COs mapped with PO8 because; understanding the diversity of organisms and taxonomic systems inherently involves recognizing and respecting cultural perspectives on nature and classification. Developing multicultural competence fosters empathy towards different cultural approaches to systematics (CO1). Practicing systematics often involves collaboration with researchers from diverse cultural backgrounds (CO3).

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices
All COs mapped with PO9 because; developing a thorough understanding of systematics involves recognizing the intrinsic value of biodiversity and the importance of ethical practices in research and conservation efforts (CO1). Proficiency in methodologies in systematics requires awareness of ethical considerations in data collection, analysis, and interpretation, as well as a commitment to environmental stewardship (CO2)

PO10: Autonomy, Responsibility, and Accountability
All COs mapped with PO10 as they necessitate autonomy in learning, responsibility in applying knowledge, and accountability for outcomes. In systematics, students autonomously study diverse concepts, apply methodologies, conduct taxonomic collections responsibly, and adhere to nomenclature rules, while being accountable for accurate classification.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2024)

Name of the Program: M.Sc. Zoology
Program Code: ZOO
Class: M. Sc. II
Semester: III
Course Type: Major (Mandatory) Practical
Course Code: ZOO-603-MJM
Course Name: Zoology Practical- V
Number of Credits: 02
Number of Teaching hours: 60

Course Objectives:-

- Understand the histological organization and structural features of the stomach, intestine, lung, kidney, bone, and bone marrow.
- Develop proficiency in the preparation of permanent histological slides using microtomy techniques, focusing on tissues of the liver, intestine, or kidney.
- Learn and apply the Periodic Acid-Schiff (PAS) technique for the localization of glycogen within tissues.
- Master the Feulgen technique for the detection of nucleic acids within cellular structures.
- Gain expertise in staining techniques for the visualization of mucopolysaccharides within tissues.
- Acquire skills in staining lipids using Sudan Black B, enabling the identification of lipid-rich structures within cells.
- Understand the principles and methods for the detection of acid phosphatase and alkaline phosphatase, key enzymes involved in cellular metabolism and signaling pathways.

Course Outcomes:-

After completion of this course, students will be able to-:

CO1: demonstrate a comprehensive understanding of the histological organization and structural characteristics of the stomach, intestine, lung, kidney, bone, and bone marrow.
CO2: develop proficiency in the preparation of high-quality permanent histological slides, demonstrating competence in microtomy techniques and tissue sectioning.
CO3: apply the Periodic Acid-Schiff (PAS) technique effectively to accurately localize glycogen within tissues, demonstrating practical skills in histochemical staining methods.
CO4: utilize the Feulgen technique proficiently to detect nucleic acids within cellular structures, showcasing competence in specialized staining procedures.
CO5: successfully employ staining techniques to visualize mucopolysaccharides within tissues, demonstrating practical skills in histological staining methods.
CO6: demonstrate proficiency in staining lipids using Sudan Black B, enabling the identification and characterization of lipid-rich structures within cells.
CO7: apply principles and methods for the detection of acid phosphatase and alkaline phosphatase, showcasing understanding of enzymatic activity and its relevance in cellular metabolism and signaling pathways

PRACTICALS:

Practical No.	Title of Practical	E / D	Teaching hours
1.	Study of histological organization of stomach, intestine, lung, kidney, bone and bone marrow	D	4
2.	Preparation of permanent histological slides (microtomy) from tissues of liver / intestine / kidney (any one)	E	8
3.	Localization of glycogen by PAS technique	E	4
4.	Detection of nucleic acids by Feulgen technique	E	4
5.	Staining of Mucopolysaccharides	E	4
6.	Staining of lipids by Sudan Black B	E	4
7.	Detection of acid phosphatase and alkaline phosphatase	E	
8.	Anatomy of male and female reproductive system in rat /	E	4

	mice		
9.	Vaginal smear technique in mice	E/D	4
10.	Study of archectomy in white rat	D	4
11.	Study of ovarectomy in white rat	D	4
12.	Study of placenta	D	4
13.	Study of sperm morphology and sperm count	E	4
14.	Study of contraceptive devices	D	4
15.	Study of oestrous cycle	D	4

*E- Experiment D-Demonstration

Course Articulation Matrix of ZOO-603-MJM Zoology Practical- V
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

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

PO1: Comprehensive Knowledge and Understanding
CO1: This CO aligns closely with PO1 as it requires students to demonstrate a comprehensive understanding of histological organization and structural characteristics of various tissues, indicating a strong grasp of foundational knowledge in the field.

PO2: Practical, Professional, and Procedural Knowledge
CO2: Developing proficiency in preparing histological slides requires practical skills and procedural knowledge, which directly relate to PO2. Students need to demonstrate competence in microtomy techniques and tissue sectioning, reflecting practical and professional aptitude.

PO3: Entrepreneurial Mind-set, Innovation, and Business Understanding
CO3: While CO3 focuses on applying histochemical staining methods like the Periodic Acid-Schiff (PAS) technique, it indirectly relates to PO3 by fostering an understanding of innovative techniques and methodologies, which are essential for an entrepreneurial mind-set.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving
CO4: This CO directly correlates with PO4 as it emphasizes the development of specialized skills in utilizing staining techniques such as the Feulgen technique. Critical thinking and problem-solving are inherent in mastering specialized procedures.

PO5: Research, Analytical Reasoning, and Ethical Conduct
CO5: CO5 involves employing staining techniques to visualize mucopolysaccharides within tissues, which requires research, analytical reasoning, and adherence to ethical conduct, thus aligning with PO5.

PO6: Communication, Collaboration, and Leadership
CO6: CO6 involves proficiency in staining lipids and communicating findings, demonstrating collaboration skills necessary for effective teamwork. While it doesn't directly address leadership, effective communication and collaboration are fundamental aspects of leadership.

PO7: Digital Proficiency and Technological Skills
CO7: The application of principles and methods for detecting acid phosphatase and alkaline phosphatase involves technological skills and proficiency, directly aligning with PO7, which emphasizes digital proficiency.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy
No direct alignment was identified with the provided Course Outcomes. However, elements of cultural competence and empathy may be indirectly developed through collaborative and communicative aspects of the course.

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices
CO1, CO2, CO3, CO4, CO5, CO6, and CO7: While not directly addressed, the practice of ethical conduct in handling specimens and the consideration of environmental impact through proper disposal align with the values of ethical practices and environmental awareness.

PO10: Autonomy, Responsibility, and Accountability
All COs: Each CO indirectly contributes to fostering autonomy, responsibility, and accountability. Students are expected to independently carry out procedures, take responsibility for their work, and be accountable for ethical conduct and accurate results.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2024)

Name of the Program: M.Sc. Zoology
Program Code: ZOO
Class: M. Sc. II
Semester: III
Course Type: Major (Mandatory) Theory
Course Code: ZOO-604-MJM
Course Name: Zoology Practical - VI
Number of Credits: 04
Number of Teaching hours: 60

Course Objectives:-

- To identify key taxonomic characters and use them to classify animals into different phyla and orders.
- To gain proficiency in using identification keys to accurately identify specific animal species.
- To develop practical skills in collecting, preserving, and mounting insects for further study.
- To gain knowledge about setting up and maintaining a small-scale vermicomposting unit.
- To identify different beekeeping tools and explain their functionalities.
- To learn about common honey adulterants and how to detect them in samples.
- To develop skills in writing clear and concise reports based on laboratory experiments, field visits, and observations.

Course Outcomes:

After completion of this course, students will be able to-:

CO1: independently classify unknown animal specimens up to the order level based on taxonomic characteristics.
CO2: demonstrate the ability to use identification keys to effectively identify a variety of invertebrate and vertebrate species.
CO 3: collect, preserve, and mount insect specimens using appropriate techniques.
CO 4: understand and explain the process of setting up and maintaining a vermicomposting unit for organic waste management.
CO 5: identify and describe the use of beekeeping equipment
CO 6: analyze honey samples for adulteration using appropriate methods.
CO 7: produce well-organized scientific reports detailing observations, procedures, and results from laboratory experiments and field visits.

Practical No.	Title of Practical	E / D	Teaching hours
1.	Study of taxonomic characters, identification and classification (up to Orders) of members of Phylum Protozoa, Porifera, Coelenterate, Helminths, Annelids (one example from each).	D	4
2.	Study of taxonomic characters, identification and classification (up to Orders) of members of Phylum Arthropods, Molluscs and Echinoderms, Fishes, Amphibians (one example from each).	D	4
3.	Study of taxonomic characters, identification and classification (up to Orders) of members of Reptiles, Birds, Mammals and minor phyla (one example from each).	D	4
4.	Identification of animals with the help of keys-Housefly.	E	4
5.	Identification of animals with the help of keys-Honey bee.	E	4
6.	Identification of animals with the help of keys- Cockroach.	E	4
7.	Identification of animals with the help of keys- Earthworm.	E	4
8.	Study of techniques of collection, preservation and	E	4

	mounting of insects.		
9.	Preparation of small scale vermiculture unit	D/E	4
10.	Study of bee keeping equipment	D	4
11.	Setting and maintenance of bee box in college garden (activity based)		4
12.	Study of honey adulterants and their identification	D	4
13.	Temporary mounting of silk gland from silk moth larva	E	4
14.	Extraction of casein from milk and its confirmatory test	E	4
15.	A visit to sea shore / vermiculture unit / pearl farming centre / apiculture centre / sericulture centre and submission of report	-	4
16.	Visits to Scientific Institute like Zoological Survey of India and Report writing	-	4

*E- Experiment D-Demonstration

Course Articulation Matrix of ZOO-604-MJM: Zoology Practical - VI
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

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

PO1: Comprehensive Knowledge and Understanding
All COs require some understanding of biological concepts. Even CO4 (vermicomposting) requires basic knowledge of the process.

PO2: Practical, Professional, and Procedural Knowledge
CO1, CO2, CO3, CO5, and CO6 all involve practical skills in identification, specimen collection, equipment use, and analysis. CO4 (vermicomposting) requires practical skills in setting up and maintaining a unit, but may not be as professionalized. CO7 emphasizes writing reports, a transferable skill.

PO3: Entrepreneurial Mindset, Innovation, and Business Understanding
The focus here is on animal and insect identification, beekeeping equipment, and scientific skills. There's not a direct link to business or innovation in most COs. CO4 (vermicomposting) might have a low contribution to understanding business aspects of organic waste management.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving
CO1, CO2, CO3, CO5, and CO6 all require using identification keys, analyzing data (adulteration), and potentially troubleshooting issues. CO4 (vermicomposting) may involve problem-solving during setup or maintenance. CO7 requires critical thinking when organizing and interpreting scientific data.

PO5: Research, Analytical Reasoning, and Ethical Conduct
Analytical Reasoning: Even seemingly basic COs like CO1 (animal classification) or CO2 (identification using keys) involve analyzing characteristics and data to reach a conclusion. Research Skills: CO6 (honey adulteration analysis) directly uses analytical methods found in research. Other COs may involve referencing scientific information during learning. Ethical Conduct: Scientific practices emphasize accurate recording of data and responsible specimen collection (CO3). CO7 (report writing) reinforces ethical considerations in scientific reporting.

PO6: Communication, Collaboration, and Leadership
Communication: CO7 (report writing) is a core communication skill in science. Other COs may involve presenting findings or discussing identification techniques. Collaboration: While not the main focus, some COs might involve working in pairs during laboratory experiments or field visits. Leadership: Not a major focus in these specific COs, but leadership qualities could emerge during group discussions or presentations.

PO7: Digital Proficiency and Technological Skills
CO7 (Report Writing): Using software for data analysis or report generation.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy
The main focus is on animal and insect sciences, but there might be low-level contributions depending on the curriculum: Field Visits (CO7): If field visits involve interacting with people from diverse backgrounds.

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices
All COs deal with biological sciences and potentially touch upon environmental aspects: CO1-CO6: Understanding animal/insect life and beekeeping practices can promote environmental awareness. CO4 (Vermicomposting): Directly related to organic waste management and environmental sustainability. CO7 (Report Writing): Scientific reporting emphasizes ethical data collection and presentation.

PO10: Autonomy, Responsibility, and Accountability
This PO focuses on independent work and managing projects. There might be a low contribution in some COs: CO7 (Report Writing): Requires some independent work and responsibility for presenting findings.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2024)

Name of the Program: M.Sc. Zoology
Program Code: ZOO
Class: M. Sc. II
Semester: III
Course Type: Major Elective) Theory
Course Code: ZOO-611-MJE (A)
Course Name: Ichthyology
Number of Credits: 02
Number of Teaching hours: 30

Course Objectives: -

- Classify fishes up to the order level, including extant Cyclostomata, Chondrichthyes, and Osteichthyes.
- Construct a phylogenetic tree to represent the evolutionary relationships among fishes.
- Describe the external morphology of fishes, encompassing body form, appendages, pigmentation, skin, and scales.
- Explain the structure of the fish endoskeleton, including the skull, axial skeleton, and appendicular skeleton.
- Discuss the various feeding habits of fishes and the corresponding modifications of their digestive systems.
- Describe the structure and function of fish gills, including adaptations for air breathing in specific species.
- Explain the role of the air bladder in both respiration and buoyancy for fishes.

Course Outcomes: -

After completion of this course students will-

CO1: accurately classify fish species up to the order level, including extant Cyclostomata, Chondrichthyes, and Osteichthyes.
CO2: construct a phylogenetic tree that visually represents the evolutionary relationships among different fish groups
CO3: comprehensively describe the external morphology of fishes, including body form, appendages, pigmentation, skin, and scales.
CO4: explain the structure of the fish endoskeleton, encompassing the skull, axial skeleton, and appendicular skeleton
CO5: analyze the relationship between various feeding habits of fishes and the corresponding modifications of their digestive systems.
CO6: describe the structure and function of fish gills, including adaptations for air breathing in specific fish species.
CO7: explain the role of the air bladder in both respiration and buoyancy for fishes.

TOPICS:

Unit No.	Subunit No.	Details	Teaching Hours
1. Classification and Diagnostic Characters (up to orders)	1.1	Extant Cyclostomata, Chondrichthyes and Osteichthyes (9 major orders of fishes)	**4**
	1.2	Phylogeny of fishes	
2. External morphology	2.1	Body form, appendages, pigmentation, skin, and scales	**4**
3. Endoskeleton	3.1	Skull	**5**
	3.2	Axial Skeleton	
	3.3	Appendicular skeleton	
4. Digestion	4.1	Food and feeding habits	**5**
	4.2	Digestive system and its anatomical	

		modifications.	
5. Respiration	5.1	Structure and functions of gills	**6**
	5.2	Adaptations for air breathing	
	5.3	Role of air bladder in respiration and buoyancy	
6. Excretion and Osmoregulation	6.1	Glomerular and aglomerular kidneys	**6**
	6.2	Nitrogen (Ammonia, Urea and TMAO) excretions	

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3. Hoar, W.S. and D.J. Randall, (1969). Fish Physiology. Vols. I onwards, Academic Press, New York
4. Jayaram, K.C. (1981). The freshwater fishes of India. Pakistan, Bangladesh, Burma and Sri Lanka- A Handbook. Zool. Survey of India, Academic Press, New York.
5. Khanna, S.S. (1984). An Introduction to Fishes. Central Book Depot., Allahabad.

Course Articulation Matrix of ZOO-611-MJE (A) Ichthyology
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

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

PO1: Comprehensive Knowledge and Understanding
CO1, CO2, CO3, CO4, CO5, CO6 & CO7 All these COs directly contribute to building a strong foundation of knowledge about fish biology, encompassing their classification, evolution, morphology, anatomy, and physiological adaptations.

PO2: Practical, Professional, and Procedural Knowledge
CO1, CO3, CO5&CO6 These COs involve skills like identification, analysis of morphological features, and understanding of structure-function relationships in fish. These are all valuable for careers in fisheries management, aquaculture, or environmental biology.

PO3: Entrepreneurial Mindset, Innovation, and Business Understanding
CO5& CO6 Knowledge of fish feeding adaptations and respiratory systems can be crucial for developing innovative solutions in aquaculture, fisheries management, or even biomimicry for technological advancements.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving
CO1, CO2& CO5 Classifying fish, constructing phylogenetic trees, and analyzing feeding adaptations all require critical thinking, problem-solving skills, and the application of specialized knowledge in fish biology.

PO5: Research, Analytical Reasoning, and Ethical Conduct
CO2, CO5 &CO7 Constructing phylogenetic trees involves analyzing data and drawing conclusions about evolutionary relationships. Understanding feeding adaptations and the air bladder's role requires analyzing the

relationship between structure and function. These all contribute to research and analytical skills.

PO6: Communication, Collaboration, and Leadership
If the course involves group projects or presentations on fish biology topics, then: **CO1, CO2, CO3, CO4, CO5, CO6 CO7** Communicating these concepts effectively through presentations or reports would contribute to this PO.

PO7: Digital Proficiency and Technological Skills
If the course utilizes digital tools for simulations, data analysis, or creating phylogenetic trees. **CO2** Constructing phylogenetic trees might involve using specialized software, contributing to digital proficiency.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy
While not a direct fit, knowledge of fish biology can contribute to an appreciation of biodiversity and the interconnectedness of ecosystems.

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices
CO3, CO5, CO6 & CO7 Understanding fish morphology, adaptations, and the role of the air bladder fosters awareness of the importance of fish health and the impact of environmental changes on these organisms.

PO10: Autonomy, Responsibility, and Accountability
All Cos If students are expected to independently learn and demonstrate their understanding of fish biology concepts, this could contribute to developing autonomy and responsibility.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2024)

Name of the Program: M.Sc. Zoology
Program Code: ZOO
Class: M. Sc. II
Semester: III
Couse Type: Major (Elective) Theory
Course Code: ZOO-611-MJE (B)
Course Name: Comparative Animal Physiology
Number of Credits: 02
Number of Teaching hours: 30

Course Objectives: -

- Gain knowledge of diverse nutritional strategies and special dietary needs in animals.
- Analyze food intake, feeding mechanisms, and compare the physiological processes of digestion in different animal species.
- Explore the regulation of digestion, including the involvement of the visceral autonomic system and gastrointestinal hormones.
- Compare respiratory surfaces and ventilation strategies associated with gills and pulmonary respiration.
- Understand the ultrastructure of skeletal muscles and the molecular mechanisms involved in muscle contraction.
- Investigate concepts of osmole, osmolality, tonicity, and the osmoregulatory mechanisms in different environments.
- Explore biokinetic zones, thermos-biological terminologies, and comparative thermoregulatory mechanisms in poikilotherms and homeotherms.

Course Outcomes: -

After completion of this course Students will be able to -

CO1: apply knowledge of varied nutrition types and special dietary needs to address real-world scenarios.
CO2: demonstrate competence in understanding food intake, feeding mechanisms, and the comparative physiology of digestion.
CO3: proficiently apply knowledge of the regulatory aspects of digestion, including the visceral autonomic system and gastrointestinal hormones.
CO4: exhibit expertise in comparing respiratory surfaces and ventilation mechanisms associated with gills and pulmonary respiration.
CO5: master the understanding of skeletal muscle ultrastructure and the intricacies of molecular mechanisms in muscle contraction.
CO6: demonstrate expertise in applying concepts of osmole, osmolality, tonicity, and understanding osmoregulation in diverse environments.
CO7: demonstrate proficiency in applying knowledge of biokinetic zones, thermos-biological terminologies, and comparative thermoregulatory mechanisms in different temperature conditions.

TOPICS:

Unit No.	Subunit No.	Details	Teaching Hours
1. Digestion	1.1	Types of nutrition, special dietary requirements of animals	**4**
	1.2	Food intake and feeding mechanisms, Comparative physiology of digestion	
	1.3	Regulation of digestion - Visceral autonomic system and gastro-intestinal hormones	
2. Respiration	2.1	Respiratory Surfaces: Comparison of ventilation associated with gills and pulmonary respiration	**4**
	2.2	Comparative physiology of respiration, regulation of respiration	
	3.1	Ultrastructure of the skeletal muscle	**4**

3.Muscle anatomy and physiology	3.2	Proteins of the myofilaments	
	3.3	Neuro-Muscular Junction	
	3.4	Sliding filament theory	
	3.5	Sarcoplasmic reticulum and role of Ca++ in contraction	
4. Osmotic Regulation	4.1	Concepts of osmole, osmolality and tonicity, ionic regulation	**4**
	4.2	Osmoregulation and biological responses in different environments	
	4.3	Ureosmotic animals	
5. Physiology of Excretion	5.1	Comparative mechanism of urine formation	**4**
	5.2	Renal pressure system	
	5.3	Comparative biochemistry of nitrogen Excretion	
6. Temperature Regulation	6.1	Biokinetic Zones, Thermobiological terminologies	**4**
	6.2	Critical temp, and zone of thermal neutrality, comparative thermoregulatory mechanisms in poikilotherms and homeotherms	
7. Nervous System Neurophysiology	7.1	Comparative physiology of nervous system: Origin and conduction of nerve impulse, nerve excitation	**3**
8. Sense Organs	8.1	Classification & functions of sensory organs (details of photoreception as a model)	**3**

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2. Hill, R. W., Wyse, G. A. (1989). Animal physiology. India: Harper & Row.
3. Withers, P. C. (1992). Comparative Animal Physiology. Austria: Saunders College Pub.
4. Willmer, P., Stone, G., & Johnston, I. (2009). Environmental physiology of animals. John Wiley & Sons.

Course Articulation Matrix of ZOO-611-MJE (B) Comparative Animal Physiology
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

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

PO1: Comprehensive Knowledge and Understanding
All COs mapped with PO1. All COs require a strong foundation in human physiology. Students will need to understand the digestive, respiratory, muscular, and thermoregulatory systems, as well as osmoregulation concepts.

PO2: Practical, Professional, and Procedural Knowledge
All COs mapped with PO2. While the course content focuses on applying knowledge, it likely wouldn't involve professional procedures directly used in healthcare settings.

PO3: Entrepreneurial Mindset, Innovation, and Business Understanding
All COs mapped with PO3. There might be some connections to understanding the nutritional needs of specific populations for businesses, but this isn't a central theme.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving
All COs mapped with PO4. Applying knowledge to various physiological systems and real-world scenarios (CO1) requires critical thinking and problem-solving skills. Students will need to analyze information, compare mechanisms across different organisms (CO4), and understand the complexities of physiological processes (CO5, CO6, CO7).

PO5: Research, Analytical Reasoning, and Ethical Conduct
All COs mapped with PO5. The coverage of physiological processes (CO1-CO7) provides trans-disciplinary knowledge, linking animal physiology with broader biological concepts, nutrition, and environmental adaptation. The focus might be more on understanding established physiological concepts rather than designing original research or in-depth ethical considerations related to human studies.

PO6: Communication, Collaboration, and Leadership
All COs mapped with PO6. CO1-CO7 collectively enhances personal and professional competence, equipping students with a comprehensive understanding of animal physiology applicable in various professional settings. While explaining physiological concepts might involve communication, the course description doesn't emphasize collaboration or leadership.

PO7: Digital Proficiency and Technological Skills
All COs mapped with PO7. While not explicitly addressed, there might be some use of digital resources or simulations in specific lessons related to animal nutrition and well-being.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy.
All COs mapped with PO8. The course content might touch on physiological variations across populations, but multicultural competence and empathy aren't explicitly addressed in the listed COs.

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices
All COs mapped with PO9. While understanding human physiology can promote healthy lifestyle choices, environmental awareness and ethical practices aren't central themes in the listed COs.

PO10: Autonomy, Responsibility, and Accountability
All COs mapped with PO10. The focus is on applying knowledge, but the course description doesn't explicitly emphasize taking responsibility for personal health or broader societal implications.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2024)

Name of the Program: M.Sc. Zoology
Program Code: ZOO
Class: M. Sc. II
Semester: III
Couse Type: Major (Elective) Practical
Course Code: ZOO-612-MJE (A)
Course Name: Ichthyology Lab
Number of Credits: 02
Number of Teaching hours: 60

Course Objectives: -

- Identify and describe general external characteristics of fishes, including fins and scales.
- Perform morphometric measurements on a freshwater fish and analyze the data.
- Evaluate the length-weight relationship for a chosen freshwater fish species.
- Calculate and interpret gonosomatic and hepatosomatic indices in a specific fish.
- Classify locally available fish species to the genus level using provided diagnostic keys.
- Describe adaptations present in fishes, such as adhesive organs, accessory respiratory organs, stomachless fish, and specific anatomical structures.
- Compare and contrast the anatomical features of digestive and reproductive systems in different fish species (e.g. carp, catfish, *Tilapia*).

Course Outcomes: -

After completion of this course Students will be able to -

CO1: identify and describe the key external characteristics of fishes, including the different types of fins and scales.
CO2: conduct morphometric measurements on a freshwater fish, record data accurately, and analyze the data to obtain meaningful insights.
CO3: determine the length-weight relationship of a chosen freshwater fish species and interpret the results.
CO4: calculate gonosomatic and hepatosomatic indices for a specific fish and explain the biological significance of these indices.
CO5: accurately classify locally available fish species to the genus level using provided diagnostic keys.
CO6: describe and explain the various adaptations present in fishes, including adhesive organs, accessory respiratory organs, stomachless fish, and specific anatomical structures.
CO7: compare and contrast the anatomical features of the digestive and reproductive systems in different fish species, such as carp, catfish, and *Tilapia*.

Practicals:

Practical No.	Name of the practical	E/D	Teaching Hours
1	Study of external characters of fishes	**D**	**4**
2	Study of fish scales and chromatophores	**E**	**4**
3	Study of morphometric analysis of locally available freshwater fish	**E**	**4**
4	Study of length-weight relationship of locally available freshwater fish	**E**	**4**
5	Study of gonosomatic indices of locally available freshwater fish	**E**	**4**
6	Study of hepatosomatic indices of locally available freshwater fish	**E**	**4**
7	Classification of locally available fishes upto order level with the use of diagnostic keys	**E**	**8**
8	Study of adaptations in fishes (adhesive organs, accessory respiratory organs,stomachless fish, spiral valve, rostral spines etc.)	**D**	**4**
9	Anatomical observations and demonstration of digestive system of carp/ catfish/ Tilapia	**E**	**4**

10	Anatomical observations and demonstration of reproductive system of carp/ catfish/ Tilapia	**E**	**4**
11	Study of endoskeleton of fish	**E**	**8**
12	Study of common diseases in fish, their diagnosis and controls strategies	**D**	**4**
13	Detection of nitrogenous waste products from given water sample	**E**	**4**
14	Visit to fish farm/fish market/any aquarium and submission of report		**4**

*E- Experiment D-Demonstration

Course Articulation Matrix of ZOO-612-MJE (A) Ichthyology Lab
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

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

PO1: Comprehensive Knowledge and Understanding
All COs contribute to building a strong foundation in fish biology by requiring knowledge of fish anatomy, classification, and adaptations

PO2: Practical, Professional, and Procedural Knowledge
CO2, CO3, CO4, and CO5 all involve practical skills like fish morphometrics, data analysis, and fish identification using keys. These skills are valuable in fisheries research or management.

PO3: Entrepreneurial Mindset, Innovation, and Business Understanding
This PO has a weaker connection to the listed COs. However, knowledge of fish adaptations (CO6) could be relevant for biomimicry applications in product design.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving
CO2, CO3, CO4, and CO5 all require applying fish biology knowledge, data analysis, and critical thinking to interpret measurements and indices.

PO5: Research, Analytical Reasoning, and Ethical Conduct
CO2, CO3, CO4, and CO7 involve data collection, analysis, and interpretation, which are all essential research skills.

PO6: Communication, Collaboration, and Leadership
If the course involves presenting findings or group work on fish anatomy, then CO2, CO3, CO4, CO5, and CO7 could contribute to this PO.

PO7: Digital Proficiency and Technological Skills
Not directly applicable to these COs unless the course uses specialized software for fish identification or data analysis.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy.
While not a direct fit, knowledge of fish biology can contribute to an appreciation of biodiversity and the interconnectedness of ecosystems.

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices
Understanding fish anatomy and adaptations (CO1, CO6, CO7) can foster appreciation for biodiversity and the importance of healthy ecosystems

PO10: Autonomy, Responsibility, and Accountability
This may apply less directly in this context. However, depending on assessment methods (e.g., independent research projects), CO2, CO3, CO4, and CO5 could contribute to developing autonomy and responsibility.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2024)

Name of the Program: M.Sc. Zoology
Program Code: ZOO
Class: M. Sc. II
Semester: III
Couse Type: Major (Elective) Practical
Course Code: ZOO-612-MJE (B)
Course Name: Comparative Animal Physiology Lab
Number of Credits: 02
Number of Teaching hours: 60

Course Objectives: -

- Investigate the effect of temperature, pH, and inhibitors on salivary amylase activity to understand enzymatic hydrolysis of starch.
- Examine the structure and functions of taste buds and tongue papillae in relation to sensory perception.
- Compare the excretory systems of different animal species, such as kidneys, Malpighian tubules, and nephridia, to understand variations in waste excretion strategies.
- Analyze the nitrogenous waste products of animals from different habitats to explore adaptations to varying environmental conditions.
- Assess the effect of body size on oxygen consumption in aquatic animals (e.g., crab/fish) to understand metabolic scaling.
- Investigate the impact of salt concentration on oxygen consumption in aquatic animals to determine osmoregulatory responses.
- Determine heart rate and explore the effects of temperature and ions on cardiac function in crabs, focusing on physiological adaptations.

Course Outcomes: -

After completion of this course Students will be able to -

CO1: Demonstrate an understanding of the factors influencing enzymatic activity, such as temperature, pH, and inhibitors, through experimental investigation of salivary amylase hydrolysis of starch.
CO2: Explain the relationship between taste buds, tongue papillae, and sensory perception by examining their structures and functions.
CO3: Compare and contrast the excretory systems of various animal species, including kidneys, Malpighian tubules, and nephridia, to analyze the variations in waste excretion strategies.
CO4: Evaluate the adaptations of animals from different habitats through the analysis of their nitrogenous waste products, elucidating how these adaptations enable survival in varying environmental conditions.
CO5: Analyze the relationship between body size and oxygen consumption in aquatic animals, such as crabs and fish, to understand metabolic scaling principles.
CO6: Investigate the osmoregulatory responses of aquatic animals to changes in salt concentration, elucidating how these organisms maintain internal balance despite external fluctuations.
CO7: Determine the effects of temperature and ions on cardiac function in crabs by assessing heart rate variations, highlighting physiological adaptations to environmental factors.

Practicals:

Practical No.	Name of the practical	E/D	Teaching Hours
1	Effect of temperature, pH and inhibitor on salivary amylase activity	**E**	**4**
2	Study of Enzymatic hydrolysis of starch	**E**	**4**
3	Study of structure and functions of taste bud and tongue papillae	**D**	**4**
4	Compare excretory systems in different animal species (e.g., kidneys, Malpighian tubules, nephridia)	**D**	**4**
5	Study of nitrogenous waste products of animals from different habitats		**4**
6	Effect of body size on oxygen consumption in aquatic animals (crab/fish)	**E**	**4**

7	Effect of salt concentration on oxygen consumption in aquatic animals		**4**
8	Estimation of sugar and chloride content in rat / crab	**E**	**4**
9	Determination of heart beat and effect of temperature & ions in crab	**E**	**4**
10	Effect of eye stalk ablation on chloride & glucose in the hemolymph of the crab	**E**	**4**
11	Determination of oxalic acid in the mammalian urine by titration method	**E**	**4**
12	To perform physical examination of urine. (color, pH, Specific gravity and total solids)	**E**	**4**
13	Study of osmotic stress on RBCs.		**4**
14	Effect of salt concentration on volume change in earthworm	**E**	**4**
15	Effect of temperature on water loss in cockroach	**E**	**4**
16	Measurement of lung capacity. 1P		**4**
17	Preparation of glycerinated muscle fiber and study of its structure and functions	**E**	**4**
18	Determination of uric acid concentration in serum	**E**	**4**
19	To estimate creatinine in given sample of blood	**E**	**4**

*E- Experiment D-Demonstration

Course Articulation Matrix of ZOO-612-MJE (B) Comparative Animal Physiology Lab
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

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

PO1: Comprehensive Knowledge and Understanding
All COs mapped with PO1. CO1, CO2, CO3 are require students to demonstrate understanding of fundamental biological concepts related to enzymes, taste perception, and excretory systems. CO4, CO5, CO6 and CO7 are delve deeper into specific topics within animal physiology, demanding a grasp of complex physiological adaptations.

PO2: Practical, Professional, and Procedural Knowledge
All COs mapped with PO2. CO1, CO6, CO7 are involve laboratory activities or investigations, equipping students with practical skills in scientific methods and data collection.

PO3: Entrepreneurial Mindset, Innovation, and Business Understanding
All COs mapped with PO3. While not explicitly addressed, skills for clinical samples analysis can be achieved by the student which will increase scope towards pathology studies.

PO4: Specialized Skills, Critical Thinking, and Problem-Solving
All COs mapped with PO4. CO1, CO2, CO3 and CO4 Analyzing and comparing processes like enzymatic activity, waste excretion, and nitrogenous waste product formation require critical thinking and problem-solving skills. CO5, CO6, CO7 are involve interpreting data, drawing connections between physiological adaptations and environmental factors, promoting critical thinking.

PO5: Research, Analytical Reasoning, and Ethical Conduct
All COs mapped with PO5. CO1, CO6, CO7 are encourage students to design and conduct experiments, analyze data, and draw conclusions, fostering research and analytical reasoning skills.

PO6: Communication, Collaboration, and Leadership
All COs mapped with PO6. While not explicitly addressed, but may be incorporated through group projects or presentations.

PO7: Digital Proficiency and Technological Skills
All COs mapped with PO7. While not explicitly addressed, but may be introduced through using digital tools for data analysis.

PO8: Multicultural Competence, Inclusive Spirit, and Empathy.
All COs mapped with PO8. While not explicitly addressed. Not directly applicable to this specific course).

PO9: Value Inculcation, Environmental Awareness, and Ethical Practices
All COs mapped with PO9. While not explicitly addressed, but indirectly addressed through responsible conduct of scientific experiments.

PO10: Autonomy, Responsibility, and Accountability
All COs mapped with PO10. CO1, CO6 and CO7 are encouraged independent learning and experimentation, fostering autonomy and responsibility in conducting scientific inquiry.

SYLLABUS (CBCS) FOR M. Sc. ZOOLOGY as per NEP 2020
(w. e. f. June, 2024)

Name of the Program: M.Sc. Zoology
Program Code: ZOO
Class: M. Sc. II
Semester: III
Couse Type: Major (Elective) Practical
Course Code: ZOO-621-RP
Course Name: Research Project
Number of Credits: 04
Number of Teaching hours: 60

The research project course would involve:

a) Literature survey,

b) Planning and execution of experimental work,

c) Analysis of data and its presentation.

Studies would utilize few of the practicals from their course more intensively for this course. **Project should start at third** semester and **will be assessed at the end of third semester**. The experimentation work during the project should be equivalent to minimum 15 practicals in the semester.

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