



# **Savitribai Phule Pune University**

**(Formerly University of Pune)**

**Two Year Post graduate Degree Program in Zoology**

**( Faculty of Science & Technology )**

**Revised Syllabus as per National Education Policy - 2020 for**

**M. Sc. (Zoology) Part - I**

**(For Colleges Affiliated to Savitribai Phule Pune University)**

**Syllabus to be implemented from the Academic Year**

**2023 - 2024**

**PROF. DR. R. D. CHAUDHARI**

**CHAIRMAN,**

**BOARD OF STUDIES IN ZOOLOGY,**

**AND ALL B. O. S. MEMBERS**

**Savitribai Phule Pune University,**

**Pune – 411 007**

## PREAMBLE

Zoology is a major subject of Basic Sciences which deals with all aspects of animal biology. The Master of Science (M. Sc.) in Zoology is a Post graduate program under the Faculty of Science and Technology of Savitribai Phule Pune University (SPPU), Pune. University Grants Commission (UGC) has made the decision to revise the syllabus of various faculties across the country under National Education Policy (NEP), 2020. We at SPPU had revised the syllabus to be implemented from the academic year 2023 - 2024 by incorporating the guidelines and provisions outlined in the NEP, 2020. It includes an interesting range of highly diverse topics. We have skill based & employment generating syllabi, teaching methods, hands-on-training, and different learning outcomes. 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 flexibility in the curriculum allows the students to choose their areas of interest leading to enhanced employability. The NEP 2020 ensures 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.

With 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 SPPU has developed the curriculum for the first year 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 coming now-a-days. 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 20<sup>th</sup> April and 16<sup>th</sup> May, 2023, and the Circular issued by SPPU, Pune on 31<sup>st</sup> May, 2023.

After completion of M. Sc. Zoology, enrolled students will acquire complete disciplinary knowledge of 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, research or industries. Students will be able to define and explain major concepts in the biological sciences. They will be use to with various 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 organism.

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 exploration as a career option. The procedural knowledge about identification and classification of animals will provide students professional advantages in seeking the jobs in the fields of teaching, research and taxonomy in various public & private organizations *viz.*, Zoological Survey of India, National Parks/Sanctuaries etc. 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 economic zoology, biotechnology, biostatistics, bioinformatics and molecular biology can be used to achieve career as a scientist in nano-bioscience and life sciences based industries in India or abroad.

The students will be acquiring basic experimental skills in various techniques in the fields of biodiversity, 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 explicite with modification how decently it had 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 fishes, 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 as well as research laboratories. M. Sc. Zoology candidates will find opportunities in diverse fields including public services departments, NGOs, environmental agencies, universities, colleges, biotechnological, pharmaceutical, environmental & ecological fields. 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 will 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.

**Equivalence of Previous Syllabus :****Semester - I**

<b>Old Course (2019 Pattern)</b>	<b>New Course ( NEP 2023 Pattern)</b>
ZOUT 111 Biochemistry and Biochemical Techniques	ZOO 501 MJ : Advanced Biochemistry
ZOUT 112 Cell Biology and Developmental Biology	ZOO 502 MJ : Advanced Cell Biology ZOO 503 MJ : Comparative Embryology
ZOUT 113- Genetics and English in Scientific Communication.	
ZODT 114 Biostatistics / ZODT 114 Freshwater Zoology	ZOO 508 MJ : Biostatistical Applications ZOO 509 MJP : Laboratory Exercises in Biostatistical Applications ZOO 510 MJ : Freshwater Zoology
ZOUP 115 Basic Zoology Lab – I	ZOO 506 MJP : Lab. Exercises in Biochemistry and Cell Biology ZOO 507 MJP : Lab. Exercises in Biosystematics and Biodiversity and Medical Entomology ZOO 512 MJP : Lab. Exercises in Comparative Embryology ZOO 513 MJP : Lab. Exercises in Histological Techniques
ZODP 114 Zoology Practical – 1	ZOO 511 MJP : Laboratory Exercises in Freshwater Zoology

**Semester - II**

<b>Old Course (2019 Pattern)</b>	<b>New Course (NEP 2023 Pattern)</b>
ZOUT 121 Molecular Biology and Bioinformatics	ZO O 551 MJ : Molecular Biology
ZOUT 122 Endocrinology and Parasitology	ZO O 552 MJ : Comparative Endocrinology ZO O 558 MJ : Medical Parasitology
ZOUT 123 Comparative Animal Physiology & Environmental Biology	ZO O 553 MJ : Comparative Animal Physiology
ZODT 124 Metabolic pathways / Ichthyology	
ZODP 124 Zoology Practical - 2	
ZOUP 125 Basic Zoology Lab – II	ZO O 556 MJP : Laboratory Exercises in Biochemical and Molecular Techniques

	ZO O 557 MJP : Laboratory Exercises in Animal Physiology and Endocrinology ZO O 559 MJP : Laboratory Exercises in Medical Parasitology
	ZO O 554 MJ : Biochemical Techniques
	ZO O 555 MJ : Integrated Pest Management
	ZO O 560 MJ : Economic Zoology
	ZO O 561 MJP : Laboratory Exercises in Economic Zoology
	ZOO 562 MJP : Practicals in Bio – Medical Techniques
	ZOO 563 OJT / FP : On Job Training or Field Project

**ILLUSTRATIVE CREDIT DISTRIBUTION STRUCTURE FOR TWO YEARS / ONE YEAR P. G. - M. Sc. PROGRAMME**

YEAR (2 Yr. )	LEVEL	SEM (2 Yr.)	MAJOR		RM	OJP / FP	RP	CUM. CR	DEGREE
			MANDATORY	ELECTIVES					
1	6.0	SEM - I	3 X 4 + 2 = 14	4	4			22	PG DIPLOMA (AFTER 3 YR DEGREE)
		SEM - II	3 X 4 + 2 = 14	4		4		22	
CUM CR. FOR PG DIPLOMA			24	8	4	4		40	
EXIT OPTION : PG DIPLOMA ( 40 – 44 CREDITS ) AFTER THREE YEAR UG DEGREE									
2	6.5	SEM - III	3 X 4 + 2 = 14	4	4			22	PG DEGREE (AFTER 3 YR UG OR PG DEGREE AFTER 4 – YR UG )
		SEM - IV	3 X 4 + 2 = 14	4		4		22	
CUM CR. FOR 1 YR. PG DEGREE			28	8	4	4		44	
CUM CR. FOR 2 YR. PG DEGREE			54	16	4	4	10	88	
2 YEARS – 4 SEM. PG DEGREE (80 – 88 CREDITS) AFTER THREE YEAR UG DEGREE OR 1 YEAR – 2 SEM PG DEGREE (40 - 44 CREDITS) AFTER FOUR YEAR UG DEGREE									
	8.0		COURSE WORK MIN. 12 ( 3 X 4 )	TRAINING IN TEACHING / EDUCATION / PEDAGOGY : 4		16 + Ph. D. WORK			Ph.D. SUBJECT

**M. Sc. Zoology – Course Structure & Distribution of Credits**

Year	Level	Semester I			
		Course	Subject	Credits	
1	6.0	Major Core	ZOO 501 MJ : Advanced Biochemistry	02	
			ZOO 502 MJ : Advanced Cell Biology	02	
			ZOO 503 MJ : Comparative Embryology	02	
			ZOO 504 MJ : Medical Entomology	02	
			ZOO 505 MJ : Biosystematics & Biodiversity	02	
			ZOO 506 MJP : Lab. Exercises in Biochemistry & Cell Biology	02	
			ZOO 507 MJP : Laboratory Exercises in Biosystematics, Biodiversity and Medical Entomology	02	
		Major Elective	ZOO 508 MJ : Biostatistical Applications	02	
			ZOO 509 MJP : Laboratory Exercises in Biostatistical Applications	02	
			ZOO 510 MJ : Freshwater Zoology	02	
			ZOO 511 MJP : Laboratory Exercises in Freshwater Zoology	02	
			ZOO 512 MJP : Lab. Exercises in Comparative Embryology	02	
			ZOO 513 MJP : Lab. Exercises in Histological Techniques	02	
		Research Methodology	ZOO – MJ 514 : Research Methodology	02	
			ZOO - MJP 515 : Laboratory Exercises in Research Methodology	02	
		NOTE :			
		1. Major Core = ( ZOO 501 MJ to ZOO 505 MJ = 10 C + ZOO 506 MJP to ZOO 507 MJP = 4C ) ( Major Core of 10 + 4 = 14 Credits is Compulsory ).			14
		2. Major Elective = Students can choose any two courses from ( ZOO 508 MJ to ZOO 513 MJ ) equivalent to 2 + 2 = 4 Credits.			04
		3. Research Methodology ( ZOO – MJ 514 & ZOO MJ 515 ) is compulsory for all students.			04
		<b>Total</b>			<b>22</b>

Year	Level	Semester II			
		Course	Subject	Credits	
1	6.0	Major Core	ZOO 551 MJ : Molecular Biology	02	
			ZOO 552 MJ : Comparative Endocrinology	02	
			ZOO 553 MJ : Comparative Animal Physiology	02	
			ZOO 554 MJ : Biochemical Techniques	02	
			ZOO 555 MJ : Integrated Pest Management	02	
			ZOO 556 MJP : Laboratory Exercises in Biochemical & Molecular Techniques	02	
			ZOO 557 MJP : Laboratory Exercises in Animal Physiology and Endocrinology	02	
		Major Elective	ZOO 558 MJ : Medical Parasitology	02	
			ZOO 559 MJP : Laboratory Exercises in Medical Parasitology	02	
			ZOO 560 MJ : Economic Zoology	02	
			ZOO 561MJP : Laboratory Exercises in Economic Zoology	02	
			ZOO 562 MJP : Laboratory Exercises in Bio- Medical Techniques	02	
		On Job Training OR Field Project	ZOO 563 OJT / FP : On Job Training OR Field Project	04	
		NOTE :			
		1. Major Core = ( ZOO 551 MJ to ZOO 555 MJ = 10 C + ZOO 556 MJP to ZOO 557 MJP = 4C ) ( Major Core of 10 + 4 = 14 Credits is Compulsory ).			14
		2. Major Elective = Students can choose any two courses from ( ZOO 558 MJ to ZOO 562 MJ) equivalent to 2 + 2 = 4 Credits.			4
		3. On Job Training OR Field Project ( ZOO 563 OJT / FP ) is compulsory for all students.			4
Total			22		



Year	Level	Semester III			
		Course	Subject	Credits	
2	6.5	Major Core	ZOO 601 MJ : Animal Physiology – I / Entomology – I / Genetics – I	04	
			ZOO 602 MJ : Physiology of Reproduction	02	
			ZOO 603 MJ : Developmental Biology	02	
			ZOO 604 MJ : Insect Physiology & Biochemistry	02	
			ZOO 605 MJP : Laboratory Exercises in Animal Physiology – I / Entomology – I / Genetics – I	02	
			ZOO 606 MJP : Laboratory Exercises in Physiology of Reproduction and Immunology	02	
		Major Elective	ZOO 607 MJ : Applied Genetics	02	
			ZOO 608 MJP : Laboratory Exercises in Applied Genetics	02	
			ZOO 609 MJ : Animal Behaviour	02	
			ZOO 610 MJP : Laboratory Exercises in Animal Behaviour	02	
		Research Project	ZOO 611RP : Research Project	04	
		<b>NOTE :</b>			
		1. Major Core = ( ZOO 601 MJ to ZOO 604 MJ = 10 C + ZOO 605 MJP to ZOO 606 MJP = 4C ) ( Major Core of 10 + 4 = 14 Credits is Compulsory ).			14
		2. Major Elective = Students can choose any two courses from ( ZOO 607 MJ to ZOO 610 MJ ) equivalent to 2 + 2 = 4 Credits.			04
		3. ZOO 611 RP : Research Project is compulsory for all students.			04
		<b>Total</b>			<b>22</b>

Year	Level	Semester IV			
		Course	Subject	Credits	
2	6.5	Major Core	ZOO 651 MJ : Animal Physiology – II / Entomology – II / Genetics – II	04	
			ZOO 652 MJ : Ecology and Evolution	02	
			ZOO 653 MJ : Environmental Biology	02	
			ZOO 654 MJ : Wild Life Management & Conservation	02	
			ZOO 655 MJP : Laboratory Exercises in Animal Physiology – II / Entomology – II / Genetics – II	02	
			ZOO 656 MJP : Laboratory Exercises in Ecology, Evolution and Environmental Biology	02	
		Major Elective	ZOO 657 MJ : Applied Entomology	02	
			ZOO 658 MJP : Laboratory Exercises in Applied Entomology	02	
			ZOO 659 MJP : Genetic Toxicology	02	
			ZOO 660 MJP : Laboratory Exercises in Genetic Toxicology	02	
		Research Project	ZOO 661 RP : Research Project	06	
		NOTE :			
		1. Major Core = ( ZOO 651 MJ to ZOO 654 MJ = 10 C + ZOO 655 MJP to ZOO 656 MJP = 4C ) (Major Core of 10 + 4 = 14 Credits is Compulsory).			14
		2. Major Elective = Students can choose any two courses from ( ZOO 657 MJ to ZOO 660 MJ ) equivalent to 2 + 2 = 4 Credits.			04
		3. ZOO 611 RP : Research Project is compulsory for all students.			06
		Total			24

**Program outcomes (POs) :**

After successfully completing the M. Sc. Zoology program students will be able to :

1. Identify a range of invertebrates and vertebrates and justify their conservation.
2. Analyse the relationships of animals with abiotic factors and different biotic factors like plants and microbes. They will be able to identify the species based on molecular taxonomy.
3. Apply the knowledge of Zoology, Life Sciences and allied subjects to the understanding of complex life processes and phenomena.
4. Identify, review research literature and analyse complex situations of living forms.
5. Design concepts that meet the specified needs with appropriate consideration for the public health, safety, cultural, societal, and environmental considerations.
6. Propose hypothesis, formulate tests, use various modern instruments for biological analysis, data collection, field surveys, interpret the data and find answers.
7. Distinguishes different ecosystems based on biological, chemical and physical features; correlates the morphology, physiology and behaviour with the properties of habitat.
8. Utilize research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions in real situations.
9. Create, select and apply appropriate techniques, resources and ICT tools for understanding of the subject.
10. Illustrate the impact of natural and anthropogenic activities in societal and environmental contexts and demonstrate the knowledge and need for sustainable development.
11. To sensitized regarding the ethical principles, professional ethics, responsibilities and norms of permission from the concerned agencies regarding animal experimentation and collection of biological resources.
12. Exhibits management skills in applied branches of Zoology like Vermiculture, Apiculture, Sericulture, Aquaculture, Agriculture & Entomology.
13. Elaborate knowledge and understanding of Zoology and management principles and apply these to one's own work, as a member and leader in a team.

**Title of the Course : M. Sc. (Zoology)****SEMESTER - I**

<b>ZOO 501 MJ : Advanced Biochemistry</b>							
<b>Teaching Scheme</b>					<b>Marking Scheme</b>		
<b>Year</b>	<b>Semester</b>	<b>Course Type</b>	<b>Credits</b>	<b>Lectures per week</b>	<b>Continuous Internal Assessment</b>	<b>End Semester Examination</b>	<b>Total</b>
<b>I</b>	<b>I</b>	<b>Major Core</b>	<b>02</b>	<b>02</b>	<b>15</b>	<b>35</b>	<b>50</b>

**Course Outcomes:**

After completing the course student will be able to :

CO1 : Understand the basic terminologies of Biochemistry.

CO2 : Describe the concepts and regulation of metabolism.

CO3 : Describe the oxidation of fatty acids and its significance.

CO4 : Illustrate the reactions, energetic and regulation of glycolysis, glycogen biosynthesis, TCA cycle, purine and pyrimidine metabolism.

CO5 : Draw the general reactions of various metabolic pathways.

CO6 : Justify the role of enzymes and their regulation in metabolism.

**Detailed Syllabus :**

<b>Sr. No.</b>	<b>Topic</b>	<b>Lectures Assigned (L)</b>
<b>1.</b>	<b>Carbohydrates :</b> Various classes of carbohydrates, Glycosaminoglycans (hyaluronan, chondroitin sulphate, keratin sulphate, heparin), Bacterial polysaccharides, Blood group substances, Glycoproteins (O - and N - glycoproteins), Glycolysis, Tricarboxylic acid cycle, Glycogenolysis, Glycogenesis, Gluconeogenesis.	<b>5</b>
<b>2.</b>	<b>Lipids :</b> Characteristics of fatty acids and fats (saponification, iodine, acid, acetyl and peroxide values), Rancidity of fats, refractive index, melting point and boiling point of fats and their physical properties, Waxes, triacylglycerols, phosphoglycerides, sphingolipids, eicosanoids, sterols. Fat soluble vitamins and biological functions of	<b>5</b>

	Vitamin A, D, E and K.	
3.	<p><b>Amino Acids :</b></p> <p>Physical and chemical properties of amino acids, Titration of amino acids, Separation of amino acids by paper chromatography and ion exchange chromatography, Urea cycle and inherited defects of urea cycle, General reactions of amino acids : Role and clinical significance of SGOT and SGPT.</p>	5
4.	<p><b>Proteins :</b></p> <p>Structure and biological functions of globular proteins (haemoglobin, myoglobin) and fibrous proteins (collagen, keratin and silk fibroin), sickle cell haemoglobin, Conjugated proteins - Lectins and their biological functions. Disorders : phenylketonuria, alkaptonuria, maple syrup urine disease, methylmalonic academia (MMA), homocystinuria.</p>	5
5.	<p><b>Nucleic acids :</b></p> <p>Purine, Pyrimidine nucleotide synthesis and regulation. Synthesis of deoxyribonucleotides, Salvage pathway, Purine and Pyrimidine degradation. Disorders of purine and pyrimidine metabolism – Lesch - Nyhan syndrome, Gout, SCID.</p>	5
6.	<p><b>Enzymes:</b></p> <p>Enzymes in medicine and industry, Enzymes used in clinical biochemistry as reagents, diagnostics and therapy. Role of immobilized enzymes in industry, Application of enzymes in diagnostics - creatine kinase, alkaline and acid phosphatases, enzyme immunoassay (HRPO), enzyme therapy (Streptokinase).</p>	5

**Suggested Readings :**

1. Biochemistry, 3<sup>rd</sup> Ed., Voet Donald and Voet Judith G. John, Publisher, Wiley & Sons, New York. (2005).
2. Biochemistry 6<sup>th</sup> Ed., Berg Jeremy, Tymoczko John, Stryer Lubert, Publisher, W. H. Freeman, New York. (2007).
3. Lehninger's Principles of Biochemistry, 8<sup>th</sup> edition, Nelson D. L. and Cox M. M. W. H. Freeman & Co. NY. (2021).

4. Biochemical Calculations, 2<sup>nd</sup> Ed., Segel Irvin H., Publisher : John Wiley and Sons, New York. (2010).
5. Enzymes : Biochemistry, Biotechnology & Clinical chemistry, Palmer Trevor, Publisher, Horwood Pub. Co., England. (2001).
6. Biochemistry, 4<sup>th</sup> ed., Geoffrey Zubay, William C Brown Pub. (1999).
7. Principles and Techniques of Biochemistry & Molecular Biology, Keith 6<sup>th</sup> edition (2008).
8. Illustrated Biochemistry, 31<sup>st</sup> Ed., Harper *et. al.* (2018).
9. Biochemistry, 5<sup>th</sup> Ed., Lubert Strayer. (2002).

**Website resources :**

1. <https://metacyc.org/MetaCyc> is a database of experimentally elucidated metabolic pathways.
2. <https://biocyc.org/>: BioCyc is a collection of more than 20 thousand for model eukaryotes and for thousands of microbes, plus software tools for exploring them.

ZOO 502 MJ : Advanced Cell Biology							
Teaching Scheme					Marking Scheme		
Year	Semester	Course Type	Credits	Lectures per week	Continuous Internal Assessment	End Semester Examination	Total
I	I	Major Core	02	02	15	35	50

**Course Outcomes :**

After completing the course student will be able to :

- CO1 : The learner will understand the preparation of staining methods and nuclear organization.
- CO2 : Demonstrate the ability to use discipline specific research techniques.
- CO3 : Organization of cytoskeleton and their associated protein.
- CO4 : The learner will understand the application and pluripotency of stem cell.
- CO5 : The learner will be aware about the cell culture & its applications.
- CO6 : To understand the organization of cell signaling and their receptors.

**Detailed Syllabus :**

Sr. No.	Topics	Lectures Assigned (L)
1.	Organization of cell, cell organelles, nuclear organization and function, chemical nature of the cell.	5
2.	Plasma membrane structure, channels, carriers and pumps, membrane potential and synaptic transmission, phagocytosis and pinocytosis mechanism, transport : active and passive.	5
3.	Endomembrane system, protein sorting into endoplasmic reticulum, mitochondria and chloroplast, protein trafficking, nuclear transport.	5
4.	Cell Cycle : Phases, check points, mechanism of regulation, regulators of cell, cycle progression – MPF, cyclins and cyclin dependent kinases (CDKs).	5
5.	Cell signaling : Signaling molecules and their receptors, the significance of cell signaling.	4
6.	Cytoskeleton : Types associated proteins and their role.	3
7.	Cell culture and applications, stem cells & their significance.	3

**Suggested Readings :**

1. Cell Biology, 6<sup>th</sup> Edition, Karp Gerald, John Willey & Sons (Asia) Pvt. Ltd. (2010).
2. The Cell : A Molecular Approach, Cooper Geoffrey M. ASM Press, Washington D.C., U.S.A. (1997).
3. Cell Biology – Organelle Structure and Function, Sadava David E. Jones & Barlett Publishers, Boston, London. (1993).
4. World of the Cell, 8<sup>th</sup> Edition, Hardin Jeff, Gregory Bertoni and Lewis J. Kleinsmith, Pearson Education, Inc., San Francisco, U.S.A. (2012).
5. Molecular Biology of the Cell, 5<sup>th</sup> Edition, Alberts B., A. Johnson, J. Lewis, M. Raff, K. Roberts and P. Walter Garland Science, New York, U.S.A. (2008).
6. Molecular Cell Biology, 3<sup>rd</sup> Ed., Lodish H., D. Baltimore, A. Berk, L. Zipursky, M. Matsudaira and J. Darnell, Scientific American & W. H. Freeman, New York. (1995).
7. Cell and Molecular Biology, 8<sup>th</sup> Edition, De Robertis E. D. P. and De Robertis E. M. E. Lea and Febiger, Philadelphia (1987).

ZOO 503 MJ : Comparative Embryology							
Teaching Scheme					Marking Scheme		
Year	Semester	Course Type	Credits	Lectures per week	Continuous Internal Assessment	End Semester Examination	Total
I	I	Major Core	02	02	15	35	50

**Course Outcomes :**

After completing the course student will be able to :

CO1 : The course gives detailed idea about advantage in the area of clinical embryology.

CO2 : Basic definitions and concepts in embryology.

CO3 : Concept of fertilization and how internal and external fertilization ensures species specificity.

CO4 : Different types of egg and cleavage patterns according to developmental need of embryo and processes of blastulation.

CO5 : To understand the mechanism of gastrulation resulting into separation of germ layers.

CO6 : To understand the mechanism of regeneration and metamorphosis in organisms.

**Detailed Syllabus :**

Sr. No.	Topics	Lectures Assigned (L)
1.	<b>Fundamentals of Embryology :</b> Definition, Early theories of experimental embryology, Concepts of developmental biology – Growth, stem cells and it's type, cell differentiation, patterning, induction and competence.	3
2.	<b>Gametogenesis :</b> <b>2.1</b> Germ cell specification : Germplasm and its localization, primordial germ cell formation and migration in nematodes ( <i>C. elegans</i> ), insects ( <i>Drosophila</i> ), frog, Zebra fish, birds (chick), and mammals (mouse). <b>2.2</b> Development of gametes in <i>C. elegans</i> , <i>Drosophila</i> , frog, Zebra fish, birds (chick) and mammals (mouse) : Spermatogenesis, spermiogenesis and capacitation. Structure of sperm, regulation of sperm motility, oogenesis and vitellogenesis, programmed	5



	amplification of rRNA genes (lamp brush chromosomes).	
3.	<p><b>Fertilization :</b></p> <p>3.1 Concept of fertilization, types of fertilization, egg maturation, Species specific sperm attraction, recognition of egg &amp; sperm, acrosome reaction, strategies to avoid polyspermy, egg activation, fusion of gametic material in sea urchin and mammals.</p>	4
4.	<p><b>Types of eggs, Cleavage patterns and comparative aspects of blastulation :</b></p> <p>4.1 Types of eggs, cleavage : Patterns with examples, planes, laws and significance.</p> <p>4.2 Blastulation : Embryonic cell cycle, Mid-blastula transition, cell migration in snail, <i>C. elegans</i>, <i>Drosophila</i>, sea urchins, frog and mouse.</p>	4
5.	<p><b>Gastrulation :</b></p> <p>5.1 Morphogenetic movements and cell adhesion molecules, fate maps, comparative study of gastrulation in snail, <i>C. elegans</i>, <i>Drosophila</i>, sea urchins, frog, bird (chick) and mouse.</p>	5
6.	<p><b>Organizers :</b></p> <p>6.1 Spemann Mangold in frog, Nieuwkoop center in fish, Avian Henson's node, primary embryonic induction, functions of the organizer.</p>	5
7.	<p><b>Regeneration and Metamorphosis :</b></p> <p>7.1 Epimorphic regeneration of Salamander limb.</p> <p>7.2 Morphallaxis and epimorphosis regeneration in <i>Hydra</i>.</p> <p>7.3 Morphological changes and hormonal control in amphibia.</p> <p>7.4 Insect metamorphosis.</p>	4

**Suggested Readings :**

1. Developmental Biology, 12<sup>th</sup> edition, Michael J Barresi and S.F. Gilbert. Publisher – Sinauer, Associates Inc. (2020).
2. Principles of Development, 5<sup>th</sup> edition, Lewis Wolpert, Publisher- Oxford, University Press. (2018).

3. An Introduction to Embryology, 5<sup>th</sup> edition, B. I. Balinsky. Publisher – Thomas Asia Pvt. Ltd. (2004).
4. Developmental Biology, R. M. Twyman, Publisher - Bios Scientific, Publishers Ltd. (2001).
5. Analysis of Biological Development, 2<sup>nd</sup> edition, Klaus Kalthoff, McGraw Hill Science / Engineering / Math. (2000).

ZOO 504 MJ : Medical Entomology							
Teaching Scheme					Marking Scheme		
Year	Semester	Course Type	Credits	Lectures per week	Continuous Internal Assessment	End Semester Examination	Total
I	I	Major Core	02	02	15	35	50

#### Course Outcomes :

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

CO1 : Understand, classify, and identify insects of medical and veterinary importance.

CO2 : Incorporate the subject knowledge in designing innovative techniques of vector control.

CO3 : Better prepared to contribute to the field of public and community health.

CO4 : Understand molecular aspects of diseases of medical importance.

CO5 : Capable of joining the research areas pertinent to vector borne diseases.

#### Detailed Syllabus :

Sr. No.	Topics	Lectures Assigned (L)
1.	<p><b>Introduction to Medical Entomology :</b></p> <p><b>1.1</b> History, importance, need and scope.</p> <p><b>1.2</b> Importance of insects in relation to human health : Annoyance, entomophobia, myiasis, envenomization, allergies, urtication, blistering, injuries to sense organs.</p> <p><b>1.3</b> Modes of transmission of insect borne diseases : Mechanical transmission and biological transmission.</p> <p><b>1.4</b> Parasitism in insects : Ectoparasites, endoparasites, vector-</p>	4

Sr. No.	Topics	Lectures Assigned (L)
	parasite relationship.	
2.	<p><b>Vector Insect Biology</b> : Systematics, morphology, life cycle, medical importance and control measures of :</p> <p><b>2.1</b> Order – Diptera : Forest fly ( <i>Hippobosca</i> sp.), mosquito (<i>Anopheles</i> sp.).</p> <p><b>2.2</b> Order – Siphonaptera : Cat flea (<i>Ctenocephalides felis</i>), oriental rat flea (<i>Xenopsylla cheopis</i>).</p> <p><b>2.3</b> Order Psocodea : Head louse (<i>Pediculus humanus</i>), pubic louse, (<i>Phthirus pubis</i>).</p> <p><b>2.4</b> Order – Hemiptera : Reduviid bug (<i>Panstrongylus</i> sp.), bed bug (<i>Cimex lectularius</i>).</p>	10
3.	<p><b>Insect Borne Diseases in Human</b> : Mode of transmission, pathogenicity, prophylaxis, and control measures of :</p> <p><b>3.1</b> Protozoan diseases : Leishmaniasis, Malaria.</p> <p><b>3.2</b> Viral diseases : Dengue fever, Japanese encephalitis.</p> <p><b>3.3</b> Bacterial disease : Bubonic plague, Bartonellosis.</p> <p><b>3.4</b> Rickettsiosis : Epidemic and endemic typhus.</p> <p><b>3.5</b> Helminthiasis : Filariasis.</p>	8
4.	<p><b>Arthropods of Veterinary and Medical importance</b> :</p> <p>Introduction to arachnids of medical importance with respect to Morphology, life cycle, medical/public health significance.</p> <p><b>4.1</b> Ticks : Soft ticks and hard ticks.</p> <p><b>4.2</b> Mites.</p>	2
5.	<p><b>Forensic Entomology</b> :</p> <p><b>5.1</b> Introduction to forensic entomology.</p> <p><b>5.2</b> Study of forensic insects : Life history, and importance in forensic investigations : Blow flies, Flesh flies, House flies, Carrion beetle, Rove beetle, Scarab beetles, Dermestid beetle, Sap beetle.</p>	2
6.	<p><b>Vector surveillance and Vector control</b> :</p> <p><b>6.1</b> Methods and techniques of vector surveillance.</p> <p><b>6.2</b> Vector incrimination.</p>	4

Sr. No.	Topics	Lectures Assigned (L)
	<b>6.3</b> Vector control : a) Mechanical methods, b) Ecological control, c) Chemical methods, d) Genetic control , e) Integrated vector management.	

**Suggested Readings :**

1. Community Health, Jones and Bartlett Publishers, Canada. (2005).
2. Forensic Entomology : An Introduction, Dorothy Gennard, John Wiley and Sons.
3. Medical Entomology : A Textbook on Public Health and Veterinary Problems Caused by Arthropods 2<sup>nd</sup> Edition, Eldridge B. F., J. D. Edman, Springer. (2003).
4. The Future of the Public's Health, Washington, DC : Institute of Medicine, The National Academies Press. (2003).
5. An Introduction to Medical and Veterinary Entomology, 2018 Edition, James F. McKenzie Robert R. Pinger Jerome E. Kotecki by Gary R. Mullen, Lance A. Durden, Elsevier. (2018).
6. Medical Entomology A Textbook on Public Health and Veterinary Problems Caused by Arthropods 2<sup>nd</sup> Edition, Hardbound by B. F. Eldridge, J.D. Edman, Springer. (2003).
7. A History of Public Health, Rosen, G. New York : MD Publications. (1958).
8. World Health Organization, "Constitution of the World Health Organization, Chronicle of the World Health Organization. (1947).

ZOO 505 MJ : Biosystematics and Biodiversity							
Teaching Scheme					Marking Scheme		
Year	Semester	Course Type	Credits	Lectures per week	Continuous Internal Assessment	End Semester Examination	Total
<b>I</b>	<b>II</b>	<b>Major Core</b>	<b>02</b>	<b>02</b>	<b>15</b>	<b>35</b>	<b>50</b>

**Course Outcomes :**

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

CO1 : Explain Fundamental concepts and principles used in Systematics and Biodiversity.

CO2 : Assess the current status of animal biodiversity of our Nation & the World and threats to biodiversity.

CO3 : Identity and classify major groups of animal kingdom.

CO4 : Apply techniques of animal collection, preservation, and identification.

CO5 : Explain and perform basic Taxonomic procedures employed by animal taxonomists.

CO6 : Explain and use Zoological nomenclature during taxonomic research.

CO7 : Explain and Discuss the basic concepts in molecular phylogenetics.

CO8 : Explain and apply Techniques used in Phylogenetic analysis and Calculation of biodiversity indices.

**Detailed Syllabus :**

Sr. No.	Topics	Lectures Assigned (L)
1.	<p><b>Fundamentals of Biosystematics and Biodiversity :</b></p> <p><b>1.1</b> Systematics : Concept, Need, Objectives and Principles.</p> <p><b>1.2</b> Classification : Concept, Linnaean system of Classification.</p> <p><b>1.3</b> Concept of Taxonomic Hierarchy : Taxon, species, Variants of Speciation (Allopatric, Peripatric, Parapatric and Sympatric).</p> <p><b>1.4</b> Methods of classification : Phenetic, Evolutionary, Cladistics.</p> <p><b>1.5</b> Terminologies used in cladistics : Apomorphy, Plesiomorphy, Synplesiomorphy, Terminal taxa, Autapomorphy, Sister groups, Synapomorphy, Monophyletic and polyphyletic group, transformation series.</p> <p><b>1.6</b> Biodiversity : Definition, History, Importance.</p> <p><b>1.7</b> Levels of Biodiversity : Ecological, Genetic and Organismal.</p> <p><b>1.8</b> Biodiversity Resources of India.</p>	6
2.	<p><b>Species Identification for Biodiversity Documentation :</b></p> <p><b>2.1</b> Species Identification keys : Simple non-bracket key,</p>	9

	<p>Bracket key, Combined indented key.</p> <p><b>2.2</b> Identification tools : Text key, Picture Key, Identify It, Map key.</p> <p><b>2.3</b> Nomenclature : International Codes of Zoological Nomenclature (ICZN)</p> <p><b>2.4</b> Type (type- specimen) and its function. Primary types : Holotype, Allotype, Paratype. Supplementary types : Neotype, Plesiotype. Icotypes : Topotype, Metatype, Morphotype, Lectotype, Voucher specimen.</p> <p><b>2.5</b> Morphology based identification : Its merits and demerits.</p> <p><b>2.6</b> Molecular based identification : Procedure &amp; applications of DNA barcoding, Reference databases for DNA barcoding (iBOL, BOLD, UNITE).</p> <p><b>2.7</b> Molecular Markers : RFLP and RAPD techniques and applications in systematics.</p> <p><b>2.8</b> Bioinformatics and its applications in systematic, introduction to phylogenetic software (PHYLIP, MEGA).</p> <p><b>2.9</b> Estimates of Animal biodiversity in India, Biodiversity hotspot in India, Endemic and exotic species.</p>	
3.	<p><b>Assessment of Biodiversity :</b></p> <p><b>3.1</b> Inventorying and monitoring Biodiversity</p> <p><b>3.2</b> Spatial scale of measurement of Inventorying and Monitoring : Site or local level, Sub-national level, National level, Regional and continental level, global level.</p> <p><b>3.3</b> Methods for Inventorying and Monitoring Faunal Population :</p> <p>i) Mark-recapture, ii) Radio-tracking, iii) Remote sensing of population, iv) Territory mapping, point count and transects, v) Single species inventorying and monitoring (high impact species),</p>	4

	vi) Multi-species inventorying and monitoring (taxa inventorying).	
4.	<p><b>Biodiversity and its components and measurement :</b></p> <p><b>4.1</b> Species Diversity :</p> <p>i) Measuring biodiversity :</p> <p>ii) Species Richness</p> <p>iii) Relative abundance : Alpha, Beta, Gamma diversity</p> <p>iv) Species diversity indices : Shannon diversity index, Margalef diversity index, McIntosh diversity index, Pielou evenness index, Simpson's diversity indices.</p> <p><b>4.2</b> Genetic Diversity :</p> <p>i) Gene Frequencies in population.</p> <p>ii) Mutation.</p> <p>iii) Gene flow.</p> <p>iv) Natural selection.</p> <p>v) Genetic drift.</p> <p><b>4.3</b> Ecosystem Diversity :</p> <p>i) Structural / Habitat diversity.</p> <p>ii) Community Diversity.</p>	4
5.	<p><b>Types of Taxonomic Publication - Specification and Importance :</b></p> <p><b>5.1</b> Taxonomic revisions.</p> <p><b>5.2</b> Taxonomic checklists.</p> <p><b>5.3</b> Taxonomic reports .</p> <p><b>5.4</b> New records.</p> <p><b>5.5</b> Taxonomic surveys.</p> <p><b>5.6</b> Monographs.</p> <p><b>5.7</b> Manuals.</p> <p><b>5.8</b> Field guides.</p> <p><b>5.9</b> Description or redescription of new species / taxa.</p> <p><b>5.10</b> Leading journals for Taxonomic publications.</p>	3
6.	<p><b>Biodiversity Laws and Governing bodies in India :</b></p> <p><b>6.1</b> Indian Forest Act.</p> <p><b>6.2</b> Indian Wildlife Protection Act, 1972.</p>	4

	<p><b>6.3</b> Biological Diversity Act, 2002.</p> <p><b>6.4</b> Major Governing bodies in India : Role and Procedure to apply for Biodiversity studies - The National Biodiversity Authority (NBA), The State Biodiversity Boards (SBB), Maharashtra State Biodiversity Borad (MSBB), Biodiversity Management Committees (BMC), and People's Biodiversity Registers (PBRs). The Chief Wildlife Warden / Principal Chief Conservator of Forest – Wildlife (PCCF- WL).</p>	
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### Suggested Readings :

1. Faunal Diversity in India: An Overview: In Faunal Diversity in India, Alfred JRB, 1-495. (Editors. Alfred, JRB, et al., 1998). ENVIS Centre, Zoological Survey of India, Kolkata. (1998).
2. Threatened Animals of India, Tikadar B. K., ZSI publication, Kolkata. (1983).
3. Principles of Systematic Zoology, 2<sup>nd</sup> edition, Mayr E and Ashlock P. D. McGraw-Hill Inc., USA. (1991).
4. The Diversity of Life, The College edition, Wilson E. O., W. W. Northem & Co. (2010).
5. The Biology of Biodiversity, Kato M., E-Book. Springer. (2012).
6. The Phylogenetic Handbook: A Practical Approach to Phylogenetic Analysis and Hypothesis Testing, 2<sup>nd</sup> edition, Vandamme A. M., Salemi M., Lemey P. Cambridge University Press. (2009).
7. An Introduction to Taxonomy, Narendran T. C., Zoological Survey of India, Kolkata, India. (2000).
8. The book of Indian animals. 3<sup>rd</sup> Ed., Prater S. H., Bombay Natural History Society and Oxford University Press. (1971).
9. Principles and Techniques of Contemporary Taxonomy, Quicke D. L. J., New York : Chapman and Hall. (1993).
10. Indian Wildlife -Threats and Preservations, Sharma B. D., Anmol Publications Pvt. Ltd., New Delhi. (2002).
11. Global Biodiversity, Sinha R. K. and Singh D., INA Shree Publishers, New Delhi. (1997).



12. Theory and Practice of Animal Taxonomy, Kapoor V. C. Oxford & IBH Publishing Co. (2008).

ZOO 506 MJP : Laboratory Exercises in Biochemistry and Cell Biology							
Teaching Scheme					Marking Scheme		
Year	Semester	Course Type	Credits	Practical per week	Continuous Internal Assessment	End Semester Examination	Total
I	I	Major Core	02	01	15	35	50

### Course Outcomes :

After completion of the course student will be able to :

CO1 : Make the buffers of known pH and molarity.

CO2 : Estimate protein & carbohydrates from the given sample.

CO3 : Assess the enzyme activity and factors affecting it.

CO4 : Perform paper chromatography, thin layer chromatography.

CO5 : Analyse samples using thin layer and paper chromatography.

CO6 : Isolate subcellular organelles and perform marker enzyme assays.

CO7 : Identify various stages of mitosis and meiosis.

CO8 : Understand and differentiate between dead and live cells.

CO9 : Isolate nuclei, lysosomes & mitochondria from cells.

### Detailed Syllabus :

Sr. No.	Title of the Practical	Practical Assigned (P)
<b>Section - I : Biochemistry</b>		
1.	Separation of amino acids by thin layer chromatography. <b>(Compulsory)</b>	<b>1P</b>
2.	Estimation of ascorbic acid in fruit juice.	<b>1P</b>
3.	Estimation of carbohydrates by Anthrone method. <b>(Compulsory)</b>	<b>1P</b>
4.	Protein estimation by Bradford method. <b>(Compulsory)</b>	<b>1P</b>
5.	Isolation of alpha amylase from potato.	<b>1P</b>
6.	Effect of Substrate concentration on enzyme activity. Calculation of $K_m$ and $V_{max}$ . <b>(Compulsory)</b>	<b>2P</b>

7.	Effect of pH on enzyme activity.	1P
8.	Effect of inhibitor/activator on enzyme activity.	1P
9.	Estimation of uric acid.	1P
10	Estimation of Vitamin A / E.	1P
<b>Section - II : Cell Biology</b>		
11.	Preparation of cellular staining (Acidic, basic, neutral and their example).	1P
12.	Demonstration of Bar body from the oral mucosa of human female.	1P
13.	Principle of different types of cancer therapy (chemotherapy, hormone therapy, radio therapy).	1P
14.	Temporary preparation of human cheek epithelial cells. <b>(Compulsory)</b>	1P
15.	Study of different stages of mitosis using onion root tips / any suitable material and Mitotic index. <b>(Compulsory)</b>	1P
16.	Study of meiosis in grasshopper testes / onion flower buds / <i>Aloe vera</i> with emphasis on all stages of prophase.	1P
17.	Sub cellular fractionation and Nuclear counting.	2P
18.	Determination of Percent Hemolysis and the Osmotic Fragility of Erythrocytes.	1P
19.	Preparation of blood smear : Cell type identification and differential count.	1P

<b>ZOO 507 MJP : Laboratory exercises in Biosystematics, Biodiversity and Medical Entomology</b>							
<b>Teaching Scheme</b>					<b>Marking Scheme</b>		
Year	Semester	Course Type	Credits	Practical per week	Continuous Internal Assessment	End Semester Examination	Total
<b>I</b>	<b>I</b>	<b>Major Core</b>	<b>02</b>	<b>01</b>	<b>15</b>	<b>35</b>	<b>50</b>

**Course Outcomes :**

After successfully completing this course, students will be able to :

CO1 : Apply and perform the techniques of animal collection, preservation, and identification.

CO2 : Apply and perform the techniques of animal specimen storage and curation of

preserved specimens.

CO3 : Apply and perform the calculation of biodiversity indices.

CO4 : Apply and Perform Phylogenetic analysis using MEGA software.

CO5 : Conduct biodiversity survey with scientific and non-invasive collection techniques and understand role as biodiversity protector, preserver and promotor of life of animals.

CO6 : Understand the medical importance of insects and their role as vector. Know the causes of arthropod-borne diseases.

CO7 : Know the role of insects in forensic investigations.

CO8 : Apply knowledge of prophylaxis or preventive measures against diseases caused by insect vectors.

### Detailed Syllabus :

Sr. No.	Title of the Practical	Practical Assigned (P)
<b>Section – I : Biosystematics and Biodiversity</b>		
1.	Study of various sampling methods used in biodiversity survey : Transects, point counts, spot mapping.	1P
2.	Study of preservation methods for organism specimens : <b>Dry method</b> : Curation and Pinning (Insects), carding and double mounting (Small insects e. g. beetles, hymenopteran & dipteran).	1P
3.	Study of preservation methods for organism specimens : <b>Wet method</b> : Formalin preservation (Invertebrates, Amphibians, Fishes and Reptiles); Preservation in alcohol (ethyl alcohol, isopropyl alcohol ).	1P
4.	Hands on training on use of different insect collection equipments (Any 5) : (1) Cage trap (for small mammals), (2) Light traps, (3) Pitfall traps, (4) Berlese funnel, (5) Pan traps /beating tray, (6) Aspirator, (7) Collection Nets (Sweep net / aerial net / aquatic net), (8) Sticky colour traps.	1P
5.	Survey, collection (Minimum 20 insect specimens), preservation and identification of insect pests from local area / habitat from various orders. <b>(Compulsory)</b>	2P
6.	Identification of given specimens to the level of species using	1P

Sr. No.	Title of the Practical	Practical Assigned (P)
	identification keys provided (any two) : (1) Honey bee, (2) cockroach, (3) freshwater snails, (4) freshwater fishes. <b>(Compulsory)</b>	
7.	Calculation of Biodiversity indices : Simpson's diversity Index, Shannon's diversity Index, Evenness Index and relative abundance. <b>(Compulsory)</b>	1P
8.	Phylogenetic analysis and tree construction using Phylogenetic Software [MEGA].	1P
9.	Compulsory visit to Coastal area / Tiger reserve / National park / Wildlife sanctuary / ZSI / BNHS and submission of report.	2P
<b>Section – II : Medical Entomology</b>		
10.	Survey, collection, preservation and identification of any five arthropod vectors. <b>(Compulsory)</b>	1P
11.	Study of insect with respect to distinguishing features, role as vector and control measures of (Any 5) : <b>Diptera</b> : <i>Phlebotomus</i> (Sand fly), <i>Culicoides</i> (Biting midges), <i>Tabanus</i> (Horse fly), <i>Anopheles</i> (Mosquito), <i>Aedes</i> (Mosquito), <b>Siphonaptera</b> : <i>Ctenocephalides felis</i> (Cat flea), <i>Xenopsylla cheopis</i> (Oriental Rat flea). <b>(Compulsory)</b>	1P
12.	Study of insect with respect to distinguishing features, role as vector and control measures of (Any 5) : <b>Psocodea</b> : <i>Pediculus humanus</i> (Head Louse), <i>Phthirus pubis</i> (Pubic louse), <b>Hemiptera</b> : <i>Panstrongylus</i> (Reduviid bug), <i>Cimex</i> (Bedbug), <b>Blattoidea</b> : <i>Blatta</i> , <i>Blattella</i> , <i>Periplaneta</i> (Cockroaches). <b>(Compulsory)</b>	1P
13.	Study of Arthropod borne diseases with reference to symptoms, pathogenicity and control : a) Protozoan disease (Leishmaniasis, Malaria), b) Viral disease (Dengue fever), c) Bacterial disease (Bubonic plague, Bartonellacea / Carrions	2P

Sr. No.	Title of the Practical	Practical Assigned (P)
	disease), d) Rickettsiosis (epidemic and endemic typhus).	
14.	Study of insects of forensic importance : Identification, life history, and economic importance : Blow flies, Flesh flies, House flies, Carrion beetle, Rove beetle, Scarab beetles, Dermestid beetle, Sap beetle etc. (Any 3)	1P
15.	Collection of life cycle stages from flies of forensic importance using decaying flesh bait and identification of larval instars with its correlation to time of death.	1P
16.	Study of venomous and allergic arthropods.	1P
17.	Housefly rearing in the laboratory and study of its life cycle.	1P
18.	Compulsory visit to nearby institute of Medical Entomology / Forensic laboratory and Report writing.	2P

ZOO 508 MJ : Biostatistical Applications							
Teaching Scheme					Marking Scheme		
Year	Semester	Course Type	Credits	Lectures per week	Continuous Internal Assessment	End Semester Examination	Total
I	I	Major Elective	02	02	15	35	50

**Course Outcomes :**

After successfully completing this course, students will be able to :

CO1 : To understand the computational procedure of summary statistics.

CO2 : To understand the computational procedure of testing of hypothesis.

CO3 : To write the meaning of statistical computations in domain language.

**Detailed Syllabus :**

Sr. No.	Topics	Lectures Assigned (L)
1.	Introduction, Definition of Statistics, Data types (Numerical and categorical), Raw data.	1
	Measures of central tendency : Mean, median, mode, quartiles of raw data.	2
	Measures of Dispersion : Variance, Standard deviation, Coefficient of variation of raw data, Contingency tables for categorical data.	3
	Bivariate data : Concept of Bivariate data, identifying dependent and independent variables, Scatter diagram.	2
	Correlation Study : Coefficient of correlation, interpretation of scatter diagram, and Coefficient of correlation.	4
	Regression Study : Computing line of regression, Interpretation of regression coefficient, Predicting response variable.	3
2.	Introduction, Concept of sample and population, parameter and statistic, concept of testing of hypothesis.	2
	Some Definitions : Hypothesis - Null and Alternative, One-sided and two-sided alternative hypothesis, Critical region, region of acceptance, types of errors, level of significance (LoS), p-value.	4
	T Test : Single sample t - test; two sample t-test - independent and paired sample t-test.	3
	F test : F test for equality of variance.	1
	Chi - Square Test : Chi - square test for independence of attributes.	1
	Analysis of Variance : ANOVA - One way and Two way.	4

**Suggested Readings :**

1. Fundamentals of Statistics By Gun Gupta and Das Gupta. World Press Publishers. (2016).
2. Common Statistical Tests By Anil Gore and Madhav Kulkarni. International Journal of current research. (2020).
3. Testing Statistical Hypotheses By E. L. Lehmann., Springer Press Publishers. (2005).

<b>ZOO 509 MJP : Laboratory Exercises in Biostatistical Applications</b>							
<b>Teaching Scheme</b>					<b>Marking Scheme</b>		
<b>Year</b>	<b>Semester</b>	<b>Course Type</b>	<b>Credits</b>	<b>Practical per week</b>	<b>Continuous Internal Assessment</b>	<b>End Semester Examination</b>	<b>Total</b>
<b>I</b>	<b>I</b>	<b>Major Elective</b>	<b>02</b>	<b>01</b>	<b>15</b>	<b>35</b>	<b>50</b>

**Detailed Syllabus :**

<b>Sr. No</b>	<b>Title of the Practical</b>	<b>Practical Assigned (P)</b>
<b>1.</b>	Computation of mean, median, mode, quartiles.	<b>2 P</b>
<b>2.</b>	Computation of Variance, Standard Deviation, Coefficient of Variation.	<b>2 P</b>
<b>3.</b>	A plot of Scatter diagram, Computation of correlation coefficient.	<b>2 P</b>
<b>4.</b>	Computing regression line, and predicting response variable.	<b>1 P</b>
<b>5.</b>	Testing of hypothesis – t - test for single mean.	<b>1 P</b>
<b>6.</b>	Testing of hypothesis – t - test for comparison of two means.	<b>2 P</b>
<b>7.</b>	Testing of hypothesis – paired t - test.	<b>2 P</b>
<b>8.</b>	Testing of hypothesis – F test.	<b>1 P</b>
<b>9.</b>	Testing of hypothesis – Chi - Square test.	<b>2 P</b>
<b>10.</b>	ANOVA One Way.	<b>1 P</b>
<b>11.</b>	ANOVA Two Way.	<b>1 P</b>

<b>ZOO 510 MJ : Fresh Water Zoology</b>							
<b>Teaching Scheme</b>					<b>Marking Scheme</b>		
<b>Year</b>	<b>Semester</b>	<b>Course Type</b>	<b>Credits</b>	<b>Lectures per week</b>	<b>Continuous Internal Assessment</b>	<b>End Semester Examination</b>	<b>Total</b>
<b>I</b>	<b>I</b>	<b>Major Elective</b>	<b>02</b>	<b>02</b>	<b>15</b>	<b>35</b>	<b>50</b>

**Course Outcomes :**

After completing the course student will be able to :

CO1 : Get introduced to the freshwater ecosystems.

CO2 : Illustrate the physical and chemical properties of water.

CO3 : Acquire first-hand experience of the aquatic biodiversity.

CO4 : Acquire skills to critically evaluate scientific aspects of Freshwater Zoology.

CO5 : Get aware with the threats and an opportunity to resolve the issues related to freshwater habitats.

CO6 : Introduced with the current issues of the subject.

### Detailed Syllabus :

Sr. No.	Topics	Lectures Allotted (L)
1.	<b>Introduction to Freshwater Zoology :</b> <b>1.1</b> Freshwater habitats : Lentic, lotic and ephemeral. <b>1.2</b> Zonation in lakes : Littoral, limnetic and benthic, Light zones - photic, aphotic ; Temperature zones - epilimnion, hypolimnion, thermocline. <b>1.3</b> The importance of freshwater habitats.	3
2.	<b>Water as Medium of Life : (Physical and chemical properties of water) :</b> <b>2.1</b> Implications of physical and chemical conditions of water on freshwater fauna. <b>2.2</b> Temperature, transparency, hardness, pH, dissolved oxygen and chloride.	4
3.	<b>Introduction to Freshwater Fauna : (Study of habitats, general and distinguishing features, ecological and economical importance) :</b> <b>3.1</b> Zooplankton : Rotifera, Cladocera and Copepoda. <b>3.2</b> Meiobenthic : Gastrotricha and Tardigrada. <b>3.3</b> Fauna of temporary water bodies : Large Branchiopods (fairy shrimps and tadpole shrimps). <b>3.4</b> Aquatic insects : Water strider, giant water bug, <i>Dytiscus sp</i> and <i>Cybister sp</i> . <b>3.5</b> Fishes - catfishes, and crustaceans - crabs, prawns.	12



4.	<b>Impact on Freshwater Habitats : Drivers of freshwater biodiversity loss :</b> <b>4.1</b> Hydrological alteration (dams), pollution, habitat degradation, species over exploitation, urbanization, and climate change. <b>4.2</b> Exotic species invasion in freshwater : biodiversity loss and biotic homogenization. <b>4.3</b> Cultural eutrophication : causes and consequences.	7
5.	<b>Conservation measures of Freshwater :</b> <b>5.1</b> Need and importance of conservation. <b>5.2</b> Legislative measures : Ramsar convention, Ramsar sites in India. <b>5.3</b> Interlinking of Indian rivers : Need and associated challenges. <b>5.4</b> National Water Policy.	4

#### Suggested Readings :

1. Limnology : Lake and River Ecosystems, 3<sup>rd</sup> edition, Robert G. Wetzel. Academic Press. (2001).
2. Ecology and Classification of North American Freshwater Invertebrates, James H. Throp and Alan P. Covich, Academic Press. (1991).
3. Pennak's Freshwater Invertebrates of the United States : Porifera to Crustacea, Douglas G. Smith, John Wiley and Sons. (2001).
4. Freshwater Biology, Edmondson W. T., John Wiley and Sons. (1959).
5. Freshwater Animals of India : An Ecological Approach, Tonapi G. T., Oxford and IBH Press. (1980).
6. Limnology, Paul Smith Welch, McGraw Hill. (2022).
7. Animal Life in Fresh Water A Guide to Fresh - Water Invertebrates, Helen Mellanby, Methuen and Co. (2012).
8. Stream Ecology, Allan J. D. Chapman and Hall, New York. (1994).
9. Elements of Ecology, Smith R. L. 3<sup>rd</sup> edition, Harper Collins Publishers, New York. (2012).
10. Limnology, Wetzel R. G. 3<sup>rd</sup> edition, Academic Press, San Deigo, California. (2001).
11. Freshwater Ecology Concepts and Environmental Applications of Limnology, Walter K. Dodds, Matt R. Whiles. Elsevier, Amsterdam. (2002).

ZOO 511 MJP : Laboratory Exercises in Freshwater Zoology							
Teaching Scheme					Marking Scheme		
Year	Semester	Course Type	Credits	Practical per week	Continuous Internal Assessment	End Semester Examination	Total
I	I	Major Elective	02	01	15	35	50

**Course Outcomes :**

After completing the course student will be able to :

CO1 : Get hands on training experience in limnological techniques.

CO2 : Will be able to identify freshwater invertebrates.

CO3 : Understand the relevance of freshwater fauna to the aquatic ecosystems.

CO4 : Able to culture zooplanktons.

CO5 : Understand the aquatic adaptations in freshwater fauna.

**Detailed Syllabus :**

Sr. No.	Title of the Practical	Practical Assigned (P)
1.	Estimation of chloride form given water sample.	1P
2.	Estimation of calcium and total hardness of given water sample.	1P
3.	Determination of water quality parameters of a freshwater body - pH, temperature, conductivity, total dissolved solids, salinity, secchi disk transparency. (Any five)	2P
4.	Estimation of total alkalinity of given water sample.	2P
5.	Collection, preservation and storage of zooplankton from freshwater habitat.	2P
6.	A qualitative and quantitative analysis of zooplankton from a given freshwater sample using Sedgwick rafter counting cell. (Any four zooplanktons)	2P
7.	Laboratory culture of Rotifers.	1P
8.	Laboratory culture of <i>Paramecium</i> .	1P
9.	Laboratory culture of <i>Daphnia</i> .	1P

10.	Estimation of phosphate from given water sample.	1P
11.	Estimation of sulphate from given water sample.	1P
12.	Estimation of nitrate from given water sample.	1P
13.	Study of fresh water nekton (any four aquatic insects).	1P
14.	Study of locomotory and respiratory adaptations in water strider, giant water bug, <i>Dytiscus sp.</i> and <i>Cybister sp.</i>	1P
15.	Study of any two locally available freshwater fishes and crustaceans.	1P
16.	A compulsory field visit and submission of report : Lentic / Lotic / Ephemeral water bodies.	1P

ZOO 512 MJP : Laboratory Exercises in Comparative Embryology							
Teaching Scheme					Marking Scheme		
Year	Semester	Course Type	Credits	Practical per week	Continuous Internal Assessment	End Semester Examination	Total
I	I	Major Elective	02	01	15	35	50

**Course Outcomes :**

After completing the course student will be able to :

CO1 : The course provides detailed idea about embryonic zoology and develops skills required to work in the area of clinical embryology and fertility centres.

CO2 : Different types of egg and cleavage patterns according to developmental need of embryo and processes of blastulation.

CO3 : To understand the mechanism of regeneration and metamorphosis in lower organisms.

CO4 : To understand teratogenic effects of developing embryo.

CO5 : To understand the mechanism of gastrulation resulting into separation of germ layers.

CO6 : Identify the different developmental stages of frog & chick embryo.

**Detailed Syllabus :**

Sr. No.	Title of the Practical	Practical Assigned (P)
1.	Study of different eggs. (Insect, Amphioxus, Frog and Hen).	1P

2.	Study of early developmental stages in any freshwater snail.	1P
3.	Effects of Lithium Chloride on the development of <i>Lymnea</i> .	2P
4.	Study of life cycle of <i>Drosophila melanogaster</i> .	2P
5.	Study of life cycle of House fly.	2P
6.	Study of effect of ligature in <i>Drosophila</i> / House fly larva.	2P
7.	Study of embryonic and post-embryonic development using frog egg as a model system.	1P
8.	Gross anatomy and histology of chick embryo up to 96 hrs. (18 hrs, 24 hrs, 33hrs, 48 hrs, 56 hrs, 72 hrs and 96 hrs) Brain, heart, lens development.	2P
9.	Mounting of chick embryos by using filter paper and preparation of permanent mounts.	2P
10.	Chick embryo culturing by ex - ovo method. (Shell less culture).	2P

ZOO 513 MJP : Laboratory Exercises in Histological Techniques							
Teaching Scheme					Marking Scheme		
Year	Semester	Course Type	Credits	Practical per week	Continuous Internal Assessment	End Semester Examination	Total
I	I	Major Elective	02	01	15	35	50

### Course Outcomes :

After completing the course student will be able to :

CO1 : Learner will be able to understand and compare the different key concepts of histology and histochemistry.

CO2 : Learner will be able to understand structural aspect of different organs.

CO3 : Learner will be able to understand the clinical histopathology of abnormal tissue.

CO4 : Learner will be able use various histochemical techniques for analysis of different biomolecules like proteins, carbohydrates, lipids and nucleic acid etc.

**Detailed Syllabus :**

Sr. No.	Title of the Practical	Practical Assigned (P)
1.	Fixation, dehydration, embedding, sectioning, staining, permanent mounting of tissues and histology.	5P
2.	Study of histopathological changes (permanent slides) – gastric ulcers, cirrhosis of liver, breast tumors, cystic follicles of ovary, pancreas in diabetics, cryptorchid testis and leukemia.	2P
3.	Microscopic measurements of histological samples using micrometers and planimeters.	2P
4.	Preparation of different reagents / stains for histology.	2P
5.	Proteins and lipids staining by Sudan Black, Nucleic acid staining by Methyl green – Pyronine, Feulgen stain.	2P
6.	Millon's reagent and histochemical detection of basic proteins.	2P
7.	Principles and methods of application and utility of classical histochemical Techniques : for localization of glycoproteins (PAS), nucleic acids (Feulgen) and steroid dehydrogenase activity.	2P

ZOO 514 MJ : Research Methodology							
Teaching Scheme					Marking Scheme		
Year	Semester	Course Type	Credits	Lectures per week	Continuous Internal Assessment	End Semester Examination	Total
I	I	Research Methodology	02	02	15	35	50

**Course Outcomes :**

CO1 : Explain concept of research methodology.

CO2 : Define research problem.

CO3 : Explain need of literature review in research.

CO4 : Prepare research designs and explain their characteristics.

CO5 : Collect and present the data.

CO6 : Analyse data by using appropriate tests.

CO7 : Write research report and research paper.

**Detailed Syllabus:**

Sr. No.	Topics	Lectures Assigned (L)
1.	<b>Research :</b> 1.1 Meaning. 1.2 Objectives, Types of research. 1.3 Types, approaches and significance of research. 1.4 Planning research project. 1.5 Identifying Research problems. 1.6 Selection of problem. 1.7 Formulation of a problem.	4
2.	<b>Data Collection :</b> 3.1 Meaning. 3.2 Methods and tools of Data collection, Hypothesis sampling. 3.3 Data processing, analysis and interpretation of data.	3
3.	<b>Research Design :</b> 4.1 Meaning and objectives. 4.2 Characteristics of good research design. 4.3 Components of the research design & steps in scientific research process.	2
4.	<b>Research Methodology in Medical and Biological Sciences :</b> 4.1 Introduction to ethics in human and animal studies. 4.2 Basic principles of human research ethics, international regulations, introduction to clinical research, controlled clinical research, estimating sample size. 4.3 Epidemiology - concepts and methods, study designs of epidemiological studies, experimental studies and randomized control trials. 4.4 Biomedical waste disposal, Biodiversity act 2008.	10
5.	<b>Measurement and Scaling :</b> 5.1 Qualitative and quantitative data; Classification of measurement scales; goodness of measurement scales. 5.2 Sources of error in measurement; Techniques of developing	3

	measurement tools; Scaling techniques. <b>5.3</b> Multi dimensional scaling.	
6.	<b>Computer application</b> : Bioinformatics, data bases and their applications.	2
7.	<b>Dissertation structure</b> : 7.1 Components, Writing Introduction, review of literature, Materials & Methods. 7.2 Presentation of results, discussion of results based on literature, arriving conclusions, briefing of summary, arrangement and how to quote reference in thesis, appendix.	2
8.	<b>Publishing of Articles in National and International Journals</b> : Selection of journals, ISSN number, Peer reviewed journals, UGC CARE list journals, H - Index, Science citation index, Impact factor and its importance.	1
9.	<b>Intellectual property rights and patent law</b> : Trade Related aspects of Intellectual Property Rights, Reproduction of published material, Plagiarism, Citation and acknowledgement, Patent Criteria and procedure of patenting, patenting biological material, Publication ethics.	3

**Suggested Readings :**

1. Research Methodology: Methods and Techniques, Kothari, C. R. Wiley Eastern. (1985).
2. Research Methods, Dominowski, R. L., Prentice Hall Inc., New Jersey. (1980).
3. Research Methodology, Handbook Concept Publishing Company, Mishra, R. P. New Delhi. (1980).
4. Research and Writtings By P. Ramdas, A. Wilson srnai M. J. Publisher. (2009).
5. Scientific thesis writings and Paper presentations, N. Gurumani., M. J. Publisher. (2010).
6. Thesis and assignment, Anderson, Durston & Polle writing Wiley Eastern Limited. (1970).
7. Research Methods : Tip & Techniques, G. Vijayalakshmi and C. Sivapragasam M. J. P. Publishers, Chennai. (2008).
8. Statistical analysis in Biology, Malter K., Chapmen Hall, London. (1972).

9. Research Methods in Education, 5<sup>th</sup> edition, Cohen, L. Lawrence, M., & Morrison, K. Oxford, Oxford University Press. (2005).
10. Practical Research : Planning and design, Leedy, P. D. Washington : Mc Millan Publishing Co., Inc. (1980).
11. Fundamental of Research Methodology and Statistics, Singh, Y. K. New Delhi. New International Limited, Publishers. (2006).

<b>ZOO 515 MJP : Laboratory Exercises in Research Methodology</b>							
<b>Teaching Scheme</b>					<b>Marking Scheme</b>		
<b>Year</b>	<b>Semester</b>	<b>Course Type</b>	<b>Credits</b>	<b>Practical per week</b>	<b>Continuous Internal Assessment</b>	<b>End Semester Examination</b>	<b>Total</b>
<b>I</b>	<b>I</b>	<b>Research Methodology</b>	<b>02</b>	<b>01</b>	<b>15</b>	<b>35</b>	<b>50</b>

#### **Course Outcomes :**

After completing the course student will be able to :

CO1 : Suggest suitable title for a research article.

CO2 : Write the abstract, key words, result, discussion, conclusion and citations of references.

CO3 : Write a research project proposal to seek funding.

CO4 : Use MS excel in presentation and analysis of data using common statistical tests.

CO5 : Conduct a scientific survey.

#### **Detailed Syllabus :**

<b>Sr. No.</b>	<b>Title of the Practical</b>	<b>Practical Assigned (P)</b>
<b>1.</b>	Selecting a title for the paper, writing the abstract and key words. <b>(Compulsory)</b>	<b>1 P</b>
<b>2.</b>	Writing the results, discussion and conclusions, citation of references. <b>(Compulsory)</b>	<b>2 P</b>
<b>3.</b>	Writing of introduction and material and methods. <b>(Compulsory)</b>	<b>1 P</b>
<b>4.</b>	Layout of a research paper. <b>(Compulsory)</b>	<b>1 P</b>
<b>5.</b>	Importance of scientific surveys, primary data and secondary data in research.	<b>1 P</b>



6.	Writing a project proposal to a funding agency. <b>(Compulsory)</b>	1 P
7.	Use of MS Excel in data presentation.	2 P
8.	Examples of some common statistical tests.	2 P
9.	Preparation of ICT enabled scientific presentation. <b>(Compulsory)</b>	2 P
10.	Presentation of any ONE recent research paper. <b>(Compulsory)</b>	1 P
11.	Laboratory safety during handling of pathogenic organisms and hazardous chemicals. <b>(Compulsory)</b>	1 P
12.	Compulsory field visit for collection of samples for research.	2 P



**SEMESTER - II**

<b>ZOO 551 MJ : Molecular Biology</b>							
<b>Teaching Scheme</b>					<b>Marking Scheme</b>		
<b>Year</b>	<b>Semester</b>	<b>Course Type</b>	<b>Credits</b>	<b>Lectures per week</b>	<b>Continuous Internal Assessment</b>	<b>End Semester Examination</b>	<b>Total</b>
<b>I</b>	<b>II</b>	<b>Major Core</b>	<b>02</b>	<b>02</b>	<b>15</b>	<b>35</b>	<b>50</b>

**Course Outcomes :**

After completing the course student will be able to :

CO1 : Discuss the basic features of chromatin essentially to get insight of gene.

CO2 : To study the structure and types of DNA and RNA, physical properties and topology of DNA and genome organization.

CO3 : Understand the details of DNA replication in prokaryotes and eukaryotes, enzymes involved in the process of replication, significance of replisome and primosome.

CO4 : Understand the process of transcription both in prokaryotes and eukaryotes with reference to enzymes involved in details, transcriptional unit.

CO5 : Understand the genetic code; ribosome structure.

**Detailed Syllabus:**

<b>Sr. No.</b>	<b>Topics</b>	<b>Lectures Assigned (L)</b>
<b>1.</b>	<p><b>Basics of Chromatin :</b></p> <p><b>1.1 Ultrastructure of Chromatin :</b> Multi strand model, folded fiber model and nucleosome model.</p> <p><b>1.2 Chromatin organization :</b> Nucleosome and Bead on string, 30 nm chromatin fiber, higher level of DNA packaging into metaphase chromosome.</p> <p><b>1.3 Chromatin remodeling :</b> Definition, mechanism of chromatin remodeling reconstruction, enzyme - induced covalent modification, and repositioning).</p> <p><b>1.4 Function of Chromatin.</b></p> <p><b>1.5 Organization of chromosome, centromere and telomere with</b></p>	<b>4</b>

	respect to unique and repetitive DNA sequences - LINEs, SINEs, satellite DNA.	
2.	<p><b>DNA topology and genome Organization :</b></p> <p><b>2.1</b> Structure and types of DNA and RNA.</p> <p><b>2.2 Physical properties of DNA :</b> T<sub>m</sub>, Hypo and hyperchromicity, solubility, mutarotation and buoyancy.</p> <p><b>2.3 Topology of DNA -</b> Supercoiling-positive and negative supercoiling, knots and catenanes, linking number, twist and writhe.</p> <p><b>2.4 Genome organization :</b> C value paradox and genome size, Cot curves, Cot ½ kinetic and sequence complexity.</p>	6
3.	<p><b>DNA Replication :</b></p> <p><b>3.1</b> Types of DNA polymerases in Prokaryotes and Eukaryotes.</p> <p><b>3.2</b> Replisome and Primosome.</p> <p><b>3.3</b> Process of replication in Prokaryotes – Initiation - Origin of replication, formation of replication bubble, replication fork, leading and lagging strand, elongation and termination.</p> <p><b>3.4</b> Process of replication in Eukaryotes - Concept of multiple replicons, initiation, elongation, termination.</p> <p><b>3.5</b> Assembly of Nucleosome after replication.</p>	7
4.	<p><b>Transcription</b></p> <p><b>4.1</b> Transcriptional unit.</p> <p><b>4.2</b> RNA polymerases, Transcription factors and machinery - TATA binding proteins (TBP) and TBP associated factors (TAF).</p> <p><b>4.3</b> Process of Transcription in prokaryotes and eukaryotes : Initiation, Elongation and termination of transcription – Rho-dependent and independent.</p> <p><b>4.4</b> Ribonucleoproteins (SnRNPs &amp; ScRNPs).</p> <p><b>4.5</b> Nuclear export of mRNA.</p>	7
5.	<p><b>Translation :</b></p> <p><b>5.1</b> Genetic Code, ribosome structure, Formation of initiation complex.</p> <p><b>5.2</b> Aminoacylation of tRNA, tRNA - identity, aminoacyl tRNA</p>	6

	synthetase. <b>5.3</b> Initiation, elongation and termination of translation in prokaryotes and eukaryotes.	
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**Suggested Readings:**

1. Molecular Biology of the gene, 7<sup>th</sup> edition, James D Watson, Pearson publication. (2013).
2. Gene XII, Benjamin Lewin, 12<sup>th</sup> edition, Jones and Barlett Publishers. (2018).
3. Molecular Biology of the Cell, 7<sup>th</sup> edition, Bruce Alberts, Rebecca Heald, Alexander D. Johnson, David Morgan, Martin C. Raff, Garland Science, Taylor and Francis Group, (2015).
4. Molecular Cell biology, 6<sup>th</sup> edition, Lodish Berk, Matsudaira, Kaiser, Krleger pub., By W. H. Freeman & Company, New York. (2007).

ZOO 552 MJ : Comparative Endocrinology							
Teaching Scheme					Marking Scheme		
Year	Semester	Course Type	Credits	Lectures per week	Continuous Internal Assessment	End Semester Examination	Total
I	II	Major Core	02	02	15	35	50

**Course Outcomes:**

After successfully completing this course, students will be able to:

CO1 : Discuss the chemical signals & bioregulation of endocrine gland in vertebrates.

CO2 : Explain the synthesis, secretion, metabolism & mechanism of action of vertebrate hormone.

CO3 : Describe the hypothalamus - pituitary system.

CO4 : Justify the comparative aspects of hormones and their physiological functions / role in vertebrates.

CO5 : Describe the adrenal glands of mammalian and non - mammalian vertebrates.

CO6 : Explain the hormonal control of calcium and phosphate homeostasis.

CO7 : Discuss the comparative endocrinology of feeding, digestion and metabolism in vertebrates.

**Detailed Syllabus:**

Sr. No.	Topics	Lectures Assigned (L)
1.	Chemical signals and bioregulation in vertebrates : An overview and methods used to study bioregulation.	5
2.	Synthesis & secretion, Metabolism and mechanism of action of vertebrate hormones.	5
3.	Hypothalamus - Pituitary system : structural organization and comparative aspects of hypothalamus - Pituitary system in vertebrates; hormonal secretions and biological functions.	5
4.	Hypothalamus – Pituitary - Thyroid axis of vertebrates : comparative aspects; hormones and their physiological functions.	5
5.	Adrenal glands of mammalian and non-mammalian vertebrates : structural organization, comparative aspects; hormonal secretions and physiological functions. Hormonal control of calcium and phosphate homeostasis.	5
6.	Comparative endocrinology of feeding, digestion and metabolism in vertebrates; gastrointestinal and pancreatic hormones and their role in digestion and metabolism.	5

**Suggested Readings :**

1. Comparative Vertebrate Endocrinology by P. J. Bently, Cambridge Univ. Press. (1998).
2. General and Comparative Endocrinology by E. J. W. Barrington, Oxford Clarendon Press. (1975).
3. Text Book of Comparative Endocrinology by Gorbman A. and Bern H. A., John Harley and Sous, New York. (2017).
4. Essential of Endocrinology, 4<sup>th</sup> ed., Wiely. Brook, C. G. D. and Marshall, N. J. (2001).
5. Text Book of Endocrinology, 10<sup>th</sup> edition, Larson Williams., W. B. Saunders Company, Philadelphia. (2002).
6. William's Text Book of Endocrinology, 11<sup>th</sup> edition, H. M. Kronenberg S. Melmed, K. S. Polonsky and P. R. Larsen. Publisher Saunders, Elsevier Inc. (2009).
7. Fundamentals of Comparative Endocrinology, Chester Jones *et. al.*, Plenum Press, New York, London. (1987).

8. Comparative Endocrinology, Gorbman *et. al.*, John Wiley and Sons, New York. (1983).
9. Vertebrates Endocrinology, 2<sup>nd</sup> edition, Norris, Lea and Febiger. (1997).
10. Molecular Endocrinology, 2<sup>nd</sup> edition, Acad. Press, San Diego, Bollander F. (1994).
11. Introduction to Endocrinology, Chandra S. Negi, PHI Learning Private Limited, Delhi. (2022).

ZOO 553 MJ : Comparative Animal Physiology							
Teaching Scheme					Marking Scheme		
Year	Semester	Course Type	Credits	Lectures per week	Continuous Internal Assessment	End Semester Examination	Total
I	II	Major Core	02	02	15	35	50

#### Course Outcomes :

After completing this course, students will be able to :

CO1 : Explain digestive system, concept of digestion and enzymes involved digestion.

CO2 : Understand the process of respiration and importance of O<sub>2</sub> and CO<sub>2</sub>.

CO3 : Illustrate the structure of the skeletal muscle, proteins involved in muscle contraction and role of Calcium ions in contraction.

CO4 : Justify the concepts of osmole, osmolarity, tonicity and ionic regulation in different environment.

CO5 : Explain process of excretion, functions of mammalian kidney and role of Renin - Angiotensin system in excretion.

CO6 : Understand different thermo-biological terminology and mechanism of thermoregulation in different animals.

CO7 : Explain different types of sense organs and their functions.

#### Detailed Syllabus :

Sr. No.	Topics	Lectures Assigned (L)
1.	<b>Digestion</b> 1.1 General outline of digestive system of human, ruminant and fish.	2

	<b>1.2 Physiology of Digestion in herbivorous and carnivorous.</b>	
2.	<b>Respiration</b> <b>2.1</b> Respiratory Surfaces : Gills and lungs. <b>2.2</b> Ventilation associated with pulmonary respiration. <b>2.3</b> Structure and functions of respiratory pigments : Haemoglobin, Hemerythrin, Chlorocruorin and Hemocyanin. <b>2.4</b> Oxygen (O <sub>2</sub> dissociation curves) transport and Carbon dioxide Transport. <b>2.5</b> Physiological and Ecological significance of O <sub>2</sub> .	4
3.	<b>Osmoregulation</b> <b>3.1</b> Concept of osmolarity and tonicity, osmo regulators and osmo conformers. <b>3.2</b> Osmoregulation in fishes, reptiles, birds and mammals. <b>3.3</b> Ionic regulation in isosmotic, hypo-osmotic, hyperosmotic and terrestrial environment.	5
4.	<b>Muscle contraction</b> <b>4.1</b> Structure of the skeletal muscle (light and electron microscopic). <b>4.2</b> Proteins of the myofilaments. <b>4.3</b> Nature of actin - myosin interaction. <b>4.4</b> Sarcoplasmic reticulum and role of Ca <sup>++</sup> in contraction.	4
5.	<b>Circulation</b> <b>5.1</b> Comparative anatomy of heart in different vertebrates. <b>5.2</b> Cardiac cycle in mammals.	3
6.	<b>Excretion</b> <b>6.1</b> Structure of mammalian kidney. <b>6.2</b> Different types of nitrogenous waste products. <b>6.3</b> Processes of urine formation in mammalian kidney. <b>6.4</b> Renal regulation.	5
7.	<b>Thermoregulation</b> <b>7.1</b> Biokinetic zones. <b>7.2</b> Thermobiological terminologies. <b>7.3</b> Thermoregulation in poikilotherms and homeotherms.	4
8.	<b>Sense organ</b>	3

	<b>8.1</b> Introduction, classification and function of sense organs. <b>8.2</b> Organs of photoreception. <b>8.3</b> Role of rod and cone cells in vision.	
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**Suggested Readings :**

1. Comparative animal physiology, Clifford Ladd Prosser, John Wiley & Sons. (1991).
2. Animal physiology, Richard W. Hill, Gordon A. Wyse. Harper and Row. (2004).
3. Comparative animal physiology, Philip Carew Withers, Saunders College Pub., (1992).
4. Principles of Animal Physiology, C. D. Moyes and P. M. Schulte, Publisher Pearson Education and Dorling Kindersley Publishing Inc. (2006).
5. Text book of Medical Physiology, 10<sup>th</sup> edition, A. C. Guyton and J. E. Hall Publisher W. B. Saunders Company, Philadelphia. (2001).
6. Principles of Anatomy and Physiology, 11<sup>th</sup> edition, G. J. Tortora and B. Derrickson, Publisher-John Wiley and Sons Inc. (2006).
7. The World of the Cell, 7<sup>th</sup> edition, Wayne M. Becker, Lewis J. Kleinsmith, Jeff Hardin., Publisher - Benjamin Cummings. (2005).

ZOO 554 MJ : Biochemical Techniques							
Teaching Scheme					Marking Scheme		
Year	Semesters	Course Type	Credits	Lectures per week	Continuous Internal Assessment	End Semester Examination	Total
I	II	Major Core	02	02	15	35	50

**Course Outcomes :**

After successful completion of the course, student will be able to :

CO1 : Understand the principle of light, fluorescence, scanning, transmission electron microscope.

CO2 : Understand the principle of centrifugation, various types of Centrifugations, rotors and its applications.

CO3 : Understand the principle and differences between various types of chromatography techniques.

CO4 : Know about agarose and polyacrylamide gel electrophoresis.



**Detailed Syllabus :**

Sr. No.	Topics	Lecture Assigned (L)
1.	<b>Chromatography :</b> 1.1 Principle and applications. 1.2 Ion-Exchange Chromatography, Affinity chromatography. Molecular exclusion chromatography, Thin layer chromatography, HPLC.	5
2.	<b>Electrophoresis :</b> 2.1 Principle of Electrophoresis, Electrophoresis unit, different supports used for electrophoresis and its functions. 2.2 PAGE, 2D electrophoresis, Capillary electrophoresis, Agarose gel electrophoresis.	4
3.	<b>Centrifugation :</b> 3.1 Principle, g and RPM concept, Types of rotors, Preparative and analytical centrifugations. 3.2 Density gradient centrifugation. 3.3 Applications of centrifugation.	4
4.	<b>Spectroscopy :</b> 4.1 Principle and components of spectrophotometer, concepts of light & electromagnetic spectrum. 4.2 Ultraviolet and Visible spectrophotometer. 4.3 Atomic absorption spectroscopy.	4
5.	<b>Microscopy :</b> Principle, working and applications : Inverted and upright microscope, Phase contrast microscope, Fluorescence microscope, Confocal microscope, Transmission and scanning microscope.	5
6.	<b>DNA and Protein sequencing method :</b> 6.1 DNA sequencing method : Maxam - Gilbert Sequencing, Chain termination method, Dye terminator sequencing. 6.2 Next Generation Sequencing. 6.3 Protein sequencing method : N - terminal sequencing, C -	5

	terminal sequencing.	
7.	<b>Biophysical Techniques</b> <b>7.1</b> NMR. <b>7.2</b> Surface Plasma Resonance. <b>7.3</b> Structure determination using X-ray diffraction.	3

### Suggested Readings :

1. An Introduction to Molecular Biotechnology : Molecular Fundamentals, Methods and Applications in Modern Biotechnology, ed., 2<sup>nd</sup> M. Wink. Wiley. (2011).
2. Molecular and cellular Biology, Stephen L.Wolfe, Wadsworth Publishing Company. (1993).
3. Molecular Biology, T. A. Brown, Bios Scientific Publishers Ltd., Oxford. (1991).
4. Electrophoresis in Practice : A Guide to Methods and Applications of DNA and Protein Separations, 4<sup>th</sup> Edition, Dr. Reiner Westermeier. (2004).
5. Principles and Techniques of Biochemistry and Molecular Biology, 6<sup>th</sup> edition, Keith Wilson and John Walker, Publisher Cambridge University Press. (2008).
6. Light Microscopy in Biology : A Practical Approach, 2<sup>nd</sup> edition, Alan J. Lacey, Publisher Oxford University Press. (1999).
7. Electron Microscopy : Principles and Techniques for Biologists, Lonnie D. Russell, Publisher Jones & Bartlett. (1992).

ZOO 555 MJ : Integrated Pest Management							
Teaching Scheme					Marking Scheme		
Year	Semester	Course Type	Credits	Lectures per week	Continuous Internal Assessment	End Semester Examination	Total
I	II	Major Core	02	02	15	35	50

### Course Outcomes :

On the successful completion of the course, student will be able to :

CO1 : Understand basics of IPM, principles, tools, ethics & significances.

CO2 : Detect and diagnose different insect pests, their diseases & calculate economic injury level, economic threshold level.

CO3 : Understand pesticides, fungicides, herbicides, bio-herbicides and different methods used for pest control.

CO4 : Know different Entomopathogenic organisms.

CO5 : Apply advanced technology for pest control.

**Detailed Syllabus :**

Sr. No.	Topics	Lectures Assigned (L)
1.	<p><b>Introduction :</b></p> <p>1.1 Definition.</p> <p>1.2 Principles and tools.</p> <p>1.3 Significance.</p> <p>1.4 Ethics in IPM.</p> <p>1.5 Social and political constraints.</p> <p>1.6 Ecological applications to IPM.</p>	3
2.	<p><b>Methods of detection and diagnosis of insect pest and diseases :</b></p> <p>2.1 Damage caused by insect pests having different types of mouth parts and their damage symptoms, Plant and Pest diagnosis and Identification through Distance Diagnostic and Identification System (DDIS), IoT based pest detection with its benefits - Low power cameras &amp; sensors, High power thermal sensors, Florescence image sensing, Acoustic sensors, Gas sensors.</p> <p>2.2 Calculation and dynamics of economic injury level.</p> <p>2.3 Importance of economic threshold level.</p>	8
3.	<p><b>Pest Management Tactics :</b></p> <p>3.1 Introduction to Pesticides, Fungicides and Herbicides.</p> <p>3.2 Regulatory Control - Quarantine, Eradication, Control districts, Crop-free periods, Certification of seed and planting stock.</p> <p>3.3 Cultural control - Sanitation, Tillage, Crop rotation, Cropping systems.</p> <p>3.4 Chemical Control - Ecological considerations - Pesticide classification, Pesticide resistance, Chemical modes of action, Pesticide Use - Health and environmental concerns, Safety protocols.</p> <p>3.5 Biological Control - Ecological considerations, biological control of insects, biological control of plant disease, biological</p>	12

	control of weeds, role of Pheromones in Insect Pest Management. <b>3.6</b> Genetic manipulation of crop (plant resistance) - Sources of genetic variation, overview of plant resistance to insects, Inheritance and expression of plant resistance, deployment of resistance genes. <b>3.7</b> Genetic manipulation of pest population - Sterile insect release, Delayed sterility, Genetic displacement.	
<b>4.</b>	<b>4.1</b> Entomopathogenic Viruses and Bacteria for Insect pest control. <b>4.2</b> Entomopathogenic Nematodes in Integrated pest management. <b>4.3</b> Bioherbicide approach to weed control by using plant pathogens.	<b>5</b>
<b>5.</b>	Role of information and communication technology in integrated pest management.	<b>1</b>
<b>6.</b>	Application of Remote Sensing in integrated pest management.	<b>1</b>

**Suggested Readings :**

1. Integrated Pest Management, William D. Hutchison, Rafael E. Cancelado, Edward B. Radcliffe, Cambridge University Press. (2009).
2. Integrated Pest Management : Principles and Practices, D. P. Abrol, Uma Shankar CABI. (2012).
3. Natural Enemies Handbook, Mary Louise Flint, Steve H. Dreistadt, UC Division of Agriculture and Natural Sciences. (1998).
4. Insect Pest Management : Ecological Concepts, T. V. Sathe, Jyoti M. Oulkar, Daya Publishing House. (2010).
5. Pest control : A Survey By A. Woods, McGraw Hill, London. (1974).
6. Pest control, By W. W. Kilgore and R. L. Doutt, Academic Press, New York. (1967).

<b>ZOO 556 MJP : Laboratory Exercises in Biochemical &amp; Molecular Techniques</b>							
<b>Teaching Scheme</b>					<b>Marking Scheme</b>		
<b>Year</b>	<b>Semester</b>	<b>Course Type</b>	<b>Credits</b>	<b>Practical per week</b>	<b>Continuous Internal Assessment</b>	<b>End Semester Examination</b>	<b>Total</b>
<b>I</b>	<b>II</b>	<b>Major Core Subject</b>	<b>02</b>	<b>01</b>	<b>15</b>	<b>35</b>	<b>50</b>

**Course Outcomes :**

On the successful completion of the course, student will be able to :

CO1 : Understand various components of light, fluorescence, scanning, transmission electron microscope.

CO2 : Perform density gradient centrifugation.

CO3 : Perform thin layer chromatography.

CO4 : Perform paper chromatography.

CO5 : Perform sterilization of lab equipment.

CO6 : Isolation and quantification of prokaryotic and eukaryotic nucleic acids.

CO7 : Understand how to extract and quantify DNA from samples.

CO8 : Understand how to extract and quantify RNA from samples.

CO9 : Understand how to extract and quantify proteins from samples.

CO10 : Know the in-depth knowledge about agarose and polyacrylamide gel electrophoresis.

**Detailed Syllabus :**

Sr. No.	Title of the Practical	Practical Assigned (P)
<b>Section - I : Biochemical Techniques</b>		
1.	Principles of Electrophoresis, separation of proteins using Gel Electrophoresis. <b>(Compulsory)</b>	<b>2P</b>
2.	To study the effect of different solvents for a given dye using thin layer chromatography. <b>(Compulsory)</b>	<b>1P</b>
3.	Study of principle and uses of different microscopes. Components of light microscopy, upright & inverted microscopes, episcopic & diasopic microscopic alignment. Different types of lenses, numerical apertures. <b>(Compulsory)</b>	<b>2P</b>
4.	Estimation of protein by Lowry <i>et. al.</i> , method. <b>(Compulsory)</b>	<b>1P</b>
5.	Separation of sugars by paper chromatography.	<b>1P</b>
6.	Characterization of any Bio / nanomaterial by using suitable techniques : UV - Visible spectroscopy / XRD / SEM / TEM / EDS / FT - IR Studies	<b>2P</b>
7.	Visit to any nearby Central Instrumentation Facility Centre and to	<b>2P</b>

	study the principle and working of Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Fluorescence Microscope etc. and Report writing.	
<b>Section – II : Molecular Biology</b>		
<b>8.</b>	Lab Safety Techniques and sterilization.	<b>1P</b>
<b>9.</b>	Isolation of bacterial DNA. <b>(Compulsory)</b>	<b>2P</b>
<b>10.</b>	Estimation of isolated bacterial DNA by UV spectrophotometry. <b>(Compulsory)</b>	<b>1P</b>
<b>11.</b>	Separation of isolated bacterial DNA by agarose gel electrophoresis. <b>(Compulsory)</b>	<b>1P</b>
<b>12.</b>	Estimation of isolated bacterial DNA by diphenylamine method. <b>(Compulsory)</b>	<b>1P</b>
<b>13.</b>	Isolation of Liver DNA.	<b>2P</b>
<b>14.</b>	Estimation of isolated RNA by Orcinol method.	<b>1P</b>
<b>15.</b>	Demonstration of DNA amplification by PCR.	<b>1P</b>

<b>ZOO 557 MJP : Laboratory Exercises in Comparative Animal Physiology &amp; Endocrinology</b>							
<b>Teaching Scheme</b>					<b>Marking Scheme</b>		
<b>Year</b>	<b>Semester</b>	<b>Course Type</b>	<b>Credits</b>	<b>Practical per week</b>	<b>Continuous Internal Assessment</b>	<b>End Semester Examination</b>	<b>Total</b>
<b>I</b>	<b>II</b>	<b>Major Core Subject</b>	<b>02</b>	<b>01</b>	<b>15</b>	<b>35</b>	<b>50</b>

**Course Outcomes :**

After successfully completing this course, students will able to :

CO1 : Perform estimation of amylase from human saliva.

CO2 : Demonstrate oxygen consumption in relation to body size.

CO3 : Demonstrate rate of salt loss / gain in fish.

CO4 : Demonstrate effect of different physiological conditions on red blood cells.

CO5 : Perform detection of nitrogenous waste products in different animal groups.

CO6 : Perform estimation of sugar in rat / crab / human blood.

CO7 : Demonstrate bleeding & clotting time of human blood.

CO8 : Understand structural and functional difference between invertebrate and vertebrate neurosecretory and endocrine organs.

CO9 : Demonstrate location of endocrine glands.

CO10 : Illustrate blood sugar regulation in the crab - role of eye stalk.

CO11 : Demonstrate alloxan diabetes introduction in mouse / rat.

CO12 : Demonstrate pancreatectomy and thyroidectomy in experimental animals.

CO13 : Demonstrate effect of epinephrine on blood sugar level and liver glycogen.

### Detailed Syllabus :

Sr. No.	Title of the Practical	Practical Assigned (P)
<b>Section - I : Comparative Animal Physiology</b>		
1.	Study of nitrogenous waste products of animals from different habitats. <b>(Compulsory)</b>	<b>1P</b>
2.	Study of RBCs in different vertebrates and in different physiological conditions.	<b>1P</b>
3.	Study of relation of Body size and oxygen consumption in aquatic animals (crab / fish). <b>(Compulsory)</b>	<b>2P</b>
4.	Estimation of sugar in crab / rat / human blood. <b>(Compulsory)</b>	<b>1P</b>
5.	Measurement of lung capacity.	<b>1P</b>
6.	Determination of the heart beat in the crab & effect of temperature.	<b>1P</b>
7.	Measurement of blood pressure by using Sphygmomanometer.	<b>1P</b>
8.	Study of skeletal muscles from suitable material. <b>(Compulsory)</b>	<b>1P</b>
<b>Section – II : Comparative Vertebrate Endocrinology</b>		
9.	Study of histological slides of Endocrine glands of vertebrates - Pituitary, Thyroid, Parathyroid, Thymus, Adrenal. <b>(Compulsory)</b>	<b>2P</b>
10.	Study of histological slides of Endocrine glands of vertebrates - Pancreas, Ovary, Testis, and Uterus. <b>(Compulsory)</b>	<b>2P</b>
11.	Blood sugar regulation in the crab - Role of eye stalk. <b>(Compulsory)</b>	<b>1P</b>

<b>12.</b>	Introduction of alloxan diabetes in the mouse / rat. ( <b>Compulsory</b> )	<b>1P</b>
<b>13.</b>	Effect of insulin on blood sugar, hepatic and muscle glycogen of the rat.	<b>1P</b>
<b>14.</b>	Gonadectomy / Pancreatectomy / Thyroidectomy in the mouse / rat.	<b>1P</b>
<b>15.</b>	Effect of thyroid hormone on amphibian metamorphosis.	<b>1P</b>

<b>ZOO 558 MJ : Medical Parasitology</b>							
<b>Teaching Scheme</b>					<b>Marking Scheme</b>		
<b>Year</b>	<b>Semester</b>	<b>Course Type</b>	<b>Credits</b>	<b>Lectures per week</b>	<b>Continuous Internal Assessment</b>	<b>End Semester Examination</b>	<b>Total</b>
<b>I</b>	<b>II</b>	<b>Major Elective</b>	<b>02</b>	<b>02</b>	<b>15</b>	<b>35</b>	<b>50</b>

**Course outcomes :**

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

CO1 : Understand the concept of parasitism and host - parasite interactions.

CO2 : Specify various aspects of parasites of medical importance as geographical distribution and epidemiologic principles and describe the morphology and life cycle.

CO3 : Understand about reduced sensitivity to anti - malarial drugs.

CO4 : Recognize the scientific basis of the conventional and up to date diagnostic procedures needed to carry out accurate diagnosis of common parasitic diseases with emphasis on their prioritization in management plans.

CO5 : Describe the various successful adaptations evolved by parasites.

CO6 : Identify common arthropods act as vectors and their medical importance.

**Detailed Syllabus :**

<b>Sr. No.</b>	<b>Topic</b>	<b>Lectures Assigned (L)</b>
<b>1.</b>	<b>General Introduction : Parasitology</b> Parasite, host, basic concept of parasitism, parasitoids, evolution of parasitism, types of parasites and hosts, types of vectors, parasitic characteristics, parasitic transmission, alteration of host behavior by	<b>3</b>



	parasites and social parasitism.	
2.	<p><b>Immune Response Mechanism and Adaptation to Parasitism</b></p> <p>Immune response to parasitic infection, immunomodulation by parasites, polymorphism in the immune system, coevolution of host-parasite interactions, morphological adaptations, life cycle adaptations, immunological adaptations, biochemical adaptations.</p>	4
3.	<p><b>Biology of Parasites</b></p> <p>Geographical distribution, morphology, life cycle, mode of infection, clinical features, disease management, treatment and prophylaxis of parasites :</p> <p>Protozoa - <i>Trypanosoma</i> sp., <i>Plasmodium</i> sp., <i>Entamoeba histolytica</i>, <i>Leshmania</i> sp.; Trematodes – <i>Fasciolopsis buski</i>, <i>Paragonimus westermani</i>, <i>Schistosoma mansoni</i>; Cestodes - <i>Hymenolepis nana</i>, <i>Taenia solium</i>, <i>Echinococcus granulosus</i>, <i>Diphyllobo thriumlatum</i>; Nematodes - <i>Trichuristrichura</i>, <i>Strongyloides stercoralis</i>, <i>Dracunculus medinensis</i>, <i>Wuchereria bancrofti</i>.</p>	10
4.	<p><b>Arthropods as Parasitic vectors</b></p> <p>Significance of arthropods as vectors, general features and control measures of biting Dipterans - Mosquitoes, Black flies, Sand flies, Tsetse flies, Tabanid flies, Fleas, Lice, Ticks, Mites.</p>	3
5.	<p><b>Zoonotic Diseases</b></p> <p>Introduction, Rabies, Toxoplasmosis, Brucellosis, Anthrax symptoms, preventive and control measures.</p>	2
6.	<p><b>Diagnostic Laboratory Methods of Parasitic infections</b></p> <p>Introduction, Diagnostic methods : Examination of Stool, Blood, Sputum, Tissue Biopsy, Urogenital Specimen Culture Methods, Xenodiagnosis, Immunological diagnosis and molecular methods.</p>	3
7.	<p><b>Control Measures and Vaccination Development</b></p> <p>Chemical control - Drugs against parasites, Drug resistance, Status of Drug Resistance in India. Anti-malarial drug resistance : Chloroquine; Sulphadoxine - Pyrimethamine and Artemisinin. Mechanism of drug resistance in <i>Leshmania</i>. Biological and Genetic control of parasites, Vaccine development strategies against parasitic diseases.</p>	5

**Suggested Readings :**

1. Introduction to Parasitology, 10<sup>th</sup> ed., Chandler, A. C. & Read. C. P., John Wiley & Sons Inc. (1961).
2. General Parasitology, 2<sup>nd</sup> ed., Cheng, T. C. Academic Press, Inc. Orlando. U.S.A. (1986).
3. Modern Parasitology. 2<sup>nd</sup> ed., Cox, F. E. G., Blackwell Scientific Publications, Lea and Febiger, Philadelphia. (1993).
4. Parasitism : The Diversity and Ecology of Animal Parasites, Tim Goater, Timothy M. Goater, Cameron P. and Esch, Gerald W. Cambridge University Press. (2014).
5. Principles of Veterinary Parasitology, 1<sup>st</sup> ed., Dennis E. Jacobs, Mark Fox, Lynda M. Gibbons, Carols Hermosilla, John Wiley & Sons. (2016).
6. Foundation of Parasitology, 3<sup>rd</sup> ed., Schmidt, G. D. & Roberts, L. S., McGraw Hill Publishers. (2001).
7. Essentials of Parasitology, Schmidt, G. D. Wm. C. Brown Publishers, Indian print; 1990, Universal Book Stall. (1989).
8. Animal Parasitology. 3<sup>rd</sup> ed., Smyth, J. D., Cambridge University Press. (1994).
9. Helminths, Arthropods and Protozoa of domesticated animals, Soulsby, E. J. L. ELBS and Bailliere Tindall, London. (1982).
10. Atlas of Medical Helminthology and Protozoology, 3<sup>rd</sup> ed., H. C. Jeffrey, R. M. Leach and G.O. Cowan, Churchil Livingstone (2002).

<b>ZOO 559 MJP : Laboratory Exercises in Medical Parasitology</b>							
<b>Teaching Scheme</b>					<b>Marking Scheme</b>		
<b>Year</b>	<b>Semester</b>	<b>Course Type</b>	<b>Credits</b>	<b>Practicals per week</b>	<b>Continuous Internal Assessment</b>	<b>End Semester Examination</b>	<b>Total</b>
<b>I</b>	<b>II</b>	<b>Major Elective</b>	<b>2</b>	<b>01</b>	<b>15</b>	<b>35</b>	<b>50</b>

**Course Outcomes :**

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

CO1 : Practice examination of mounted slides microscopically to identify, draw and label diagrams of parasites and their different stages (eggs, cysts, larvae, trophozoites) or any of their body parts (segment, hooks, scolices. etc).

CO2 : Practice examination of some parasites or their stages (e.g., hydatid cyst) macroscopically for their identification and drawing.

CO3 : Practice examination of the whole body or any part of arthropods of medical Importance (mounted slide) in order to identify them.

### Detailed Syllabus :

Sr. No.	Title of the Practical	Practical Assigned (P)
1.	Measurements of ANY FIVE protozoan specimen using micrometry slide. <b>(Compulsory)</b>	2P
2.	Identification and study of pathogenicity and diagnosis of <i>Plasmodium</i> sp., <i>Leishmania</i> sp., <i>Entamoeba</i> sp., <i>Ascaris</i> sp., <i>Wuchereria</i> sp., <i>Fasciola</i> sp., <i>Taenia</i> sp., <i>Diphyllobothrium</i> sp., and <i>Hymenolepis</i> sp. using permanent slides or photographs.	2P
3.	Collection, Fixation, staining and identification of gastrointestinal parasites (ANY TWO) from fish / chicken / goat / sheep. <b>(Compulsory)</b>	2P
4.	Smear preparation, staining and identification of parasites from faecal content of cattles. <b>(Compulsory)</b>	2P
5.	Smear preparation, staining and identification of gut parasites from locally available insect pest. <b>(Compulsory)</b>	1P
6.	Study of permanent slides of arthropod vectors - Mosquito, Ticks, Mites, Flea, Sand flies.	1P
7.	Study of structural adaptive organs in ANY TWO helminthes - rostellum, hooks, suckers, spines, bothria.	1P
8.	Field collection, preservation, mounting and identification of locally available common insect vectors / pests. <b>(Compulsory)</b>	2P
9.	Identification of parasites (ANY FIVE) with the help of taxonomic key.	1P
10.	Study of types of parasitic zoonotic diseases (THREE TYPES).	1P
11.	Study of ANY FIVE ecto - parasites with respect to their structural and physiological adaptations.	2P

ZOO 560 MJ : Economic Zoology							
Teaching Scheme					Marking Scheme		
Year	Semester	Course Type	Credits	Lectures per week	Continuous Internal Assessment	End Semester Examination	Total
I	II	Major Elective	02	02	15	35	50

**Course Outcomes:**

CO1 : To gain knowledge about economically important branches of zoology.

CO2 : To gain knowledge about aquaculture.

CO3 : To acquaint knowledge about the culture techniques of fish.

CO4 : To acquaint the knowledge about biofloc fish farming.

CO5 : To learn concepts of sponge cultivation and related practices.

CO6 : To motivate the students for starting their self-employment.

**Detailed Syllabus :**

Sr. No.	Topics	Lectures Assigned (L)
1.	<b>Introduction of Economic Zoology :</b> 1.1 Introduction to economically important branches of Zoology. 1.2 Review of parasitic protozoans, helminthis, nematodes and insects harmful to human, domestic animals and livestock.	5
2.	<b>Aquaculture:</b> 2.1 Definition, scope and objectives, present status and problems of aquaculture in global and Indian perspective. 2.2 Aquaculture systems : Extensive, semi-intensive and intensive culture, pen and cage culture, polyculture.	5
3.	<b>Prawn Culture :</b> 3.1 Culture of fresh and brackish water prawns. 3.2 Preparation of farm. 3.3 Harvesting, preservation, processing and export.	4
4.	<b>Shellfish culture :</b> 4.1 Culture of Molluscs : Present status, scope and challenges.	4

	<b>4.2</b> Maintenance of Mussels. <b>4.3</b> Pearl culture in India – Distribution and practices. <b>4.4</b> Process of pearl formation: Natural and Artificial.	
<b>5.</b>	<b>Pisciculture :</b> <b>5.1</b> Types of fisheries. <b>5.2</b> Fish culture. <b>5.3</b> Processing & packaging of fish and fish products. <b>5.4</b> Value added products from Fisheries. <b>5.5</b> Ornamental fish farming, types of ornamental fishes.	<b>4</b>
<b>6.</b>	<b>Biofloc fish farming :</b> <b>6.1</b> Introduction to the biofloc technology, principle, prospects and challenges. <b>6.2</b> Types of biofloc systems - Heterotrophic, autotrophic and mixotrophic. <b>6.3</b> Microbial role in biofloc system. <b>6.4</b> Tank design and construction in biofloc production system. <b>6.5</b> Biofloc technology for water quality management. <b>6.6</b> Economics of biofloc farming. <b>6.7</b> Disease management, nutrition and feeding management. <b>6.8</b> Harvesting and marketing.	<b>6</b>
<b>7.</b>	Sponge culture and its application to humans and others.	<b>2</b>

**Suggested Readings:**

1. Economic Zoology, Shukla and Upadhyaya, Rastogi Publishers. (2002).
2. Economic Zoology, Yadav Manju, Discovery Publishing House. (2003).
3. Textbook of applied Zoology, Jabde Pradip V Discovery Publishing House, New Delhi. (2005).
4. Aquarium fishes and plants, Zuka. R. I. and Hamiyn. (1971).
5. Animal Disease, Bairagi K. N. Anmol Publications Pvt. Ltd. (2014).
6. Economics of Aquaculture, Singh R. K. P., Danika Publishing Company. (2003).
7. Aquaculture, Gilbert B. Vol. II. Ellis Horwood. (1990).
8. Handbook of Fisheries and Aquaculture. ICAR. (2006).

ZOO 561 MJP : Laboratory Exercises in Economic Zoology							
Teaching Scheme					Marking Scheme		
Year	Semester	Course Type	Credits	Practical per week	Continuous Internal Assessment	End Semester Examination	Total
I	II	Major Elective	02	01	15	35	50

**Course Outcomes :**

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

CO1 : To gain knowledge about economic importance of prawn species.

CO2 : To gain knowledge about economic importance of molluscs.

CO3 : To acquaint knowledge about the culture techniques of pearl.

CO4 : To acquaint the knowledge about biofloc fish farming.

CO5 : To learn tank design and construction.

CO6 : To motivate the students for starting their self-employment.

**Detailed Syllabus :**

Sr. No.	Title of the Practical	Assigned Practical (P)
1.	Study of economic importance of commercially used prawn species.	1P
2.	Study of economic importance of molluscs - Mussels, oysters, pearl oysters, scallops, clams, cockles, abalones.	2P
3.	Study of ornamental fish farming.	1P
4.	Study of economic importance of following fishes - <i>Labeo</i> , <i>Mrigala</i> , <i>Notopterus</i> , <i>Mystus</i> sp., <i>Clarius</i> , <i>Channa</i> , <i>Heteropneustes</i> . (Compulsory)	2P
5.	Study of tank design and construction in biofloc production system.	1P
6.	Study of disease management, nutrition and feeding management in biofloc fish farming. (Compulsory)	1P
7.	Study of aquarium : Setting up of an aquarium, size and volume of water, equirements for construction of an aquarium. (Compulsory)	2P

8.	Vermicomposting bin preparation and maintenance. <b>(Compulsory)</b>	<b>2P</b>
9.	Study of Poultry breeds, feeding utensils in poultry.	<b>1P</b>
10.	Study of cattle breeds and dairy products. <b>(Compulsory)</b>	<b>2P</b>
11.	Study of earthworm species for commercial production of vermicompost.	<b>1P</b>
12.	Study of Apiculture equipments.	<b>1P</b>
13.	Visit and submission of report - Any aquaculture farm/ poultry farm/ advanced cattle farm. <b>(Compulsory)</b>	<b>2P</b>

ZOO 562 MJP : Practical in Bio Medical Techniques							
Teaching Scheme					Marking Scheme		
Year	Semester	Course Type	Credits	Practical per week	Continuous Internal Assessment	End Semester Examination	Total
I	II	Major Elective	02	01	15	35	50

### Course Outcomes :

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

CO1 : Understand laboratory management and planning.

CO2 : To know specimen collection methods from clinical samples.

CO3 : Learn technique for preparation of standard solutions and Storage.

CO4 : Preparation, standardization and estimation of constituents in blood.

CO5 : To know the working of commonly used analytical instruments and techniques.

CO6 : Practice biochemical test profiles.

CO7 : Estimation of haemoglobin and determination of ESR.

CO8 : Study of Parasites in the blood.

**Detailed Syllabus :**

Sr. No.	Titles of the Practical	Practical Assigned (P)
1.	<b>Laboratory management and planning</b> : Reception and recording of specimens, maintenance of laboratory records, reporting. ( <b>Compulsory</b> )	1P
2.	<b>Specimen collection</b> : Whole blood, plasma, serum, urine, C.S.F & other body fluids, preservation of specimens, anticoagulants.	2P
3.	<b>Technique for preparation of standard solutions and Storage</b> e.g. glucose, albumin etc. ( <b>Compulsory</b> )	1P
4.	<b>Basic laboratory equipments</b> : Types, use, care and maintenance of following equipments : Ovens, Incubators, Refrigerators, Deep freezer, Centrifuges, Water baths, Water distillation units, Analytical balances, Microscopes.	2P
5.	<b>Preparation, Standardization and Estimation of following constituents in blood</b> : Glucose, urea, uric acid, creatinine, proteins (total proteins, A/G ratio), S.G.P.T., S.G.O.T., alkaline phosphatase. ( <b>Compulsory</b> )	2P
6.	<b>Analytical instruments and techniques</b> : Principles, types, use, care and maintenance of photoelectric colorimeters, spectrophotometers, flame photometers, electrophoresis, Chromatography, Elisa and RIA, isotopes. ( <b>Compulsory</b> )	1P
7.	<b>Biochemical test profiles</b> : Principle and use of Glucose tolerance test, liver function tests, kidney function tests, Thyroid Function test. ( <b>Compulsory</b> )	2P
8.	<b>Urine examination</b> : Routine physical and chemical and for abnormal constituents. ( <b>Compulsory</b> )	1P
9.	To Measure blood pressure using Sphygmomanometer, semi-automatic blood pressure measuring instrument and automatic blood pressure measuring instrument. ( <b>Compulsory</b> )	1P
10.	Estimation of Hemoglobin and determination of ESR (erythrocyte sedimentation rate). ( <b>Compulsory</b> )	1P



11.	To measure the ultrasound blood flow in order to identify arteries and veins.	1P
12.	Heart sound measurement using PCG. (Compulsory)	1P
13.	Study of Parasites in the blood. (Compulsory)	1P

ZOO 563 JT / FP : On Job Training OR Field Project							
Teaching Scheme					Marking Scheme		
Year	Semester	Course Type	Credits	Practical per week	Continuous Internal Assessment	End Semester Examination	Total
1	II	On Job Training / Field Project	04	2	30	70	100

**Course Outcomes :**

After successfully completing this course, students will able to:

CO1 : Develop problem-solving skills.

CO2 : Demonstrate knowledge of research processes.

CO3 : Develop hands-on experience in a specific field of zoology.

CO4 : Perform literature review using print and online databases.

CO5 : Select and define appropriate research problem and parameters to prepare a project report.

CO6 : Identify, explain, compare, and prepare the key elements of a research proposal.

CO7 : Compare and contrast quantitative and qualitative research paradigms.

CO8 : Use sampling methods, measurement scales and instruments, and appropriate uses of each.

CO9 : Develop awareness about biodiversity conservation.

**Detailed Syllabus :**

Sr. No.	Topics	Practical Assigned (P)
1.	On Job Training OR Field Project :	

	<p>On job training could be organized by respective P. G. Department of the College. It may be in any Government organizations / Research laboratories / Institutions like ZSI, NCL, NCCS, IISER, Agricultural Institutions / Higher Education Institutions / Universities / Institutes / Wildlife Sanctuary, National Park, Tiger Reserve / Fishery institute etc. OR any other Local Industrial organization / Industry related to Zoology etc. OR Authorized pathological laboratories.</p> <p>Submission of On Job Training Report and Certificate.</p> <p><b><u>OR</u></b></p> <p>The field project should involve teaching, demonstration and training, experimentation, field work etc. of students under the guidance of research guide.</p> <p>The tenure of field project should be equivalent to at least 30 practicals of 4 hours in the semester.</p> <p>Possible key aspects of the field project –</p> <ol style="list-style-type: none"> <li>1. Planning the project,</li> <li>2. Selecting a suitable title,</li> <li>3. Defining significance of the work,</li> <li>4. Hypothesis, Objectives,</li> <li>5. Reviewing the available literature,</li> <li>6. Materials and Planning Methodologies,</li> <li>7. design experimental set up and execution of experimental work, laboratory work,</li> <li>8. Hands-on practical investigation and field work,</li> <li>9. Data collection, compilation and its analysis</li> <li>10. Outcomes of the Project work,</li> <li>11. Conclusion and Discussion,</li> <li>12. References / Bibliography,</li> <li>13. Future plans.</li> <li>14. Presentation and submission etc.</li> </ol> <p><b>Students should be made aware of plagiarism and research ethics.</b></p>	
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	<p>Field work to be carried out under proper guidance, supervision and permission from the concerned authorities. It may be selected so as to satisfy local or social need of area.</p> <p>Field Project Report should not exceed 100 pages.</p>	
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