



College of Arts,  
Science &  
Commerce (Autonomous)

AC/27.6.23/RS 2

RISE WITH EDUCATION

NAAC REACCREDITED - 'A' GRADE

*(Affiliated to University of Mumbai)*

**Faculty: Science**

**Program: M.Sc. – II**

**Subject: ZOOLOGY**

**Specialization: Animal Physiology**

**Academic Year: 2023 – 2024**

**Revised Syllabus under Choice Based Credit System (CBCS)**

**Approved by the Board of Studies in Zoology**

**Effective from Academic year: 2023-24**

### **Preamble**

*“It is what we know already, that prevents us from learning” – Claude Bernard (1813-1878; French Physiologist – ‘The father of physiology’ who put forth the concept of internal environment and homeostasis)*

*Under the aegis of academic autonomy, the Department of Zoology has the privilege of ‘academic freedom’ to revise its course and curriculum, however, it is also aware of the fact that ‘academic freedom’ needs to be justified with ‘academic excellence’. One of the ways to achieve this is through fine-tuning the curriculum. As students at the postgraduate level would have a foundation of the basics of the subject, this syllabus focuses on the need to furnish them with skills and understanding essential to make them self-sufficient and build a future.*

*Some of the key features of this revised syllabus are as follows:*

- ✓ *Physiological processes and Membrane physiology – to introduce to the students the fundamental concepts of physiology and how the cell membrane is the cornerstone of an elaborate interplay between the extracellular and the intracellular worlds; to familiarize the students in understanding the physiology of the cell membrane whereby it provides the foundation for understanding many processes in the human body.*
- ✓ *Cancer Biology and Toxicology – to make students understand the mechanisms that underlie fundamental processes such as cell growth, the transformation of normal cells to cancer cells, and the spread (metastasis) of cancer cells; to introduce to the students the principles of toxicology and types of toxins, venoms and their mechanism of action, besides relevance of toxicity studies.*
- ✓ *Applied Physiology and Environmental Physiology – to introduce to the students the emerging concepts in Applied Physiology and Environmental Physiology as sub disciplines within the discipline of Physiology, to make students understand the relevance of the cutting edge advancements in Assisted Reproductive Technology, Sports Physiology, and Environmental Physiology.*
- ✓ *Clinical Diagnostics – to introduce to the students the field of clinical diagnosis - a process of identifying and detecting the nature of a disorder or illness; to justify the applications of different types of clinical diagnostic tests, tools/techniques and their clinical significance in medical science.*
- ✓ *Industry Internship – to strengthen academia-industry linkage and to increase employability of students, to give students structured training for exposure to working environment so as to combine experiential learning with theoretical concepts.*
- ✓ *Research project/Dissertation – to inculcate research aptitude and to develop an open, inquiring mind that is willing to explore new territories and learn new things; to encourage the spirit of curiosity of students, who are not just learners but also potential problem solvers and scientific investigators.*

*Considering the overarching influence of tools and techniques in biological sciences, educationists need to understand that students need to inculcate an interdisciplinary approach in understanding and contemplating pure sciences. In this context, the revised syllabus is an arena for students to explore the bridge between science and society. It is indeed reflected in the contents and topics introduced in this revised syllabus, thanks to the collective and constructive efforts of the members of the board of studies comprising distinguished faculty, experts from industry/allied area and research institutions. The valuable comments, suggestions and recommendations of the contributors and reviewers have been carefully considered and implemented wherever feasible.*

*For effective teaching learning, teachers are advised not to follow the syllabus too rigidly, but to exercise their professional discretion and judgement in implementing it. After all teaching is about creating a conducive environment for learners to sustain enthusiasm about the subject. The revised syllabus will encourage critical thinking, instil analytical skills, besides inculcating interdisciplinary approach amongst student’s to make learning more meaningful, thereby pursuing academic excellence. We sincerely hope that all stakeholders from faculty to learners exploring this course will appreciate the importance of a well-designed curricular framework in shaping educational outcomes.*

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### **Members of the Board of Studies in the subject of Zoology and Syllabus Committee**

- ✓ *Professor (Dr.) Manisha Kulkarni – Department of Zoology, Institute of Science, Fort, Mumbai (Vice Chancellor's Nominee)*
- ✓ *Professor (Dr.) Manoj Mahimkar – Principal Investigator, Cancer Research Institute, ACTREC, Kharghar, Navi Mumbai; (Subject expert from outside the Parent University to be nominated by the Academic Council)*
- ✓ *Dr. Sasikumar Menon – Director, Institute for Advanced Training & Research in Interdisciplinary Sciences (IATRIS), (Therapeutic Drug Monitoring Lab), Sion, Mumbai; Faculty, Pharma Analytical Sciences, Ruia College, Mumbai (Subject Expert from outside college/Industry expert)*
- ✓ *Mr. Kedar Gore – Director, The Corbett Foundation (Non-profit Organization), Mumbai, (Subject expert from outside college / Representative from Corporate sector / Allied area)*
- ✓ *Ms. Uma Bandekar – Clinical Team Manager with ICON plc (Postgraduate Meritorious Alumnus)*
- ✓ *Mr. Pushparaj Shetty – Faculty, Department of Zoology, SIES College, Mumbai*
- ✓ *Dr. Rupali Vaitly – Faculty, Department of Zoology, SIES College, Mumbai*
- ✓ *Dr. Madhavan Gopalan – Faculty, Department of Zoology, SIES College, Mumbai*
- ✓ *Dr. Aditya Akerkar – Faculty, Department of Zoology, SIES College, Mumbai*
- ✓ *Ms. Shraddha Patil – Faculty, Department of Zoology, SIES College, Mumbai*
- ✓ *Ms. Rutuja Nighot – Faculty, Department of Zoology, SIES College, Mumbai*
- ✓ *Dr. Satish Sarfare – Head and Faculty, Department of Zoology, SIES College, Mumbai*

**M.Sc. Part II – Zoology (Animal Physiology) syllabus-Semester III**  
**Approved by the Board of Studies in Zoology effective from Academic year: 2023-24**

<b>THEORY</b>				
Course name/code	Unit	Topic Headings	Credits	Lectures / week
<b>SEMESTER III</b>				
<b>Paper I: Physiological Processes - I</b>				
<b>SIPZOPHY31</b>	1	Principles of Physiology	<b>4</b>	<b>1</b>
	2	Cell signaling and cell communication		<b>1</b>
	3	Physiology of Nutrition		<b>1</b>
	4	Physiology of Movement and Locomotion		<b>1</b>
<b>Paper II: Physiological Processes - II</b>				
<b>SIPZOPHY32</b>	1	Physiology of Gas exchange and Acid base balance	<b>4</b>	<b>1</b>
	2	Physiology of Excretion and Osmoregulation		<b>1</b>
	3	Physiology of Circulation		<b>1</b>
	4	Physiology of Reproduction		<b>1</b>
<b>Paper III: Membrane Physiology, Toxicology and Cancer Biology</b>				
<b>SIPZOPHY33</b>	1	Membrane Physiology	<b>4</b>	<b>1</b>
	2	Toxicology-I		<b>1</b>
	3	Toxicology-II		<b>1</b>
	4	Cancer Biology		<b>1</b>
<b>Paper IV: Industry Internship/Training</b>				
<b>SIPZOPHY34</b>		<b>Industry Internship/Training</b>	<b>4</b>	<b>4</b>
<b>PRACTICAL</b>				
<b>SIPZOPHY31</b>		Based on <b>SIPZOPHY31</b>	<b>2</b>	<b>4</b>
<b>SIPZOPHY32</b>		Based on <b>SIPZOPHY32</b>	<b>2</b>	<b>4</b>
<b>SIPZOPHY33</b>		Based on <b>SIPZOPHY33</b>	<b>2</b>	<b>4</b>
<b>SIPZOPHY34</b>		Based on <b>SIPZOPHY34</b>	<b>2</b>	<b>4</b>
		<b>Total</b>	<b>24</b>	<b>32</b>

**M.Sc. Part II – Zoology (Animal Physiology) syllabus-Semester IV**  
**Approved by the Board of Studies in Zoology effective from Academic year: 2023-24**

<b>THEORY</b>				
Course name/code	Unit	Topic Headings	Credits	Lectures / week
<b>SEMESTER IV</b>				
<b>Paper I: Physiological Processes - III</b>				
<b>SIPZOPHY41</b>	1	Comparative Endocrinology	<b>4</b>	<b>1</b>
	2	Neurobiology-I		<b>1</b>
	3	Neurobiology-II		<b>1</b>
	4	Sensory Physiology		<b>1</b>
<b>Paper II: Applied Physiology</b>				
<b>SIPZOPHY42</b>	1	Sports Physiology-I	<b>4</b>	<b>1</b>
	2	Sports Physiology-II		<b>1</b>
	3	Nutrition and Diet		<b>1</b>
	4	Assisted Reproductive Technology		<b>1</b>
<b>Paper III: Environmental Physiology and Clinical Diagnostics</b>				
<b>SIPZOPHY43</b>	1	Electrophysiology and Radiation Biology	<b>4</b>	<b>1</b>
	2	Environmental Physiology		<b>1</b>
	3	Tools and Techniques for clinical diagnostics-I		<b>1</b>
	4	Tools and Techniques for clinical diagnostics-II		<b>1</b>
<b>Paper IV: Research Project/Dissertation</b>				
<b>SIPZOPHY44</b>		<b>Research Project/Dissertation</b>	<b>4</b>	<b>4</b>
<b>PRACTICAL</b>				
<b>SIPZOPHY41</b>		Based on <b>SIPZOPHY41</b>	<b>2</b>	<b>4</b>
<b>SIPZOPHY42</b>		Based on <b>SIPZOPHY42</b>	<b>2</b>	<b>4</b>
<b>SIPZOPHY43</b>		Based on <b>SIPZOPHY43</b>	<b>2</b>	<b>4</b>
<b>SIPZOPHY44</b>		Based on <b>SIPZOPHY44</b>	<b>2</b>	<b>4</b>
		<b>Total</b>	<b>24</b>	<b>32</b>

**SIES College of Arts, Science and Commerce (Autonomous)**  
**Sion (West), Mumbai – 400 022**

**Programme: Master of Science, M.Sc. Part 2 – Zoology**

*“That is the essence of science: ask an impertinent question, and you are on the way to a pertinent answer.”*  
*- Jacob Bronowski*

The characteristic Post-graduate attributes comprising of Programme Outcomes, Programme Specific Outcomes and Course Outcomes for a science post graduate in the subject of Zoology are as follows:

**Note the list of abbreviations:**

*PO: Programme Outcome, PSO: Programme Specific Outcome, CO: Course Outcome*

*Cognitive Levels: R: Remember, U: Understand, Ap: Apply, An: Analyze, E: Evaluate, C: Create*

Serial Number	Details of Programme Outcomes (POs)
PO1 <i>(Skill Level)</i>	Problem Solving Ability ( <i>U, Ap</i> ) Apply the knowledge of various courses learned under a program to break down complex problems into simple components. Adopt and assimilate problem-based learning models and apply one’s learning to solve real life problem situations.
PO2 <i>(Skill Level)</i>	Critical Thinking ( <i>U, An, E</i> ) Develop critical thinking based on a rationale to identify assumptions, verifying the accuracy and validity of assumptions, and making informed decisions. Inculcate the ability of logical reasoning to question the rationale behind concepts, ideas, and perspectives.
PO3 <i>(Skill Level)</i>	Effective Communication Skills ( <i>Ap, C</i> ) Improve written and oral communication skills so as to express thoughts and ideas effectively. Demonstrate the ability to listen carefully and imbibe soft skills to convey and receive instructions clearly. Develop presentation skills to present complex information in a clear, lucid and concise manner.
PO4 <i>(Skill Level)</i>	Proficiency with Information and Communication Technology <i>(U, An, E)</i> Demonstrate ability to access, evaluate and use a variety of relevant information resources inclusive of internet and electronic media for the purpose of collating and analyzing data. Understand the scope and limitations of tools or software used in Information and Communication Technology.
PO5 <i>(Skill Level)</i>	Leadership Skills and Team Work ( <i>U, Ap, An, C</i> ) Demonstrate leadership skills formulating an inspiring vision, thereby building a team, motivating and inspiring team members to engage and achieve that vision. Develop management skills to guide people in taking tasks to their logical conclusion. Inculcate the ability to facilitate coordinated effort as a group or team in the interests of common cause and recognize the contribution of team members.
PO6 <i>(Attitude Level)</i>	Self-directed and Lifelong Learning ( <i>U, Ap, An</i> ) Demonstrate the ability to work independently and take responsibility for one’s actions. Acquire the ability to explore and evolve by becoming self-sufficient and self-reliant. Adapt lifelong learning approaches to broaden one’s horizons for personal growth
PO7 <i>(Attitude Level)</i>	Ethical Values and Environmental Concerns ( <i>U, Ap, E</i> ) Embrace moral or ethical values in conducting one’s life and implement ethical practices in all aspects of life. Create awareness and concern for environmental and sustainability issues. Understand and realize the significance and relevance of co-habitation and co-evolution in attaining the needs of sustainable development.

PO8 (AttitudeLevel)	Gender Sensitization and Community Service ( <i>U, Ap, An</i> ) Respect gender sensitivity, gender equity and gender justice. Encourage mutual understanding and express empathetic social concern towards different value systems and different strata of society. Engage in community service through Institutional Social Responsibility.
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Serial Number	Details of Programme Specific Outcomes (PSOs) (Animal Physiology)
PSO1	<b><u>Conceptual Understanding and Emerging Applications (R, U, Ap, An)</u></b> Inculcate conceptual and coherent understanding of Animal Physiology, and demonstrate a broad understanding of physiological processes and sub-disciplines of animal physiology. With reference to animal physiology, understand the detailed concepts of cell biology, cell signaling and communication, biochemistry, developmental biology, molecular biology, cancer biology, toxicology, ecology, evolution so as to recognize the relationships between structure and functions at different levels of biological organization for the major groups of animals. Analyze the scope of emerging applications of animal physiology in medicine, sports, genetics, wild life, etc. and apply appropriate methodologies with cutting edge tools/techniques to seek solutions to emerging problems faced by mankind.
PSO2	<b><u>Analytical reasoning and Scientific Inquiry (U, An, E)</u></b> Inculcate a sense of inquiry and capability for asking relevant or appropriate questions, articulating problems or concepts or questions. Encourage the ability to analyze, interpret and draw conclusions from qualitative/quantitative data and critically evaluate ideas, experiences, theories and concepts by following scientific approach to knowledge development from an open minded and reasoned perspective. Develop analytical skills involving paying attention to detail and imbibe the ability to construct logical arguments using correct technical language related to the relevant subject. Analyze and interpret data/information collected or related to experiments or investigations, using appropriate methods involving Biostatistics, Bioinformatics among others and report accurately the findings of the experiment/investigations while relating the conclusions/ findings to relevant theories of zoology.
PSO3	<b><u>Laboratory Skills and Fieldwork (R, U, E, C)</u></b> Understand and apply standard operating procedures as per Good Laboratory Practices so as to develop laboratory skills and qualities required for successful career in teaching, research, industry, etc. Demonstrate awareness regarding animal ethics, human ethics, so as to promote safe environment and ecosystem, in the pursuit of disciplinary knowledge. Develop instrumentation handling skills and laboratory techniques relevant to academia and industry; integrate knowledge, skills with technical competency, so as to create solutions for issues and problems related to biological sciences. Demonstrate leadership qualities, command trust and respect, thereby, motivating and inspiring team members to work effectively in diverse teams during excursions or study tours.
PSO4	<b><u>Research Aptitude and Interdisciplinary Approach (Ap, An, E, C)</u></b> Inculcate and adapt to research aptitude and culture, integrate research-based knowledge in an interdisciplinary framework, and realize the relevance of choosing research as an alternative career option. Demonstrate the awareness regarding compliance with research ethics, awareness about conflicts of interests and Intellectual Property Rights, and avoiding unethical behavior such as fabricating, falsifying or misrepresenting data or to committing plagiarism. Inculcate the ability to recognize cause and effect relationships, formulate hypothesis, reporting the results of an experiment or investigation, and application of research tools for analysis and interpretation of data. Inculcate an interdisciplinary approach, to understand and consolidate fundamental concepts through inquiry-based curriculum, develop critical thinking and problem-solving ability required to solve different types of biology related problems with well-defined solutions, and tackle open-ended problems that may cross disciplinary-area boundaries.

## Course Outcomes for M.Sc. Part 2

### **At the root of all (science) education (Core Learning Outcome):**

“The imaginative and original mind need not be overawed by the imposing body of present knowledge or by the complex and costly paraphernalia which today surround much of scientific activity. The great shortage in science now is not opportunity, manpower, money, or laboratory space. What is really needed is more of that healthy skepticism which generates the key idea – the liberating concept.” – *P.H. Abelson*

Purity of mind leads to clarity in thought and action for creation of an original archaic work. As well, to consciously attempt the basic pursuit of understanding human existence.

### Animal Physiology

#### Semester III – Theory

**Course Code:** SIPSZOPHY31

**Course Name:** Physiological Processes – I

The study of this course will accomplish the following outcomes:

<b>Unit</b>	<b>Course Outcome (CO)</b>	<b>Cognitive Level</b>	<b>Affinity with PO/ PSO</b>
Unit 1: Principles of Physiology	<b>CO1:</b> <ul style="list-style-type: none"> <li>Have an enhanced knowledge and appreciation of animal physiology and its sub-disciplines like environmental physiology and able to perform, analyze and report on experiments and observations in physiology.</li> </ul>	<i>U, R</i>	<i>PO1, PO2</i>  <i>PSO1</i>
Unit 2: Cell signaling and cell communication	<b>CO2:</b> <ul style="list-style-type: none"> <li>To gain knowledge, recognize and discuss the main types of cell communication, including the signaling molecules (ligands/transmitters) and its role in understanding the importance of cell signaling in biology and to be able to apply this knowledge in future laboratory work.</li> </ul>	<i>An, E</i>	<i>PO1, PO2</i>  <i>PSO1, PSO2</i> <i>PSO4</i>
Unit 3: Physiology of Nutrition	<b>CO3:</b> <ul style="list-style-type: none"> <li>To gain knowledge in feeding behavior,</li> <li>Apply biological, biochemical, and physiological and neuronal scientific principles to nutrition practice.</li> <li>Provide students with core knowledge of physiological principles within a nutritional context.</li> </ul>	<i>U, An, E</i>	<i>PO1, PO2</i>  <i>PSO1, PSO2</i>
Unit 4 Physiology of Movement and Locomotion	<b>CO4:</b> <ul style="list-style-type: none"> <li>To gain knowledge with respect to comparative studies in locomotory behavior</li> <li>Students get to learn the different types of movement, adaptive role and its regulation</li> </ul>	<i>U, R</i>	<i>PO1, PO2</i>  <i>PSO1, PSO2</i>

**Course Code:** SIPSZOPHY32

**Course Name:** Physiological Processes - II

The study of this course will accomplish the following outcomes:

<b>Unit</b>	<b>Course Outcome (CO)</b>	<b>Cognitive Level</b>	<b>Affinity with PO/ PSO</b>
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Unit 1: Physiology of Gas exchange and Acid base balance	<b>CO1:</b> <ul style="list-style-type: none"> <li>The basic principles of gas exchange in health, mechanisms of altered gas exchange in disease, how the body compensates for abnormal gas exchange</li> <li>To gain knowledge and compare respiratory structures and mechanism from invertebrates to vertebrates</li> </ul>	<i>U, R, An</i>	<i>PO1, PO2</i>  <i>PSO1, PSO2</i>
Unit 2: Physiology of Excretion and Osmoregulation	<b>CO2:</b> <ul style="list-style-type: none"> <li>An introduction to the mechanisms of how the body works concentrating on osmoregulation, excretion and different structures to maintain homeostasis of the body.</li> </ul>	<i>U, R</i>	<i>PO1, PO2</i>  <i>PSO1, PSO2</i>
Unit 3: Physiology of Circulation	<b>CO3:</b> <ul style="list-style-type: none"> <li>This course deals with the heart and the circulation system in different animal forms.</li> <li>At the end of this course the student will be able to explain how the heart works as a pump and the role of the chambers, valves, and the muscle.</li> <li>The student will be introduced to the physics of haemodynamics and the regulation of circulation.</li> </ul>	<i>U, R, An</i>	<i>PO1</i> <i>PO2</i>  <i>PSO1, PSO2</i>
Unit 4: Physiology of Reproduction	<b>CO4:</b> <ul style="list-style-type: none"> <li>Provide comprehensive, up-to-date information of reproductive physiology, including molecular and cellular.</li> <li>Knowledge of the endocrine and neuroendocrine regulation of reproduction in females.</li> </ul>	<i>U, R, An, E</i>	<i>PO1, PO2</i>  <i>PSO1, PSO2</i> <i>PSO8</i>

**Course Code:** SIPSZOPHY33

**Course Name:** Membrane Physiology, Toxicology and Cancer Biology

The study of this course will accomplish the following outcomes:

<b>Unit</b>	<b>Course Outcome (CO)</b>	<b>Cognitive Level</b>	<b>Affinity with PO/ PSO</b>
Unit 1: Membrane Physiology	<b>CO1:</b> <ul style="list-style-type: none"> <li>Understanding the functional and structural aspects of the cell membrane.</li> <li>Compare and contrast different types of transport across cell membrane and nerve conduction.</li> </ul>	<i>U, R, An</i>	<i>PO1, PO2</i>  <i>PSO1, PSO2</i>
Unit 2: Toxicology-I	<b>CO2:</b> <ul style="list-style-type: none"> <li>To gain knowledge related to the harmful actions of chemical substances, to study their mechanisms of action, and to estimate their possible risks to humans on the basis of experimental work on biological test systems.</li> </ul>	<i>U, An, E</i>	<i>PO1, PO2</i> <i>PO7</i>  <i>PSO1, PSO2</i> <i>PSO3</i>
Unit 3: Toxicology-II	<b>CO3:</b> <ul style="list-style-type: none"> <li>To understand the different composition of animal toxins, food additives and other chemical toxicants.</li> <li>To understand the cellular and molecular mode of action of toxicants.</li> </ul>	<i>U, An, Ap, R</i>	<i>PO1, PO2,</i> <i>PO7</i>  <i>PSO1, PSO2,</i> <i>PSO3</i>
Unit 4: Cancer Biology	<b>CO4:</b> <ul style="list-style-type: none"> <li>To understand the basics of cancer and its types and the role of various physical, biological and environmental carcinogens.</li> <li>To learn the role of genetic engineering and various techniques in cancer therapy.</li> </ul>	<i>U, R, An</i>	<i>PO1, PO2</i>  <i>PSO1, PSO2</i> <i>PSO3</i>

	<ul style="list-style-type: none"> <li>Know and understand the molecular biology behind the cause of cancer.</li> </ul>		
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**Course Code: SIPSZOPHY34**

**Course Name: Industry Internship/Training**

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
No theory papers	<p><b>Course outcomes:</b></p> <ul style="list-style-type: none"> <li>To give students structured training for exposure to real working environment.</li> <li>To work effectively and respectfully with diverse teams in diverse environments.</li> <li>To combine experiential learning with theoretical concepts.</li> <li>To increase employability of students.</li> <li>To strengthen academia-industry linkage.</li> <li>To acquire organizational skills and time management to set self-defined goals and targets with timelines.</li> </ul>	<i>R, U, An, Ap</i>	<p><i>PO1, PO2, PO3, PO4, PO5, PO6</i></p> <p><i>PSO2, PSO3, PSO4</i></p>

### **PRACTICAL**

“*Study nature not books.*” – An old dictum.

The practical course in Zoology is designed for first hand study of animal life through observation of preserved specimens, *in situ* organ systems, microscopic examination of permanent slides, etc. as well as to perform experiments to strengthen the concept base.

It is an effort to invigorate a thought process that can analyze and reason for the sake of awareness, hence to reach a valid answer.

### Animal Physiology

#### Semester III – Practical

**Course Code: SIPSZOPHY31, 32, 33**

**Course Name: Practical based on Theory - SIPSZOPHY31, 32, 33**

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPSZOPHY31, 32, 33	<ul style="list-style-type: none"> <li>Students will learn about the factors affecting the activity of enzyme and the mechanisms of enzyme regulation.</li> <li>Students will learn the theories of enzyme kinetics</li> <li>Using a compound microscope, students will learn to dissect and observe striated patterns of muscle fibers and measure the length of contracted sarcomeres</li> <li>Students will learn about the different types of muscle fibers</li> <li>To gain knowledge on effect of change in Physico-chemical parameters of water on respiratory rate of fish</li> <li>To gain knowledge on effect of hypoxia on anaerobic metabolism in fish</li> <li>To learn about osmoregulation and adaptive behavior in fish</li> </ul>	An, U, E	<p><i>PO1, PO2</i></p> <p><i>PSO1, PSO2, PSO3</i></p>

	<ul style="list-style-type: none"> <li>• This study will aim to compare hematological parameters by using improved Hemocytometer amongst different animal groups and their clinical significance</li> <li>• Students will learn about the different types of hearts and its physiological role</li> <li>• Students will learn about sphygmomanometers and their use in for the monitoring of vital signs, specifically blood pressure, <u>heart rate and rhythm</u>, heart sounds, and breath sounds.</li> <li>• To learn about the toxic effect of carcinogen on liver enzymes</li> </ul>		
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**Course Code:** SIPSZOPHY34

**Course Name:** Practical IV based on SIPSZOPHY34

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPSZOPHY34	<ul style="list-style-type: none"> <li>• Students are required to present the work done during the course of internship in order to:</li> <li>• Express thoughts and ideas effectively in writing and orally and communicate with others using appropriate media.</li> <li>• Confidently share views and express themselves.</li> <li>• Use ICT in a variety of learning and work situations</li> <li>• Access, evaluate, and use a variety of relevant information sources, and use appropriate software for analysis of data.</li> </ul>	<i>R, U, An, Ap, E, C</i>	<i>PO1, PO2, PO3, PO4, PO6</i>  <i>PSO1, PSO2, PSO3</i>

### Animal Physiology

#### Semester IV – Theory

**Course Code:** SIPSZOPHY41

**Course Name:** Comparative Endocrinology, Basics of Neurobiology, Physiology of Nervous system, Sensory system

The study of this course will accomplish the following outcomes:

Unit	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Comparative Endocrinology	<b>CO1:</b> <ul style="list-style-type: none"> <li>• To explain the roles of the endocrine system in maintaining homeostasis, integrating growth and development</li> <li>• Comparative Endocrinology emphasizes on many complexities of vertebrate and invertebrate endocrine systems at the sub-molecular, molecular, cellular, and at an organismal level of analysis</li> </ul>	<i>An, U, R</i>	<i>PO1, PO2</i>  <i>PSO1, PSO2</i>
Unit 2: Basics of Neurobiology	<b>CO2:</b> <ul style="list-style-type: none"> <li>• Knowledge of the organization of the nervous system and nerve conduction</li> <li>• Students will learn fundamental information about the cellular biology and electrophysiological properties of neurons, neuroanatomy, and how the</li> </ul>	<i>An, U, R</i>	<i>PO1, PO2</i>  <i>PSO1, PSO2</i>

	activity of neurons can yield sensory perception, motor control, and complex behavioral/psychological functions such as learning and motivation.		
Unit 3: Physiology of Nervous System	<b>CO3:</b> <ul style="list-style-type: none"> <li>The objective of the course is to gain knowledge about the normal functioning of the nervous system in various animal kingdoms</li> </ul>	<i>An, U</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>
Unit 4: Sensory system	<b>CO4:</b> <ul style="list-style-type: none"> <li>To gain insights into how animals detect, process, and respond to sensory stimuli such as light, odors, sound, and temperature.</li> <li>Students will learn about the molecular mechanisms and neural systems used by vertebrates and invertebrates to sense the external and internal world.</li> <li>The comparative approach emphasizes common principles of sensory coding as well as the unique strategies employed to address specific biological needs.</li> </ul>	<i>An, R</i>	<i>PO1, PO2</i> <i>PSO1, PSO2</i>

**Course Code:** SIPSZOPHY42

**Course Name:** Applied Physiology

The study of this course will accomplish the following outcomes:

<b>Unit</b>	<b>Course Outcome (CO)</b>	<b>Cognitive Level</b>	<b>Affinity with PO/ PSO</b>
Unit 1: Sports Physiology I	<b>CO1:</b> <ul style="list-style-type: none"> <li>Students will learn about the physiological basis of the components of physical fitness</li> <li>Students will learn about the muscular system, muscle anatomy, organization of muscles, and how they work together</li> <li>Apply the scientific process in exercise physiology.</li> </ul>	<i>U, R</i>	<i>PO1, PO2, PO7</i> <i>PSO1, PSO2</i>
Unit 2: Sports Physiology II	<b>CO2:</b> <ul style="list-style-type: none"> <li>To understand the physiological adaptation and metabolic changes during exercise at varying intensities. Enables the students to gain an overall understanding of human body functioning during exercise</li> <li>To learn about physiology of endurance Performance</li> <li>To learn the changes in human body systems due to exercise and sporting activities in an integrated manner.</li> <li>To gain knowledge about spots training</li> <li>To learn about components of physical fitness</li> </ul>	<i>U, R, An</i>	<i>PO1, PO2</i> <i>PO8</i> <i>PSO1, PSO2</i>
Unit 3: Nutrition and Diet	<b>CO3:</b> <ul style="list-style-type: none"> <li>To enable students to identify the major chemical components of food</li> <li>To educate about basic sensory analysis of food</li> <li>To educate students about holistic nutrition, life style, wellness, and healthy living in both males and females.</li> <li>Plan diet towards the therapeutic approaches of the diseases</li> <li>Identify what foods are good sources for what nutrients Apply knowledge of the role of nutrition</li> </ul>	<i>U, R, An</i>	<i>PO1, PO2, PO8</i> <i>PSO1, PSO2</i>

	and healthy eating for disease prevention and wellness		
Unit 4: Infertility and Assisted Reproductive Technology	<b>CO4:</b> <ul style="list-style-type: none"> <li>Students will acquire knowledge regarding:</li> <li>The causes of female and male infertility and infertility associates disorders</li> <li>The different treatments for managing male and female infertility</li> <li>The genetic basis of infertility</li> <li>Techniques associated with infertility and ART</li> </ul>	<i>U, R, An</i>	<i>PO1, PO2, PO8</i>  <i>PSO1, PSO2, PSO3, PSO4</i>

**Course Code:** SIPSZOPHY43

**Course Name:** Electrophysiology and Radiation biology, Environmental Physiology and Clinical Diagnostics

The study of this course will accomplish the following outcomes:

Unit	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
Unit 1: Electro-physiology and Radiation Biology	<b>CO1:</b> <ul style="list-style-type: none"> <li>This course introduces students to the field of Cardiac Electrophysiology and enables them to have good understanding of both electrocardiography (ECG), the components of a surface ECG (P, QRS, T), cardiac anatomy and physiology a and a relatively good understanding of various cardiac arrhythmias.</li> </ul>	<i>U, R, Ap</i>	<i>PO1, PO2, PO7</i>  <i>PSO1, PSO2, PSO3</i>
Unit 2: Environmental Physiology	<b>CO2:</b> <ul style="list-style-type: none"> <li>To educate students on physiological adaptations that allow animal life to survive in diverse environments</li> <li>To gain knowledge on principles of environmental physiology and animal adaptation with emphasis on mechanisms of temperature and salt regulation.</li> </ul>	<i>U, R, Ap</i>	<i>PO1, PO2, PO7</i>  <i>PSO1, PSO2, PSO3</i>
Unit 3: Tools and Techniques for Clinical Diagnostics-I	<b>CO3:</b> <ul style="list-style-type: none"> <li>This course introduces students to the field of diagnostic immunology techniques and enzymes as biomarkers.</li> </ul>	<i>Ap, E</i>	<i>PO1, PO2</i>  <i>PSO1, PSO2, PSO3, PSO4</i>
Unit 4: Tools and Techniques for Clinical Diagnostics-II	<b>CO4:</b> <ul style="list-style-type: none"> <li>To gain knowledge related to clinical diagnostics for different physiological functional tests associated with different diseases.</li> </ul>	<i>Ap, E</i>	<i>PO1, PO2</i>  <i>PSO1, PSO2, PSO3, PSO4</i>

**Course Code:** SIPSZOPHY44

**Course Name:** Research Project/Dissertation

The study of this course will accomplish the following outcomes:

Unit	Course Outcome (CO)	Cognitive Level	Affinity with PO/ PSO
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	<ul style="list-style-type: none"> <li>• It will help students in upholding truth and building on to generate credible information.</li> <li>• Conducting research will help learners gain better knowledge and improve decision making skills.</li> <li>• It will help to examine the specifics of a topic and assist in making the conclusion and help to advise action as a means to understand issues and raise public awareness.</li> </ul>	<i>U, R, Ap, E</i>	<i>PO1, PO2, PO3, PO4, PO5, PO7</i>  <i>PSO1, PSO2, PSO3, PSO4</i>
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**Animal Physiology**

**Semester IV – Practical**

**Course Code:** SIPSZOPHY41, 42 and 43

**Course Name: Practical based on Theory:** SIPSZOPHY41, 42 and 43

Course	Course outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
SIPSZOPHY41, 42 and 43	<ul style="list-style-type: none"> <li>• Students will get to learn about anatomical features of the brain at various levels of organization</li> <li>• The hands-on approach of dissection will allow students to see, touch and explore the organs and learn the functional importance</li> <li>• Students will develop skills for preparation of slide and mounting</li> <li>• Students will learn about <u>gait analysis</u> and its importance to assess the presence of any abnormality in a patient's gait pattern, and if present, then what pathological condition may be the cause of the abnormality and depending on that, what medicine and exercises should be prescribed.</li> <li>• Students will analyze the various planes and axes of the body</li> <li>• Students will gain insights on male fertility and infertility conditions</li> <li>• Students will learn about the interaction of reproductive pathophysiological conditions and metabolic disorders and fertility issues in women</li> <li>• The goal of this practical is to determine the concentration of vitamin C in some commercial products by titration methods</li> <li>• Students will learn about the concepts of ECG and disorders associated with heart</li> <li>• Students will learn about the kidney function tests</li> <li>• A urinalysis is a common test that can assess many different aspects of your health with a urine sample</li> <li>• In this experiment, students will learn to quantitatively determine the unknown concentration of an antigen.</li> <li>• Learners will study the reaction pattern of an antigen with a set of antibodies by Ouchterlony Double Diffusion method.</li> </ul>	<i>U, An, E, Ap</i>	<i>PO1, PO2</i>  <i>PSO1, PSO2, PSO3</i>

**Course Code:** SIPSZOPHY44

**Course Name: Practical IV based on SIPSZOPHY44**

Course	Course Outcomes (CO)	Cognitive Level	Affinity with PO/ PSO
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SIPSZOOCNP44	<p><b>Course Outcomes:</b></p> <ul style="list-style-type: none"> <li>• Students are required to present the work done during the course of research project in the form of Dissertation and PowerPoint presentation in order to:</li> <li>• Express thoughts and ideas effectively in writing and orally and communicate with others using appropriate media.</li> <li>• Confidently share views and express themselves.</li> <li>• Use ICT in a variety of learning and work situations</li> <li>• Access, evaluate, and use a variety of relevant information sources, and use appropriate software for analysis of data.</li> </ul>	<p><i>R, U, An, Ap, E, C</i></p>	<p><i>PO1, PO2, PO3, PO4, PO5, PO6</i></p> <p><i>PSO1, PSO2, PSO3, PSO4</i></p>
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**Semester III – Theory**  
**Paper Code: SIPSZOPHY31**  
**Paper I: Principles of Animal Physiology and Physiological Processes – I**

**Learning objectives:**

- To orient learners about the sub disciplines of animal physiology and central themes of animal physiology
- To give the learners an overview of cellular interactions with the cellular microenvironment and the signaling events resulting from these interactions
- To understand how animals fulfill their energy demands by devising different means to procure and utilize nutrients from their surroundings by studying nutritional physiology.
- To understand physiology of movement and locomotion, one of the characteristics that separate animal kingdom from the plant kingdom

**Unit1: Principles of Animal Physiology** **(15 Lectures)**

- 1.1 Introduction to Animal Physiology
- 1.2 Sub-disciplines of animal physiology (Environmental physiology, Evolutionary physiology, Developmental physiology, Cell physiology)
- 1.3 History and the need to study animal physiology
- 1.4 Central themes of animal physiology (Structure/function relationships, Adaptation, Acclimatization and Acclimation, Homeostasis, Feedback control systems, Conformity and Regulation)
- 1.5 Experimental methods for exploring physiology

**Unit 2: Cell signaling and cell communication** **(15 Lectures)**

- 2.1 Cell signaling Hormones and receptors
- 2.2 Signal transduction pathways, primary messenger, second messengers, and tertiary messenger
- 2.3 Cell surface receptor, signaling through G- protein coupled receptors
- 2.4 Cytoplasmic receptors and transcription factors
- 2.5 Regulation of signaling pathways
- 2.6 Bacterial and plant two- component systems, bacterial chemotaxis, and quorum sensing
- 2.7 **Regulation of Cellular communication**
  - 2.7.1: General principles of cell communication
  - 2.7.2: Cell adhesion and role of different cell adhesion molecules.
  - 2.7.3: Gap junctions, Tight junction, Plasmodesmata, Anchoring Junctions : Adherens junction, desmosome, hemidesmosomes.

**Unit 3: Physiology of Nutrition** **(15 Lectures)**

- 3.1 Classification of feeding mechanisms in animals (suspension feeding, Manipulative feeding, Pumping mechanism for fluid feeding, Mechanism of direct nutrient absorption)
- 3.2 Need and specialization of digestive tract, Advantages, and disadvantages of intracellular digestion, Extracellular digestion
- 3.3 Digestive processes as chemical reactor systems (Batch reactor, Plug flow reactor, Continuous flow stirred tank reactor)
- 3.4 Generalized structure of gut (molluscan), Reception region, Esophagus, Crop in insects and birds, Mechanical digestion in Mid gut- Gizzard in rotifers, earthworm and cockroach, Hind gut
- 3.5 Function of Mucus in digestive tract, Concept of Bulk movement and peristalsis
- 3.6 Chemical digestion and absorption of food
- 3.7 Neural and hormonal regulation of secretion of digestive enzymes

**Unit 4: Physiology of Movement and Locomotion** **(15 Lectures)**

- 4.1 Locomotion in Amoeba (Sol-gel theory), Ciliary movement in Paramecia, Insect Asynchronous flight muscles
- 4.2 Adaptation for swimming in fish, jumping in frogs, Flight muscles in aves



- 4.3 Essentials of skeletal muscle contraction
- 4.4 Mechanism of muscle contraction (Sliding filament theory)
- 4.5 Energetics of muscle contraction
- 4.6 Regulation of muscle contraction (ionic control, neuronal control)

**Semester III – Theory**  
**Paper Code: SIPSZOPHY32**  
**Paper II: Physiological Processes – II**

**Learning objectives:**

- To give a comprehensive understanding of the physiology of gas exchange and acid base balance
- To acquire deep understanding of the life processes dealing with nitrogen metabolism, and dynamics of physiological fluids
- To appreciate the transformation of the transport system (circulatory system) found in animals as they became more complex in their anatomy.
- To gain knowledge about different modes of reproduction used by the animals in order to maintain their existence and to understand the role of hormones in the process of reproduction

**Unit 1: Physiology of Gas exchange and Acid base balance (15 Lectures)**

- 1.1 Essentials of respiratory structures
- 1.2 Respiratory structures in Invertebrates: Spiracles in insect, Book lungs in arachnid, Ctenidia in Mollusca, Cutaneous respiration in earthworm, Respiratory tree in Holothurian
- 1.3 Gas exchange in water via gills, Respiration in lung fishes, swim bladders in fishes, and Air breathing fishes
- 1.4 Respiration in frog (Branchial, Cutaneous, Buccal and Pulmonary)
- 1.5 Pulmonary respiration in birds and air sacs in birds (Pigeon). Gaseous exchange in cleidoic eggs.
- 1.6 Physiology of respiration in human: Functional anatomy of lung, lung ventilation (Eupnea, Hyperventilation, Hypoventilation, Hyperpnea, Apnea, Dyspnea, Polypnea) Pulmonary circulation, Mechanism of ventilation of lungs. Oxygen and Carbon dioxide transport in blood, transfer of gases to and from blood.
- 1.7 Regulation of body pH, Hydrogen ion production and excretion, Hydrogen ion distribution between compartments, factors influencing intracellular pH and blood pH

**Unit 2: Physiology of Excretion and Osmoregulation (15 Lectures)**

**2.1: Nitrogen Metabolism:**

- 2.1.1 : Amino-N Metabolism, nucleic acid metabolism, nitrogenous waste products
- 2.1.2 : Ammonia toxicity and detoxification pathways
- 2.1.3 : Ammonotelic, ureotelic, purinotelic, uricotelic, Storage excretion
- 2.1.4 : Patterns of detoxification pathways in eggs and during metamorphosis; phylogenetic patterns

**2.2: Dynamics of Physiological fluids:**

- 2.2.1 : Body fluid composition: Water, solute and intracellular regulation
- 2.2.2 : Structures involved in Excretion and osmoregulation in animals: Contractile vacuole, coelomoducts, flame cells, green gland, malpighian tubules, nephridia
- 2.2.3 : Structure and function of nephron

**Unit 3: Physiology of Circulation (15 Lectures)**

- 3.1 General plan of circulatory system, open circulation, closed circulation, Circulating fluids-Cytoplasm, Hydrolymph, Hemolymph, Lymph and Blood
- 3.2 Physiological types of hearts with special reference to arthropods, annelids, mollusca, tunicates
- 3.3 Vertebrate heart: Electrical properties, neurogenic and myogenic pacemakers, cardiac pacemaker potentials, cardiac action potential, mechanical properties of heart, cardiac output
- 3.4 Regulation of circulation: Control of central cardiovascular system, Arterial chemoreceptors, cardiac sensory receptors (arterial receptors and ventricular receptors), skeletal muscle afferent fibres, control of microcirculation, neuronal control of capillary blood flow, compounds produced in the endothelium.

3.5 Arterial system, Venous system, Blood pressure, countercurrent exchangers and Micro-circulatory beds with reference to humans

**Unit 4: Reproductive Physiology (15 Lectures)**

**4.1: Asexual Reproduction:** Fission and types of fission, fragmentation, Gemmule formation, Budding, Regeneration, Parthenogenesis.

**4.2: Sexual reproduction:**

- 4.2.1 Gametogenesis
- 4.2.2 Hormonal regulation of estrous cycle
- 4.2.3 Hormonal regulation of menstrual cycle
- 4.2.4 Molecular events in fertilization
- 4.2.5 Implantation: Process types and hormonal control
- 4.2.6 Pregnancy: Length of gestation and hormonal control
- 4.2.7 Hormonal control of parturition and lactation
- 4.2.8 Impact of age on reproduction: Menopause and andropause

**Semester III: Theory  
Paper code: SIPSZOPHY33**

**Paper III: Membrane Physiology, Toxicology, Cell communication and Cancer Biology**

***Learning Objectives:***

- *To gain an understanding of how a cell – the basic functional and structural unit of life is equipped to respond to its milieu.*
- *To develop an in depth knowledge of principles of toxicology*
- *To study animal toxins, toxicants in the form of pesticides, food additives*
- *To learn the principles of cancer biology and identify the main cellular and molecular mechanisms underlying the initiation and progression of neoplastic growth*

**Unit 1: Membrane Physiology (15 Lectures)**

- 1.1 Membrane structure
- 1.2 Membrane permeation: Diffusion, Mediated transport, dynamics of semi permeable membrane
- 1.3 Resting Membrane Potential
- 1.4 Excitable cell membranes (Action Potential, Properties of action potential)
- 1.5 Axonal propagation (Synaptic transmission, Electrical synapses, chemical synapses)

**Unit 2: Toxicology – I (15 Lectures)**

- 2.1 Definition and types of toxins
- 2.2 Ports of entry for toxins
- 2.3 Storage depots for toxins
- 2.4 Biotransformation of Toxins
- 2.5 Phase 1 reactions and Phase 2 reactions
- 2.6 Concept of LC50, LD50, NOEL, TD, Acute and Chronic toxicity
- 2.7 Elimination and excretion of toxins by various organ systems

**Unit 3: Toxicology – II (15 Lectures)**

**3.1: Composition of Animal toxins**

- 3.1.1 : Composition and types (based on target):Snake venom,
- 3.1.2 : Composition Jellyfish venom, Scorpion venom, Spider venom, Molluscan Venom
- 3.1.3 : Fish toxins

**3.2: Working mechanisms of components of venom in target organisms**

- 3.2.1 : Cellular mechanisms & Molecular mechanisms.

**3.3: Chemical toxicants:**

- 3.3.1 : Pesticides (Classification based on structure and target)
- 3.3.2 : Heavy metals (Mercury and Lead).

**3.4: Food additives, mycotoxins, Cosmetics as toxic agents.**

**Unit 4: Cancer biology****(15 Lectures)**

- 4.1** : Cancer: Terminology and Classification – Benign Vs Malignant Tumors
- 4.2** : Introduction to types of cancer- Head and Neck Breast, lung, colorectal, prostate and skin cancers.
- 4.3** : Causes of cancer: Physical ,Chemicals & Biological carcinogens Role of bacteria and viruses in cancer.  
Diet / Physical Exercise and Cancer  
Detection of cancer – Role of Imaging techniques – Sonography / CT Scan & Role of Pathologist,  
Biomarkers PSA in Prostate Cancer / ER -PR in breast cancer  
Ames Test to Detect Environmental Carcinogens / In Vitro Tissue culture-based tests and Animal Models  
Importance of early detection & Cancer Prevention
- 4.4** : Treatment: Surgery, Chemotherapy, Radiotherapy. Combination therapy, Metronomic therapy – Challenges
- 4.4.1 : Genetic Engineering - A New Era for Cancer therapy
- 4.4.2 : Immunotherapy for cancer
- 4.5** : Hallmarks of cancer- Next generation.
- 4.6** : Basic Cancer Genetics: Role of genetic predisposition in Breast / Retinoblastoma / Colorectal Cancers
- 4.6.1 : Protooncogene and oncogene, Tumor Suppressor Genes.
- 4.6.2 : Theory of "field cancerization"
- 4.6.3 : Steps theory of Invasion and Metastasis. Tumor microenvironment Metastasis Metastatic cascade,  
Basement Membrane disruption.

**Semester III: Theory****Paper code: SIPSZOPHY34****Paper IV: Industry Internship/Training*****Learning objectives:***

- *To give students structured training for exposure to real working environment*
- *To combine experiential learning with theoretical concepts*
- *To increase employability of students*
- *To strengthen academia-industry linkage*

**Semester III: Practical (SIPSZOPHY31, SIPSZOPHY32, SIPSZOPHY33)****Based on Theory – SIPSZOPHY31, SIPSZOPHY32 and SIPSZOPHY33**

1. Study of effect on the activity of amylase on: pH, temperature, activator, inhibitor.
2. Determination of Km of enzyme amylase.
3. Preparation of glycerinated muscle fiber and study of its properties
4. Mounting and identification of cardiac, striated muscle fibres
5. Observation of decreasing PO<sub>2</sub> of water on the respiratory rate of fish.
6. Effect of decreasing PO<sub>2</sub> of water on the lactic acid content in muscle.
7. Estimation of salt loss and gain in an aquatic animal when it is transferred to a salt-free medium and to a natural medium.
8. Effect of different concentrations of sodium chloride on the diameter of RBCs and determination of concentration isotonic to blood.
9. Total RBC, WBC and differential WBC count: A comparative study of fish, chicken goat and human blood.
10. Identification of hearts of: Fish, Chicken, Goat by taking longitudinal section
11. Determination of blood pressure using sphygmomanometer
12. Effect of Carbon tetrachloride on the levels of ACP, ALP, GPT, GOT, SDH and LDH

### **Semester III: Practical SIPSZOPHY34**

#### **Practical IV: Based on SIPSZOPHY34 (Industry Internship/Training)**

Background: As a part of the M.Sc Degree program in the subject of Zoology, the M.Sc. Part 2 students are required to complete an Internship / Training program at Industry / Company / Research Institute / Organization for gaining industrial experience related to the subject and or the area of specialization. This exercise carries a total of 150 marks which is partly based on the evaluation of the performance of the student by the competent authority at the industry where the student is placed and an evaluation by a team of examiners at the college during their semester end examination.

#### **Modalities of Evaluation:**

##### **1. Industry Diary / Rough Journal:**

Each student will maintain an Industry Diary / Rough Journal for keeping a record of daily activities carried out during the working period at the industry. The diary entries are to be evaluated and approved by a competent authority at the department / section where the student is placed. The diary entries must **NOT** contain any confidential information or any information that may infringe the intellectual property rights of the industry. The diary entries should be general with no details of specifics.

##### **2. Continuous Evaluation:**

The student needs to be continually evaluated for his / her performance at the industry. This evaluation may be based on a suitable criteria and modality as found appropriate and feasible at the industry. The evaluation may be best made by the immediate superior or the departmental / sectional head to whom the student reports. The evaluator may also keep regular record of the evaluations made.

##### **3. End of Program Evaluation:**

At the end of period, the immediate superior or the departmental / sectional head to whom the student reports, should make an evaluation report in the format attached with this document. The evaluation document will be approved by a competent authority at the senior managerial level, directly in the same vertical, where the student is placed.

**Semester IV – Theory**  
**Paper Code: SIPSZOPHY41**  
**Paper I: Physiological Processes-III**

**Learning Objectives:**

- *To understand the evolution and diversity of endocrine control of physiological systems using a comparative approach.*
- *Demonstrate a deep understanding of basic neuroanatomy and nervous system function at a molecular, cellular, systems level.*
- *To compare the physiology of nervous system of invertebrate and vertebrate animals*
- *To learn various types of sensations and receptors that are present in the invertebrate and vertebrate animals.*

**Unit 1: Comparative Endocrinology** **(15 Lectures)**

- 1.1 Endocrine regulation of calcium metabolism: corpuscles of stannius, Ultimobranchial bodies, Parathyroid glands.
- 1.2 Neuroendocrine system in arthropods (Crustaceans and insects): Prothoracic glands, X and Y organs, Epitracheal endocrine system, Diapause in insects
- 1.3 Neuroendocrine system in mammals: Production, function and feedback system of Oxytocin and Vasopressin.
- 1.4 Evolution of Pineal gland and its role (pathway) as biological clock
- 1.5 Hypothalamo-Hypophyseal-Thyroid Axis: Role of endostyle in development, Endocrine regulation of metamorphosis in amphibians, Structure, function and feedback system of thyroid hormones.
- 1.6 Hypothalamo-Hypophyseal-adrenal Axis: Role in osmoregulation, MSH production and function.

**Unit 2: Basics of Neurobiology** **(15 Lectures)**

- 2.1 The Nervous System:
  - 2.1.1 Basic anatomy and classification
  - 2.1.2 Types of neurons.
  - 2.1.3 Electrical conduction and action potential generation and propagation.
- 2.2 Synapse classification and conduction.
- 2.3 Neurotransmitters types, synthesis, storage, release, uptake, degradation and action of neurotransmitters.
- 2.4 The glial system: Types of glia in normal brain and its function in neuroprotection.
- 2.5 Working mechanism of Learning and memory

**Unit 3: Physiology of Nervous system** **(15 Lectures)**

- 3.1 Nervous system of Cnidaria (Hydra), Platyhelminthes (Planaria), Annelid (Earthworm) and Arthropoda (Cockroach)
- 3.2 Nervous system of Pisces (Scoliodon)
- 3.3 Nervous system of Amphibia (Frog)
- 3.4 Nervous system of Reptile (Varanus)
- 3.5 Nervous system of Aves (Pigeon)
- 3.6 Nervous system of Mammal (Rat)

**Unit 4: Sensory system** **(15 Lectures)**

- 4.1 Types of sensations, Classification of Receptors
- 4.2 Photoreception: Photoreceptor organs in invertebrates (Euglena, Planaria, Slug and Insect) Structure of human eye. Physiology of vision in human
- 4.3 Electoreception in predatory fishes
- 4.4 Mechanoreception: Invertebrate mechanoreceptors (Trichoid sensilla in crickets, Scolopidium in insects, Statocysts). Structure of human ear and mechanism of hearing in humans
- 4.5 Chemoreception:
  - 4.4.1 Olfaction
  - 4.4.2 Gustation

**Semester IV – Theory**  
**Paper Code: SIPSZOPHY42**  
**Paper II: Applied Physiology**

***Learning Objectives:***

- *To understand the basics of sports and exercise physiology*
- *To study the adaptations of various physiological systems like cardiovascular system, respiratory system, nervous system to exercise and training*
- *To learn fundamentals of nutrition and food science, nutritional biochemistry, various nutritional disorders and deficiencies.*
- *To equip the learners with general and therapeutic nutrition.*
- *To gain knowledge about causes, treatment of infertility and to understand the techniques and ethical considerations of Assisted Reproductive Technique.*

**Unit 1: Sports and Exercise Physiology-I (15 Lectures)**

- 1.1** Introduction to Exercise and Sports Physiology. (Concept of exercise and sports physiology, significance and scope of exercise and sports physiology)
- 1.2** Introduction to Muscular System: Muscles and Tendons, Classification of muscles, Structure of Skelton muscle, classification of muscles on basis of fibre arrangement
- 1.3** Physiology of muscle contraction, types of muscle contraction, Role of muscle in movement, Origin, Insertion and action of major muscle groups of the Body.
- 1.4** Components of physical fitness– Endurance, Strength, Speed, Flexibility, Coordination; Agility
- 1.5** Meaning of Kinesiology, Aims and Objectives of Kinesiology, Role of Kinesiology in Sports; Anatomical Position, Principles of Plane and Axis, Various types of movements

**Unit 2: Sports and Exercise Physiology-II (15 Lectures)**

- 2.1 Adaptations to Exercise and Training**
  - 2.1.1 Cardiovascular Adaptations to Endurance and Strength Training, Hypertrophy and Cardiomyopathy in young and older Athletes.
  - 2.1.2 Adaptations of respiratory system to endurance and strength training.
  - 2.1.3 Muscular and Neural mechanisms in aerobic endurance training
- 2.2** Concept of Overloading, Overtraining, Fatigue and Staleness, Symptoms and Causes of Fatigue, Types of Fatigue, Theories associated with Fatigue, Definition, Types, Symptoms, Findings, Underlying Mechanisms and Frequency of Overtraining and Overtraining Syndrome, Oxygen Debt Theory, Recovery Oxygen Uptake or Excess Post-exercise Oxygen Consumption (EPOC), Implications of EPOC for Exercise and Recovery, Optimal Recovery From Steady-Rate Exercise and Non–Steady-Rate Exercise, Intermittent Exercise and Recovery
- 2.3** Role of Warm-up and Cool Down

**Unit 3: Nutrition and Diet (15 Lectures)**

- 3.1 Fundamentals of Nutrition and Food science:**
  - 3.1.1 Optimum Nutrition, balanced diet
  - 3.1.2 Structure, Physical and Chemical properties of different types of food constituents - Cereals and grains, pulses and legumes, vegetables and fruits, nuts and oilseed, milk, sugar, meat and poultry
  - 3.1.3 Different food processing and preservation methods - roasting, frying, baking, fermentation, germination, drying, freezing
  - 3.1.4 Food regulation- laws, standard and agencies
- 3.2 Nutritional Biochemistry:**
  - 3.2.1 Introduction, sources, deficiency and toxicity of minerals
  - 3.2.2 Fibre - soluble/insoluble/ digestible/indigestible
- 3.3 Nutritional disorders and deficiencies:**
  - 3.3.1 Major nutritional problems- Protein energy malnutrition, Kwashiorkor, marasmus, anaemia, Vitamin A deficiency, Iodine disorders
  - 3.3.2 Minor nutritional problems - Scurvy, beri- beri, pellagra, rickets, osteoporosis

- 3.3.3 Introduction to causative agents and clinical manifestations of: Phenylketonuria, hypertyrosinemia, homocystinuria, hypervolemia (Disorders of amino acid metabolism), Pentosuria, galactosaemia (Disorders of carbohydrates metabolism) hyperchylomicronaemia (Lipid metabolism)

#### **3.4 General and Therapeutic Nutrition:**

- 3.4.1 Diet counseling of Pregnant and lactating women, infants, cardiac patients, hepatic patients, renal, endocrinological disorders, PCOS

### **Unit 4: Infertility and Assisted Reproductive Technology**

**(15 Lectures)**

#### **4.1: Infertility**

4.1.1: Female infertility:

- a. Causes: Failure to ovulate; production of infertile eggs; damage to oviducts (oviduct scarring and PID or Pelvic inflammatory disease, TB of oviduct), Uterus (TB of uterus and cervix)
- b. Infertility associated disorders: Endometriosis, Polycystic Ovarian syndrome (PCOS), Primary ovarian failure (POF), STDs; Antibodies to sperm; Genetic causes – Recurrent abortions; Role of endocrine disruptors

4.1.2: Male infertility: Causes: Testicular failure; infections of epididymis, seminal vesicles or prostate; hypogonadism; cryptorchidism; congenital abnormalities; Varicocele; Blockage; Azoospermia; Oligospermia; abnormal sperms; autoimmunity; ejaculatory disorders and Idiopathic infertility

#### **4.2: Treatment of Infertility**

- 4.1.1: Removal/ reduction of causative environmental factors
- 4.1.2: Surgical treatment
- 4.1.3: Hormonal treatment – Fertility drugs
- 4.1.4: Sperm banks
- 4.1.5: Surrogacy

#### **4.3: Techniques and Ethical considerations of ART:**

*In vitro* fertilization, Embryo transfer (ET), Intra-fallopian transfer (IFT), Intrauterine transfer (IUT), Gamete intra-fallopian transfer (GIFT), intra-zygote transfer (ZIFT), Intracytoplasmic sperm injection (ICSI) with ejaculated sperm and sperm retrieved from testicular biopsies – Testicular sperm extraction (TESE), Pronuclear stage transfer (PROST)

### **Semester IV – Theory**

**Paper Code: SIPSZOPHY43**

#### **Paper III: Electrophysiology and Radiation Biology, Environmental Physiology and Tools and Techniques for Clinical diagnostics**

#### ***Learning objectives:***

- *To understand the tests performed to access the electrical activities in the heart and the brain.*
- *To study radiation biology with respect to types of radiation, effects of radiations and to understand the concept of radiosensitivity.*
- *To understand the impact of environmental factors on the physiology of animals occupying various habitats.*
- *To gain knowledge about tools and techniques in clinical diagnostics*

### **Unit 1: Electrophysiology and Radiation biology**

**(15 Lectures)**

**1.1** Electrocardiogram: Working and Applications

1.1.1 Arrhythmias with respect to ECG.

**1.2** Electroencephalogram: Working and Applications.

**1.3** Radiation Biology: Types of radiation- X ray, UV rays,  $\gamma$  rays and microwaves

**1.4** Effects of radiation on DNA and chromosomes.

**1.5** Radiosensitivity of cells, cell survival curve.

**1.6** Factors affecting radiosensitivity: - Dose rate, Linear energy transfer, chemicals, stages of cell cycle.

**1.7** Acute effects of irradiation

## 1.8 Long term effects of radiation

### Unit 2: Environmental Physiology

(15 Lectures)

#### 2.1 Nature and levels of adaptation, Mechanism of adaptation, Concept of stress and strain in animals

#### 2.2 Thermal adaptation

- 2.2.1 Biochemical and physiological effects of temperature
- 2.2.2 Regulation of heat gain and heat loss
- 2.2.3 Role of nervous system and endocrine system in thermal biology.
- 2.2.4 Homeoviscous adaptation of membrane

#### 2.3 Salinity adaptation

- 2.3.1 Biochemical and physiological effects of salinity
- 2.3.2 Regulation and movements of water and solute
- 2.3.3 Role of membranes in osmoregulation
- 2.3.4 Strategies and mechanism in physiological adaptation with reference to marine life, estuarine life, freshwater life, terrestrial life.

#### 2.4 Physiological and morphological adaptation of the animals living in the extreme environments

### Unit 3: Tools and Techniques for Clinical Diagnostics -1

(15 Lectures)

#### 3.1: Diagnostic Immunology:

- 3.1.1. Methods based on precipitation; ODD, CIE, IEP.
- 3.1.2 Immunofixation and immunoblotting.
- 3.1.3 RE, Immunonephelometry.

#### 3.2: Methods based on Agglutination:

- 3.1.2. Agglutination of whole cells, agglutination of inert particles coated with Ag/Ab.
- 3.2.2 Haemagglutination – Direct, indirect, passive; CFT

#### 3.3: Labeled assays:

- 3.3.1 ELISA, RIA and FISH
- 3.3.2 IFT-in vivo reactions- skin tests, immune complex demonstration.

#### 3.4 Diagnostic evaluation of lymphocytic haemagglutination inhibition.

#### 3.5 Lymphocytic function and CMI, phagocytosis.

#### 3.6 Plasma specific and non-plasma specific enzymes

- 3.6.1. Diagnostic importance of LDH
- 3.6.2 Enzyme in diagnosis of myocardial infarction
- 3.6.3 Enzymes in Liver diseases
- 3.6.4 Enzymes in Cancer.

### Unit 4: Tools and Techniques for Clinical Diagnostics -2

(15 Lectures)

#### 4.1 Body fluid parameters as diagnostic tools:

- 4.1.1: Physiological fluids as diagnostic tools: Routine blood tests; plasma: Changes in composition in disease; Serum: Urea-N, creatinine, uric acid, proteins, bicarbonates, Na<sup>+</sup>, K<sup>+</sup>, Cl<sup>-</sup>
- 4.1.2: Glucose tolerance test, glycosylated haemoglobin
- 4.1.3: Lymph and cerebrospinal fluid: Changes in composition in disease
- 4.1.4: Urine composition/ constituents as a diagnostic tool: Routine urine tests Urea-N, creatinine, uric acid, tests for proteinuria, albuminuria, Glycosuria, chyluria (for filariasis)

#### 4.2 Organ Function Tests as diagnostic tools:

- 4.2.1: Liver function tests and toxicity tests
- 4.2.2: Pancreatic function tests
- 4.2.3: Gastric function tests
- 4.2.4: Kidney function tests



**Semester IV – Theory**  
**Paper Code: SIPSZOPHY44**  
**Paper IV: Research Project/Dissertation**

***Learning objectives***

- *To inculcate research aptitude and develop an open, inquiring mind amongst the students*
- *To encourage students to explore new territories and learn new things*
- *To encourage the spirit of curiosity of students and to think of research as potential career option*
- *To motivate and inspire students to come up with solutions for real life problems facing the society and nation*

**Semester IV: Practical (SIPSZOPHY41, SIPSZOPHY42, SIPSZOPHY43)**  
**Based on Theory – SIPSZOPHY41, SIPSZOPHY42 and SIPSZOPHY43**

1. Study of brains of: Fish, Chicken, Goat by taking its longitudinal section
2. Mounting of statocyst from prawns
3. Mounting of prawn ommatidia
4. Determination of Human Gait pattern.
5. To analyze various planes and axes of the body.
6. Semen analysis with the help of reports.
7. Analysis of hormone assay reports of PCOD patients
8. Estimation of Vitamin C by titrimetric method
9. Study of normal ECG and patients with arrhythmia
10. Determination of urea, creatinine, uric acid in Human blood
11. Routine urine tests and preparation of report as per pathological laboratory. Performance of Ouchterlony technique to demonstrate immunodiffusion.
12. Demonstration of single radial immunodiffusion of antibody and antigen.

**Semester IV: Practical (SIPSZOPHYP44)**  
**Practical IV: Based on SIPSZOPHY44**

**Research Project Component based on Animal Physiology/Interdisciplinary topic under Zoology**

**Details of Research project component for Semester IV are as follows:**

1. The students will prepare an outline/ scheme of the project proposal based on Animal Physiology / Interdisciplinary topic under Zoology in Semester III.
2. A teacher from the department will act as a project mentor to the student.
4. It will be the duty of the mentor to assign to the group a topic related to a particular theme covered in the syllabi / interdisciplinary topic.
6. The mentor will prepare, guide and supervise the group by giving orientation / instructions about writing the project proposal.
7. The **outline / scheme** of the project proposal will include literature review / search, introduction, objectives, purpose and rationale, materials and methods, expected outcomes / results, relevance of the project and bibliography (Note that the students have been taught Research Methodology in the revised syllabus of M.Sc. Part I in the subject of Zoology)
8. Actual execution / practical work of this project is to be done in Semester IV, inclusive of Diwali vacation/Winter vacation and on weekends/holidays of semester IV.
9. Actual execution may involve laboratory/ table work and or field work and or survey (the approach for the project work can be *in vitro* / *in vivo* / *in silico*, among others) as per the specifications mentioned in their project proposal.
10. The mentor for the respective group will keep a track of the actual execution of the project.
11. After completion of the practical work the student will prepare a '**Dissertation**' which will have copy of the outline/scheme of the proposal, abstract/ synopsis of the research work, introduction, materials and methods, observations, interpretation of results, conclusion and discussion, future plan / extension of work.
12. The student will also give a '**Power point presentation**' for the research project.

**Evaluation of Research Project during practical examination for Semester IV will be as follows:**

1. The examiner will evaluate the '**Dissertation**' for the research project by taking into account the following evaluation criteria given below:

<b>Title</b>
Abstract/ synopsis
Materials and Methods
Observations
Interpretation of results
Conclusion and Discussion
Relevance of work

2. The examiner will evaluate the '**Power point presentation**' for the research project by taking into account the following evaluation criteria given below:

<b>Title</b>
Content of the presentation
Quality of the presentation
Presentation skills
Viva/ Question- Answer session

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