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 -II

For P.G. Department of Zoology

Tuljaram Chaturchand College of Arts, Science & Commerce, Baramati

Choice Based Credit System Syllabus (2023 Pattern)

(As Per NEP 2020)

To be implemented from Academic Year 2023-2024

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

Preamble

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

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

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

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

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

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

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

Programme Specific Outcomes (PSOs)

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

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

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

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

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

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

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

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

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

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

Anekant Education Society's
Tuljaram Chaturchand College
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Board of Studies (BoS) in Zoology

From 2022-23 to 2024-25

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

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

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

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

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

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

Name of the Program: M.Sc. Zoology
Program Code: PSZOO
Class: M. Sc. I
Semester: II
Couse Type: Major (Mandatory) Theory
Course Code: ZOO-551-MJM
Course Name: Molecular Biology
Number of Credits: 04
Number of Teaching hours: 60

Course Objectives:-

- To define DNA's basic elements and models
- To educate students about DNA replication modes and key experiments.
- To differentiate between euchromatin and heterochromatin, and understand histone's role in chromatin.
- To teach the prokaryotic genome organization, genes, and genome size concepts.
- To familiarize students with DNA damage types and repair systems.
- To describe transcription units, RNA polymerase, and mechanisms (initiation, elongation, termination).
- To introduce students with concepts of prokaryotic operon models and process of lambda phage regulation.

Course Outcomes:-

After completion of this course, student will be able to

CO1: define the basic elements and models of DNA
CO2: explain the two main modes of DNA replication
CO3: explain the role of histones in chromatin packaging and gene expression.
CO4: describe the organization of the prokaryotic genome.
CO5: identify and describe the different types of DNA damage
CO6: elucidate the step-by-step mechanisms of transcription
CO7**:** develops comprehensive understanding regarding DNA damage and repair mechanism

Topics:

Unit No.	Subunit No	Details	Teaching Hours
1. DNA Structure	1.1	Basic elements of DNA	6
	1.2	Watson-Crick model of DNA	
	1.3	Types of DNA -A, B & Z forms	
	1.4	Physical properties of DNA: Tm, hypo and hyperchromicity, solubility, mutarotation and buoyancy	
2. DNA Replication	2.1	Modes of DNA replication	7
	2.2	Meselson and Stahl experiment	
	2.3	Prokaryotic and eukaryotic DNA	
	2.4	Enzymes and accessory proteins involved in DNA replication	

	2.5	Mechanism of DNA replication	
	2.6	Inhibitors of replication	
3. Structure of chromatin and nucleosome	3.1	Chromatin organization (higher order organization)	6
	3.2	Chromatin structure: Euchromatin, heterochromatin,	
	3.3	Histones and its effect on structure and function of chromatin	
4. Genome organization	4.1	Organization of prokaryotic genome and concept of gene	6
	4.2	Repetitive sequences and non-repetitive DNA sequences, clusters and repeats.	
	4.3	Intron and exon	
	4.4	Genome size of different organisms, C-value and C value paradox	
	4.5	Cot curves, Cot ½	
5.DNA Damage and Repair	5.1	Types of DNA damage, DNA repair systems	7
	5.2	Light dependent repair system: Photoreactivation.	
	5.3	Light independent repair system: Nucleotide excision repair, base excision repair, mismatches repair, recombination repair, Error prone repair and SOS response	
6. Prokaryotic & Eukaryotic Transcription	6.1	Transcriptional unit in prokaryotes and eukaryotes	10
	6.2	RNA polymerase, types RNA and its structure	
	6.3	Role and significance of promoter, enhancer, intron, exon, silencer, transcriptional factors	
	6.4	Mechanism of prokaryotic and eukaryotic transcription (Initiation, elongation & termination)	
	6.5	Post transcriptional modifications-5' capping, 3' polyadenylation, splicing and editing	
	6.6	Inhibitors of transcription	
7. Prokaryotic & Eukaryotic Translation	7.1	Genetic Code, differences in prokaryotic, mitochondrial and eukaryotic genetic codes	8
	7.2	Structure of ribosomes	
	7.3	Translation in prokaryotes and eukaryotes	
	7.4	Post-translational modifications	
	7.5	Inhibitors of protein synthesis	
8. Introduction to transposable elements	8.1	Definition & types of Transposable elements	2
9. Regulation of Gene Expression	9.1	Operon model of gene regulation in prokaryotes	8
	9.2	Lac and Tryptophan operons	
	9.3	Lytic cascade and lysogenic repression in lambda	

REFERENCES

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Course Articulation Matrix of ZOO-551-MJM: Molecular Biology
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	2	1
CO2	1	3	2	1	2	1	1	2	1	1
CO3	2	3	2	3	2	1	1	1	1	1
CO4	3	2	1	1	3	1	1	1	1	1
CO5	1	1	2	2	1	1	1	3	1	1
CO6	3	1	1	1	1	1	1	1	1	1
CO7	1	2	2	2	1	2	1	1	1	1

Program Outcome (PO)	Course Outcome (CO)	Justification
PO1: Comprehensive Knowledge and Understanding	CO1: Define the basic elements and models of DNA	CO1 builds foundational knowledge of DNA structure and models (PO1).
	CO2: Explain the two main modes of DNA replication	CO2 deepens understanding of the fundamental processes of DNA replication (PO1).
	CO3: Explain the role of histones in chromatin packaging and gene expression.	CO3 expands knowledge of how DNA interacts with proteins to regulate gene expression (PO1).
	CO4: Describe the organization of the prokaryotic genome.	CO4 strengthens understanding of the structural organization of genetic material in prokaryotes (PO1).
	CO5: Identify and describe the different types of DNA damage	CO5 equips students with knowledge of various types of DNA damage and their implications (PO1).
	CO6: Elucidate the step-by-step mechanisms of transcription	CO6 builds understanding of the detailed steps involved in the process of transcription (PO1).
	CO7: Develops comprehensive understanding regarding DNA damage and repair	CO7 expands knowledge of the mechanisms by which cells repair DNA damage (PO1).

	mechanisms	
PO2: Practical, Professional, and Procedural Knowledge	(Indirect Correlation - CO5, CO6, CO7)	While the course might not involve extensive practical work, understanding DNA damage (CO5), transcription (CO6), and repair mechanisms (CO7) is valuable for professions like genetic engineering or diagnostics (PO2).
PO3: Entrepreneurial Mindset, Innovation, and Business Understanding	(Indirect Correlation - All COs)	Knowledge of molecular biology (all COs) can be applied to develop new technologies in areas like gene therapy, personalized medicine, or bioengineering (PO3).
PO4: Specialized Skills, Critical Thinking, and Problem-Solving	CO3: Explain the role of histones in chromatin packaging and gene expression.	CO3 involves critical thinking about how DNA-protein interactions influence gene regulation (PO4).
	CO5: Identify and describe the different types of DNA damage	CO5 necessitates critical thinking to analyze the causes and consequences of various DNA damage types (PO4).
	CO6: Elucidate the step-by-step mechanisms of transcription	CO6 requires critical thinking to understand the complex and coordinated process of transcription (PO4).
	CO7: Develops comprehensive understanding regarding DNA damage and repair mechanisms	CO7 involves critical thinking about the intricate mechanisms by which cells identify and repair DNA damage (PO4).
PO5: Research, Analytical Reasoning, and Ethical Conduct	(Indirect Correlation - All COs)	Knowledge of molecular biology (all COs) forms the basis for designing and conducting research in various fields of life sciences, emphasizing ethical considerations (PO5).
PO6: Communication, Collaboration, and Leadership	(Indirect Correlation)	The course can encourage communication through presentations on topics like DNA structure, replication, or gene expression (PO6).
PO7: Digital Proficiency and Technological Skills	(Indirect Correlation)	The course might involve using online resources or databases to access information related to molecular biology (PO7).
PO8: Multicultural Competence, Inclusive Spirit, and Empathy	(Indirect Correlation)	Knowledge of molecular biology underpins the universality of genetic principles in all living organisms (PO8).
PO9: Value Inculcation, Environmental Awareness, and Ethical Practices	(Indirect Correlation - CO5, CO7)	Understanding DNA damage (CO5) and repair mechanisms (CO7) can raise awareness of environmental factors influencing mutations and the importance of responsible research practices (PO9).
PO10: Autonomy, Responsibility, and Accountability	(Indirect Correlation)	By successfully navigating the complexities of molecular biology concepts, students demonstrate a sense of autonomy and responsibility in their learning (PO10).

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

Name of the Program: M.Sc. Zoology
Program Code: PSZOO
Class: M. Sc. I
Semester: II
Couse Type: Major (Mandatory) Theory
Course Code: ZOO-552-MJM
Course Name: Developmental Biology
Number of Credits: 04
Number of Teaching hours: 60

Course Objectives:-

- Understand the basic concepts of developmental biology.
- Comprehend gametogenesis and its regulation.
- Explore fertilization and its significance.
- Analyze post-fertilization events and embryonic development.
- Examine the role of organizers in embryonic development.
- Development of *Drosophila* and axis formation.
- Investigate neural competence, induction, and other developmental processes.

Course Outcomes:-

After completion of this course students will be able to
CO1: explain the fundamental principles of developmental biology.
CO2: gain knowledge about the processes of gametogenesis.
CO3: learn about the fertilization processes.
CO4: explain the post-fertilization events and embryonic development
CO5: grasp the concept of organizers and their role in development.
CO6: gain insight into the development of *Drosophila*.
CO7: explain the processes of animal development.

TOPICS:

Unit No.	Subunit No.	Details	Teaching Hours
1. Introduction to Basic concepts of Developmental Biology	1.1	Growth (Animal & Plant)	**5**
	1.2	Commitment- Specification & Determination	
2. Gametogenesis	2.1	Spermatogenesis	**6**
	2.2	Regulation of sperm motility (Role of tail fibre complex and dynein ATPase, pH and divalent cation)	
	2.3	Oogenesis	
	2.4	Types of eggs with examples	
	2.5	Vitellogenesis and its regulation	

3. Fertilization	3.1	Fertilization- Types	**8**
	3.2	Pre- fertilization events - Capacitation, acrosome reaction & signal transduction	
	3.3	Polyspermy	
	3.4	Species-specificity in fertilization	
	3.5	Significance of fertilization	
4. Post- Fertilization Events	4.1	Plane & types of cleavages	**10**
	4.2	Blastulation and types of blastulae	
	4.3	Gastrulation: process of gastrulation	
	4.4	Extra embryonic membranes in chick **and mammals**	
	4.5	Development & Axis formation in *C. elegans* (including vulva formation), Sea urchin, *Xenopus* and Mammals	
5. Organizers:	5.1	Basic concept of organizer	**5**
	5.2	Role of organizers in *X. laevis*, Zebra fish, Chick and Mammal	
6. Development of *Drosophila* and axis formation			**8**
7. Neural competence and molecular signaling during neural induction	7.1	Neural competence	**3**
	7.2	Neural induction	
8. Eye lens induction and limb development in Frog	8.1	Eye lens induction in frog	**4**
	8.2	Limb development in frog	
9. Regeneration	9.1	Introduction to regeneration	**5**
	9.2	Types of regeneration (Stem cell mediated, epimorphosis, morpholaxis and compensatory)	
10. Cell death and senescence	10.1	Apoptosis and necrosis	**5**
	10.2	Apoptosis: Mitosis mediated, intrinsic and extrinsic pathways	
	10.3	Aging and senescence	
	10.4	Hayflick's Limit	
11. Ethics in cloning			**1**

REFERENCES

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Course Articulation Matrix of ZOO-552-MJM: Developmental Biology
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

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

Program Outcome (PO)	Course Outcome (CO)	Justification
PO1: Comprehensive Knowledge and Understanding	CO1: Explain the fundamental principles of developmental biology.	CO1 builds foundational knowledge of the core concepts and processes in developmental biology (PO1).
	CO2: Gain knowledge about the processes of gametogenesis.	CO2 deepens understanding of how gametes (sperm and egg) are formed (PO1).
	CO3: Learn about the fertilization processes.	CO3 expands knowledge of the mechanisms by which fertilization occurs (PO1).
	CO4: Explain the post-fertilization events and embryonic development.	CO4 strengthens understanding of the key events that follow fertilization and lead to embryo formation (PO1).
	CO5: Grasp the concept of organizers and their role in development.	CO5 equips students with knowledge of how specific regions of the embryo influence development (PO1).
	CO6: Gain insight into the development of Drosophila.	CO6 provides a focused understanding of developmental processes in a model organism (Drosophila) (PO1).
	CO7: Explain the processes of animal development.	CO7 builds understanding of the general principles governing development in animals (PO1).
PO2: Practical, Professional, and Procedural Knowledge	(Indirect Correlation - CO2, CO3, CO4)	While the course might not involve extensive practical work, understanding gametogenesis (CO2), fertilization (CO3), and early embryonic development (CO4) is valuable for professions like embryology or assisted reproductive technologies (PO2).
PO3: Entrepreneurial Mindset, Innovation, and	(Indirect Correlation - CO4, CO5)	Knowledge of embryonic development (CO4) and organizer function (CO5) can be applied to areas like

Business Understanding		regenerative medicine or stem cell research (PO3).
PO4: Specialized Skills, Critical Thinking, and Problem-Solving	CO4: Explain the post-fertilization events and embryonic development.	CO4 involves critical thinking to understand the complex and coordinated events of embryonic development (PO4).
	CO5: Grasp the concept of organizers and their role in development.	CO5 necessitates critical thinking about how organizers influence the body plan during development (PO4).
	CO6: Gain insight into the development of Drosophila.	CO6 requires critical thinking to analyze and compare developmental processes in a model organism (Drosophila) (PO4).
	CO7: Explain the processes of animal development.	CO7 involves critical thinking to understand the diversity and underlying mechanisms of animal development (PO4).
PO5: Research, Analytical Reasoning, and Ethical Conduct	(Indirect Correlation - All COs)	Knowledge of developmental biology (all COs) forms the basis for designing and conducting research in areas like embryology or developmental abnormalities, emphasizing ethical considerations (PO5).
PO6: Communication, Collaboration, and Leadership	(Indirect Correlation)	The course can encourage communication through presentations on topics like gametogenesis, fertilization, or embryonic development (PO6).
PO7: Digital Proficiency and Technological Skills	(Indirect Correlation)	The course might involve using online resources or databases to access information related to developmental biology (PO7).
PO8: Multicultural Competence, Inclusive Spirit, and Empathy	(Indirect Correlation)	Knowledge of developmental biology underpins the universality of certain developmental processes across diverse animal species (PO8).
PO9: Value Inculcation, Environmental Awareness, and Ethical Practices	(Indirect Correlation)	The course can raise awareness of the ethical considerations in areas like assisted reproductive technologies (PO9).
PO10: Autonomy, Responsibility, and Accountability	(Indirect Correlation)	By successfully navigating the complexities of developmental biology concepts, students demonstrate a sense of autonomy and responsibility in their learning (PO10).

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

Name of the Program: M.Sc. Zoology
Program Code: PSZOO
Class: M. Sc. I
Semester: II
Couse Type: Major (Mandatory) Practical
Course Code: ZOO-553-MJM
Course Name: Zoology Practical - III
Number of Credits: 02
Number of Teaching hours: 60

Course Objectives:-

- Learn and apply precise techniques to estimate the concentration of DNA using diphenyl amine reagent and RNA using orcinol reagent, ensuring accurate quantification.
- Gain proficiency in isolating DNA from bacterial and animal sources, followed by quantification and quality assessment to ensure the integrity of the genetic material.
- Understand and utilize spectrophotometric assays and melting temperature (Tm) analysis to characterize DNA, enabling the identification of unique features of DNA samples.
- Acquire skills in the isolation of RNA from biological samples, ensuring its purity and integrity for downstream applications.
- Learn the techniques involved in the isolation of plasmids from bacterial cells, including their extraction, quantification, and quality evaluation.
- Explore mutagenic processes by conducting experiments to study the effects of chemical and physical mutagens on DNA, gaining insights into the mechanisms and outcomes of induced mutations.
- Develop the ability to perform DNA digestion using restriction enzymes, a crucial skill for genetic engineering and molecular biology applications.

Course Outcomes:-

After completion of this course students will

CO1: be proficient in employing precise techniques to accurately estimate the concentration of DNA.

CO2: gain competence in isolating DNA from diverse sources, including bacteria and animal tissues.

CO3: skilled to utilize spectrophotometric assays and melting temperature (Tm) analysis to comprehensively characterize DNA.

CO4: acquire the necessary skills to effectively isolate RNA from various biological samples while ensuring its purity and integrity for subsequent experimental applications.

CO5: proficient in the extraction, quantification, and quality assessment of plasmid DNA.

CO6: gain insights of mutagenic processes by conducting experiments to study the effects of chemical and physical mutagens on DNA.

CO7: develop the ability to proficiently perform DNA digestion using restriction enzymes.

Practical No.	Name of the Practical	E/D	Teaching hours
1	Estimation of DNA by diphenyl amine reagent.	E	04
2	Estimation of RNA by orcinol reagent.	E	04
3	Isolation of bacterial DNA and quality check.	E	08
4	Isolation of DNA from sheep/chicken liver.	E	08
5	Agarose gel electrophoresis.	E	04
6	Characterization of DNA by Spectrophotometric assay and Melting Temperature (Tm)	E	08
7	Isolation of RNA from biological sample.	E	04
8	Isolation of plasmid from bacteria.	E	04
9	Study of UV light/mutagen induced DNA damage by comet assay.	E	08
10	Study of induced mutation by chemical mutagen.	E	08
11	Study of induced mutation by physical mutagen. (U V Light).	E	08
12	Digestion of DNA with Restriction Enzymes	E	08
13	Polymerase chain reaction	D / E	04
14	Separation of amino acids by thin layer chromatography	E	04

Course Articulation Matrix of ZOO-553-MJM: Zoology Practical - III
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

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

Program Outcome (PO)	Course Outcome (CO)	Justification
PO1: Comprehensive Knowledge and Understanding	(Indirect Correlation - All COs)	While the course focuses on practical skills, performing the techniques reinforces understanding of DNA structure, isolation principles, and analysis methods (PO1).
PO2: Practical, Professional, and Procedural Knowledge	CO1: Be proficient in employing precise techniques to accurately estimate the concentration of DNA.	CO1 equips students with a practical skill valuable in various research settings requiring DNA quantification (PO2).
	CO2: Gain competence in isolating DNA from diverse sources, including bacteria and animal tissues.	CO2 provides hands-on experience with a core technique used in molecular biology research (PO2).
	CO3: Skilled to utilize spectrophotometric assays and melting temperature (Tm) analysis to comprehensively characterize DNA.	CO3 equips students with practical skills for DNA analysis used in research and diagnostics (PO2).
	CO4: Acquire the necessary skills to effectively isolate RNA from various	CO4 provides hands-on experience with a crucial technique for studying gene expression

	biological samples while ensuring its purity and integrity for subsequent experimental applications.	(PO2).
	CO5: Proficient in the extraction, quantification, and quality assessment of plasmid DNA.	CO5 equips students with practical skills for working with plasmids, essential tools in genetic engineering (PO2).
	CO6: Gain insights of mutagenic processes by conducting experiments to study the effects of chemical and physical mutagens on DNA.	CO6 provides practical experience with techniques used to study mutagenesis, a critical concept in genetics (PO2).
	CO7: Develop the ability to proficiently perform DNA digestion using restriction enzymes.	CO7 equips students with a fundamental technique for manipulating DNA in research and biotechnology (PO2).
PO3: Entrepreneurial Mindset, Innovation, and Business Understanding	(Indirect Correlation - All COs)	The skills gained in DNA isolation, quantification, and analysis (all COs) are valuable for developing new diagnostic tools, gene therapies, or other biotechnology applications (PO3).
PO4: Specialized Skills, Critical Thinking, and Problem-Solving	CO1: Be proficient in employing precise techniques to accurately estimate the concentration of DNA.	CO1 requires careful technique and problem-solving to ensure accurate DNA quantification (PO4).
	CO2: Gain competence in isolating DNA from diverse sources, including bacteria and animal tissues.	CO2 involves troubleshooting potential issues that might arise during DNA isolation from different sources (PO4).
	CO3: Skilled to utilize spectrophotometric assays and melting temperature (Tm) analysis to comprehensively characterize DNA.	CO3 necessitates critical thinking to interpret data from spectrophotometry and Tm analysis for DNA characterization (PO4).
	CO4: Acquire the necessary skills to effectively isolate RNA from various biological samples while ensuring its purity and integrity for subsequent experimental applications.	CO4 requires careful technique and problem-solving to isolate intact RNA for downstream experiments (PO4).
	CO5: Proficient in the extraction, quantification, and quality assessment of plasmid DNA.	CO5 involves critical thinking to evaluate the success of plasmid DNA isolation and quality (PO4).
	CO6: Gain insights of mutagenic processes by conducting experiments to study the effects of chemical and physical mutagens on DNA.	CO6 necessitates critical thinking to design experiments, analyze data, and draw conclusions about the effects of mutagens on DNA (PO4).
	CO7: Develop the ability to proficiently perform DNA digestion using restriction enzymes.	CO7 requires careful planning and problem-solving to perform restriction enzyme digestion for specific DNA manipulation purposes (PO4).
PO5: Research, Analytical Reasoning, and Ethical Conduct	(Indirect Correlation - All COs)	The practical skills developed (all COs) are essential for conducting research in molecular biology and genetics, emphasizing careful execution, data analysis, and responsible handling of biological samples (PO5).
PO6: Communication, Collaboration, and Leadership	(Indirect Correlation)	The course might involve lab reports or discussions of results, fostering communication skills (PO6).

PO7: Digital Proficiency and Technological Skills	(Indirect Correlation)	The course might involve using instruments or software for data collection and analysis (e.g., spectrophotometer), developing basic digital skills (PO7).
PO8: Multicultural Competence, Inclusive Spirit, and Empathy	(Indirect Correlation)	The fundamental techniques learned (all COs) are

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Program Code: PSZOO
Class: M. Sc. I
Semester: II
Couse Type: Major (Mandatory) Practical
Course Code: ZOO-554-MJM
Course Name: Zoology Practical - IV
Number of Credits: 02
Number of Teaching hours: 60

Course Objectives:-

- Develop skills in embryo dissection and observation.
- Knowledge of chick embryo development
- Learn techniques for specimen preservation and mounting
- Familiarize with techniques for measuring lung capacity, including vital capacity, tidal volume, and residual volume
- Develop proficiency in genetic experimental techniques
- Genetic analysis and manipulation
- Application of microbial genetics techniques

Course Outcomes:-

After completion of this course students will be able to
CO1: analyze and understand the structural development of various species.
CO2: develop a comprehensive understanding of chick embryo development.
CO3: proficiently dissect and analyze the anatomical structures of insects.
CO4: proficient in executing pulmonary function tests (PFTS) for lung capacity measurement
CO5: execute experimental protocols with precision, ensuring accurate observation, recording, and interpretation of genetic data.
CO6: analyze and interpret genetic data obtained from experimental setups
CO7: exhibit proficiency in fundamental microbial genetics methods

Practicals:

Sr. No.	Title of the Practical	E/D	Teaching Hours
	Section I		
1	Dissection and morphology observation of the 4-14 somite chick embryos (24-34 hours)	E	04
2	Dissection and morphology observation of the 24-38 somite chick embryos (48-85 hours)	E	04
3	Temporary mounting of chick embryo.	E	04
4	Study of embryonic and post-embryonic development using frog egg as a model system.	E	04
5	Study of larval developmental stages of *Drosophila*.	D	04
6	Study of effect of ligature in *Drosophila* / House fly larva.	E	08

7	Study of imaginal disc in *Drosophila* larva.	E	04
8	Chromosome squash preparation from *Drosophila* larval salivary glands.	E	04
9	Regeneration of *Hydra* / Planaria.	E	04
10	Isolation of Zebra fish embryo.	E	04
11	Preparation of permanent/temporary slides of developmental stages of mosquito.	E	04
Section II			
1	Visit to biodiversity spot for collection, preservation & presentation of insect	E	04
2	Dissection of digestive, nervous and reproductive system of laboratory cultured insect	E	08
3	Study of insect eggs, larvae, nymph and pupae	D	08
4	Temporary mounting of mouth parts, antenna, wings and appendage of laboratory cultured insect	E	04
5	Study of insect repellents and attractants	D	04
6	Morphological and taxonomical study of agricultural pest (any 05)	E/D	08
OR Section II			
1	Estimation serum uric acid	E	04
2	Absorption spectra of blood pigment	E	08
3	Study of osmotic stress and volume change in earthworm	E	08
4	Estimation of carbohydrates in mammalian gut	E	04
5	Measurement of lung capacity	E	04
6	Effect of exercise on breathing rate, pulse rate and blood lactate of man	E	04
7	Mapping of taste areas on human tongue	E	04
8	Preparation of glycerinated muscle fibers and study of its properties	E	04
9	Introduction to Clinical Trials Registry- India (CTRI) database	D	04
OR Section II			
1	Analysis of metric trait and estimation of phenotypic variance.	E/D	04
2	To study population cage experiments using Drosophila: a) Genetic Drift b) Artificial selection- Experimental simulation and modeling.	E/D	04
3	Extraction of Genomic DNA from *Drosophila*.	E	04
4	Microbial genetics: Basic methodology, colony count, growth curve.	E	08
5	Microbial genetics: Isolation of Auxotroph (Estimation of frequency), Replica plate technique.	E	08

6	Bacterial transformation and blue white selection.	E	08
7	Study of conventions of nomenclature of genes and gene products in different model systems.	D	04
8	Gene mapping by interrupted mating in bacteria	D	04
9	Problems based on Hardy-Weinberg law	D	04
10	Problems based on Two point and three point cross over.	D	04
11	Problems based on tetrad analysis and gene mapping	D	04

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3. Berril, N.J., & Karp, G. (2017). Developmental Biology. McGraw Hill.
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Course Articulation Matrix of ZOO-554-MJM: Zoology Practical - IV
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	2	1	1	2	1	1
CO2	3	2	2	3	3	2	2	3	2	1
CO3	3	3	1	2	2	1	1	2	1	3
CO4	1	3	2	2	2	2	2	2	2	3
CO5	1	3	1	2	2	1	1	2	1	3
CO6	1	2	1	2	2	1	1	2	1	1
CO7	1	1	2	3	2	2	2	3	2	3

Program Outcome (PO)	Description	Mapped Course Outcome(s) (CO)	Justification
PO1: Comprehensive Knowledge and Understanding	Gain in-depth knowledge of core zoological concepts.	CO1, CO2, CO3	- CO1: Analyzing structural development requires understanding different animal groups and their anatomy. - CO2: Studying chick embryo development deepens knowledge of vertebrate embryology. - CO3: Dissection of insects necessitates understanding insect morphology and internal anatomy.
PO2: Practical, Professional, and Procedural Knowledge	Develop practical skills relevant to a zoology career.	CO3, CO4, CO5, CO7	- CO3, CO4, CO7: Dissection, lung function testing, and microbial genetics techniques are all valuable skills in zoological research and related

			fields. - CO5: Following experimental protocols precisely is essential for generating reliable scientific data.
PO3: Entrepreneurial Mindset, Innovation, and Business Understanding	Not directly applicable to this course.		- Zoology Practical - IV focuses on core zoological techniques, not business applications.
PO4: Specialized Skills, Critical Thinking, and Problem-Solving	Develop specialized skills in dissection, genetic analysis, and lung function testing.	CO3, CO4, CO5, CO6, CO7	- CO3, CO4, CO7: Dissection, PFTs, and microbial genetics methods require specific technical skills. - CO5, CO6: Designing experiments, analyzing data, and interpreting genetic results involve critical thinking and problem-solving.
PO5: Research, Analytical Reasoning, and Ethical Conduct	Learn to design experiments, collect data, interpret results, and maintain ethical practices.	CO5, CO6	- CO5: Executing experimental protocols involves designing experiments, collecting data through observation and recording, and interpreting those observations. - CO6: Analyzing and interpreting genetic data is a core research skill.
PO6: Communication, Collaboration, and Leadership	Not directly applicable to this course, but may be indirectly addressed through lab reports.		- While not a primary focus, lab reports can encourage communication skills.
PO7: Digital Proficiency and Technological Skills	Not directly applicable to this course.		- This course emphasizes practical lab techniques, not digital tools.
PO8: Multicultural Competence, Inclusive Spirit, and Empathy	Not directly applicable to this course.		- The course content is not specific to cultural aspects of zoology.
PO9: Value Inculcation, Environmental Awareness, and Ethical Practices	May be indirectly addressed through responsible lab practices.		- Responsible use of specimens and following proper lab protocols promote ethical conduct.
PO10: Autonomy, Responsibility, and Accountability	Develops independent work habits and responsibility for lab work.	CO3, CO4, CO5, CO7	- Dissections, PFTs, and genetic experiments require independent work and following protocols responsibly. - CO5: Careful execution of experiments demonstrates accountability for generating accurate data.

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Name of the Program: M.Sc. Zoology
Program Code: PSZOO
Class: M. Sc. I
Semester: II
Couse Type: Major (Elective) Theory
Course Code: ZOO-561-MJE (A)
Course Name: Entomology-I
Number of Credits: 04
Number of Teaching hours: 60

Course Objectives:-

- To acquire proficiency in classifying insects based on their taxonomy, origin, and evolutionary history.
- To identify and differentiate between various insect orders, including Apterygote, Exopterygote, and Endopterygote insects, and understand their evolutionary relationships.
- To comprehending the insect integument and its diverse derivatives, their structural and functional significance.
- To familiarize students with the insect tagmata, focusing on the head, thorax, and abdomen, and comprehend their adaptations and modifications.
- To Delve into the internal systems of insects, including the digestive, respiratory, circulatory, excretory, reproductive, and nervous systems, gaining insights into their functions.
- To gain insight into the mechanisms of light and sound production in insects, and their role in communication, mating, and species survival.
- To develop proficiency in insect collection and preservation methods, ensuring the proper handling and conservation of valuable entomological specimens.

Course Outcomes:-

After completion of this course students will

CO1: have the proficiency to accurately classify insects based on their taxonomy, origin, and evolutionary history, demonstrating a deep understanding of insect diversity.

CO2: be able to identify and differentiate between various insect orders and explain their evolutionary relationships, showcasing a sound knowledge of insect evolution.

CO3: comprehensively understand the insect integument and its derivatives, recognizing their structural and functional importance in insect adaptation and survival.

CO4: be well-versed in insect tagmata, specifically the head, thorax, and abdomen, and comprehend their adaptations and modifications, gaining insights into the diversity of insect body plans.

CO5: have a strong understanding of insect internal systems and able to explain their functions within the context of insect biology.

CO6: gain insights into the mechanisms of light and sound production in insects.

CO7: develop the skills necessary for insect collection and preservation, ensuring proper handling and conservation of entomological specimens.

TOPICS:

Unit No.	Subunit No.	Details	Teaching Hours
1. Taxonomy, origin, evolution and morphology of Insect			03
2. General outline of classification of insects	2.1	Apterygote insects (Protura, Diplura, Collembola and Thysanura)	20
	2.2	Exopterygote insects (5-20 orders)	
	2.3	Endopterygote insects (21-29 orders)	
	2.4	Phylogenetics of insects	
3. Integument and its derivatives			02
4. Comparative study of insect tagmata	4.1.	Head- Origin, structure and modification; Types of mouthparts and antennae, tentorium and neck sclerites	08
	4.2.	Thorax- Areas and sutures of tergum, sternum and pleuron, pterothorax; Wings: structure and modifications, venation, wing coupling apparatus and mechanism of flight; Legs: structure and modifications	
	4.3.	Abdomen- Segmentation and appendages; Genitalia and their modifications	
5. Structure and modification of different systems	5.1.	Digestive system	18
	5.2.	Respiratory system	
	5.3.	Circulatory system	
	5.4.	Excretory system	
	5.5.	Reproductive system	
	5.6.	Nervous system	
6. Specialized topics in Entomology	6.1.	The Sense organs	05
	6.2.	Endocrine glands	
	6.3.	Exocrine glands	
7. Light and sound producing organs in insects			02
8. Techniques used in insect collection and preservation			02

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Course Articulation Matrix of ZOO-561-MJE (A) : Entomology-I
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

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

Program Outcome (PO)	Course Outcome (CO)	Justification
PO1: Comprehensive Knowledge and Understanding	CO1, CO2	CO1 and CO2 require a deep understanding of insect diversity and evolution, demonstrating comprehensive knowledge in entomology.
PO2: Practical, Professional, and Procedural Knowledge	CO7	CO7 equips students with practical skills for insect collection and preservation, a valuable procedure in the field of entomology.
PO4: Specialized Skills, Critical Thinking, and Problem-Solving	CO1, CO2, CO3, CO4, CO5	Understanding insect classification, evolution, morphology, and internal systems (CO1-CO5) involves critical thinking and problem-solving skills.
PO5: Research, Analytical Reasoning, and Ethical Conduct	CO1, CO2	CO1 and CO2 require analyzing insect diversity and evolution, demonstrating analytical reasoning.
PO7: Digital Proficiency and Technological Skills	CO7	CO7 teaches practical skills in insect handling, which requires basic digital tools for documentation.
PO9: Value Inculcation, Environmental Awareness, and Ethical Practices	CO1	Understanding insect diversity (CO1) fosters environmental awareness by appreciating the variety of life forms.
PO10: Autonomy, Responsibility, and Accountability	CO3, CO4, CO5, CO7	Dissections, PFTs, and genetic experiments require independent work and following protocols responsibly. - CO5: Careful execution of experiments demonstrates accountability for generating accurate data.

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Name of the Program: M.Sc. Zoology
Program Code: PSZOO
Class: M. Sc. I
Semester: II
Course Type: Major (Elective) Theory
Course Code: ZOO-561-MJE (B)
Course Name: Animal Physiology-I
Number of Credits: 04
Number of Teaching hours: 60

Course Objectives:-

- To understand the factors affecting animal physiology, including both extrinsic and intrinsic factors.
- To explore the concept of homeostasis and its regulatory mechanisms, including tolerance, resistance, acclimatization, and acclimation.
- To examine the role of biological clocks in regulating physiological rhythms, such as circadian rhythms, lunar and tidal rhythms, and photoperiodism.
- To study the structure and dynamics of biological membranes and their role in cellular physiology.
- To understand the physiology of digestion, including nutritional requirements, digestion and absorption, and the neuronal and hormonal control of digestion.
- To investigate muscle physiology, including the structure of skeletal muscle, muscle contraction, and types of muscle fiber.
- To introduce students to clinical physiology, including its scope, techniques, and processes involved in clinical science.

Course Outcomes:-

After completion of this course students will be able to

CO1: Understand and explain the impact of extrinsic and intrinsic factors on animal physiology, including their roles in adaptation and regulation.
CO2: Describe the structure and dynamics of biological membranes and understand their significance in cellular physiology.
CO3: Explain the concept of homeostasis, its regulation, and the mechanisms involved in maintaining internal stability.
CO4: Demonstrate knowledge of biological clocks and their role in regulating physiological rhythms in animals.
CO5: Comprehend the physiology of digestion, including nutritional requirements, digestion and absorption processes, and the control mechanisms.
CO6: Explain the different modes of respiration, gas exchange, and the neural control of respiration, as well as understand abnormalities in gas transport.
CO7: Describe muscle physiology, including muscle structure, contraction mechanisms, and muscle fiber types.

Topics:

Unit No.	Subunit No.	Details	Teaching Hours
1	**Study of extrinsic and intrinsic factors affecting animal physiology:**		08
	1.1	Extrinsic factors: Atmosphere (Aquatic & terrestrial environment)	

	1.2	Intrinsic factor (Extracellular and intra cellular environment)	
	1.3	Homeostasis and its regulation: Tolerance and resistance, acclimatisation and acclimation; Regulatory mechanism of homeostasis.	
	1.4	Biological clock and their regulation: Circadian rhythms lunar and tidal rhythm, circa annual rhythm, photoperiodism	
2	**Membrane physiology**:		09
	2.1	Membrane structure and its dynamics	
	2.2	Resting membrane potential, Nernst equation, Goldman-Hodgkin- Katz potential, conductance, current and capacitance	
	2.3	Excitable cell membrane: Action potential, role of various ion channels, role of Na+ K+ pump	
3	**Physiology of Digestion:**		09
	3.1	Nutritional requirements (Concept of balanced diet), regulation of hunger, satiety	
	3.2	Digestion and absorption (Gastro-intestinal tract- Carbohydrate, lipids & protein- Scope)	
	3.3	Neuronal and hormonal control of digestion	
	3.4	Calorimetry and BMR	
4	**Respiration:**		10
	4.1	Modes of respiration: Anatomy of respiratory system	
	4.2	Pulmonary respiration: Partial pressure, inspiration and expiration; Lung volume and capacities.	
	4.3	Gas exchange across the pulmonary and systemic capillaries	
	4.4	Gas transport: O2 transport, CO2 transport and abnormalities in the blood gas content	
	4.5	Neuronal control of respiration, role of central and peripheral receptors	
5	**Muscle physiology:**		09
	5.1	Structure of skeletal muscle, twitch summation and tetanus, relation between muscle length and tension, velocity of contraction	
	5.2	Skeletal muscle fiber types, contractile machinery of smooth muscle	
	5.3	Molecular basis of skeletal muscle contraction, types of contraction	
6	**Bioluminescence and animal electricity:**		07
	6.1	Bioluminescence: Phyletic distribution, structure of luminescent organs, biochemical and molecular mechanism.	
	6.2	Animal electricity: Electro receptors, electro organs and their structure and functions	
7	**Buoyancy:**		05
	7.1	Definition & concept	
	7.2	Density reduction	
	7.3	Gas floats with examples	

	7.4	Swim bladder (Bottom dwelling and surface dwelling fish)	
8	**Introduction to clinical physiology:**		03
	8.1	Concept and Scope	
	8.2	Techniques in clinical physiology: Ultrasound, kidney functioning, liver functioning and various imaging techniques	
	8.3	Processes involved in clinical science	

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Course Articulation Matrix of ZOO-561-MJE (B): Animal Physiology-I
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

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

PO Title	Course Outcome (CO)	Justification
PO1: Comprehensive Knowledge and Understanding	CO1, CO2, CO3, CO4, CO5, CO6, CO7	Understanding the impact of factors on animal physiology, membrane dynamics, homeostasis, biological clocks, digestion, respiration, and muscle physiology requires comprehensive knowledge of animal biology.

PO2: Practical, Professional, and Procedural Knowledge	N/A	This course does not directly focus on practical skills used in professional settings.
PO4: Specialized Skills, Critical Thinking, and Problem-Solving	CO1, CO3, CO5, CO6	Understanding the impact of factors and control mechanisms in physiological processes (CO1, CO3, CO5, CO6) involves critical thinking and problem-solving.
PO5: Research, Analytical Reasoning, and Ethical Conduct	CO1, CO3, CO4, CO6	CO1, CO3, CO4, and CO6 require analyzing physiological processes and their regulation, demonstrating analytical reasoning.
PO7: Digital Proficiency and Technological Skills	N/A	This course does not directly focus on digital proficiency or technological skills.
PO9: Value Inculcation, Environmental Awareness, and Ethical Practices	CO1	Understanding the impact of factors on animal physiology (CO1) can promote environmental awareness by appreciating the intricate workings of living organisms.
PO10: Autonomy, Responsibility, and Accountability	CO1, CO3, CO5, CO6	Experiments require independent work and following protocols responsibly. - CO5: Careful execution of experiments demonstrates accountability for generating accurate data

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: II
Course Type: Major (Elective) Theory
Course Code: ZOO-561-MJE (C)
Course Name: Genetics-I
Number of Credits: 04
Number of Teaching hours: 60

Course Objectives:-

- To understand the life cycles and advantages of model genetic systems commonly used in genetic studies.
- To recapitulate the basic concepts of population genetics and explore the Hardy-Weinberg law.
- To delve into evolutionary genetics, including concepts of continuous variation, genetic polymorphism, and the genetics of speciation.
- To explore the applications of molecular methodologies in genetic analysis, including gene localization on chromosomes and the use of chromosomal probes.
- To study microbial genetics, covering topics such as conjugation, transformation, and conjugational mapping.
- To gain an understanding of the molecular biology of viruses, including virus structure, classification, and the role of viroids and prions.
- To develop critical thinking and problem-solving skills in the field of genetics.

Course Outcomes:-

After completion of this course students will be able to

CO1: Explain the life cycles and advantages of model genetic systems such as *Neurospora, E. coli*, and *Drosophila*.
CO2: Apply the principles of the Hardy-Weinberg law and estimate gene frequencies in populations through mutation and genetic equations.
CO3: Analyze the concepts of continuous variation, genetic polymorphism, and the genetics of speciation in both classical and modern contexts.
CO4: Utilize molecular information to understand phylogenetic relationships and explore the role of molecular methodologies in genetic analysis.
CO5: Describe the mechanisms of microbial genetics, including conjugation, transformation, and the concept of Hfr conjugation.
CO6: Explain the molecular biology of viruses, including their classification, structure, and the role of viroids and prions.
CO7: Develop critical thinking skills and problem-solving abilities by applying genetic principles to various biological systems.

UNIT	SUB UNITS	SYLLABUS	NO. OF LECTURES
1. Model Genetic System: Life cycles and advantages of the following organisms commonly used in genetic studies			05

	1.1	*Drosophila*	
	1.2	Zebra fish	
	1.3	Mouse	
	1.4	T4	
2. Non-Mendelian inheritance			05
	2.1	Maternal Effect; Cytoplasmic inheritance: mitochondria, genomic imprinting	
3. Advanced Population Genetics:			12
	3.1	Recapitulation of basic concepts and Hardy-Weinberg law.	
	3.2	Estimation of change in gene frequencies in population through mutation, derivation and genetic equations	
	3.3	Mating system: Assortative mating, inbreeding	
4. Chromosome segregation and mapping:			16
	4.1	Linkage, recombination and crossing over: Crossing over as a measure of genetic distance	
	4.2	Recombination mapping with two-point and three-point test cross, recombination frequency and genetic map distance	
	4.3	Detection of linkage in experimental organisms: Tetrad analysis and gene mapping in *Neurospora*	
5. Fundamentals of bacterial genetics:			16
	5.1	Methods of gene transfer in Bacteria: Conjugation - nature of donor strains and compatibility, interrupted mating, Hfr	
	5.2	Transformation - natural transformation systems, mechanism, chemical-mediated transformation	
	5.3	Transduction - Generalized and specialized transduction	
6. Applications of Molecular methodologies in genetic analysis:			06
	6.1	Introduction to gene localization on chromosomes	
	6.2	Chromosomal probes and paints	

REFERENCES

1. Dale, J. (1998). Molecular Genetics of Bacteria (3rd edition). John Wiley & Sons Ltd.
2. Gardner, E.J., Simmons, M.J., & Snustad, D.P. (1991). Principles of Genetics. John Wiley and Sons.
3. Griffiths, A. J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C., & Gelbart, W. M. (2000). An Introduction to Genetic Analysis, WH Freeman. New York, 960.
4. Hartl, D. L., & Jones, E. W. (2009). Genetics: analysis of genes and genomes. Jones & Bartlett Learning.
5. Lewin, B., Krebs, J., Kilpatrick, S. T., & Goldstein, E. S. (2011). Lewin's genes X. Jones & Bartlett Learning.
6. Maloy, S.R., Cronan, J. Jr., Freifelder, D., & Cronan, J.E. (1994). Microbial Genetics (2nd ed.). Jones & Bartlett Publishing.

7. Streips, U.N., & Yasbin, R.E. (2002). Modern Microbial Genetics (2nd edition). John Wiley & Sons.
8. Strickberger, M.W. (2000). Genetics (3rd ed.). Mac Millan.

Course Articulation Matrix of ZOO-561-MJE (C): Genetics-I
Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related

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

PO Title	Course Outcome (CO)	Justification
PO1: Comprehensive Knowledge and Understanding	CO1, CO2, CO3, CO4, CO5, CO6	Understanding model genetic systems, applying genetic laws, analyzing genetic concepts, and understanding molecular biology requires comprehensive knowledge of genetics.
PO2: Practical, Professional, and Procedural Knowledge	N/A	This course does not directly focus on practical skills used in professional settings.
PO4: Specialized Skills, Critical Thinking, and Problem-Solving	CO2, CO3, CO7	Applying genetic laws (CO2), analyzing genetic concepts (CO3), and solving problems using genetic principles (CO7) require critical thinking and problem-solving skills.
PO5: Research, Analytical Reasoning, and Ethical Conduct	CO2, CO3, CO4	Applying genetic laws (CO2), analyzing genetic concepts (CO3), and understanding phylogenetic relationships (CO4) demonstrate analytical reasoning.
PO7: Digital Proficiency and Technological Skills	CO4	Understanding phylogenetic relationships using molecular information (CO4) involves basic knowledge of digital tools and databases.
PO9: Value Inculcation, Environmental Awareness, and Ethical Practices	N/A	This course does not directly focus on value inculcation or ethical practices.

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: II
Couse Type: On Job Training (OJT)/Field Project (FP)
Course Code: ZOO-581- OJT/FP
Course Name: On Job Training/Field Project relevant to the major course.
Number of Credits: 04
Number of Teaching hours: 60

The filed project course would involve:

1. Training to students in:

a) Literature survey,

b) Planning and execution of experimental work,

c) Analysis of data and its presentation.

Case Study Steps	UMA Instruction (Recorded content + Notes) in hr	For a Batch of 30		Individual Student's work in hr
		Course Coordinator (Instruction + Hand Holding + Review) in hr	UMA Support (On-demand hand-holding + Feedback) in hr	
Topic selection	1	2 (0 + 1 + 1)	0 (0 + 0)	4
Case Study design	2	4 (0 + 1.5 + 2.5)	2 (1 + 1)	10
Survey Design	1.5	2 (0 + 1 + 1)	3 (1 + 2)	8
Fieldwork	1	3 (1 + 0 + 2)	1 (1 + 0)	16
Analysis	1.5	4 (0 + 1.5 + 2.5)	2 (1 + 1)	10
Report writing	1	5 (1 + 1.5 + 2.5)	0 (0+ 0)	12
Total time	8	20 (2 + 6.5 + 11.5)	8 (4 + 4)	60

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

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