AC/ /RS 2025-2026

SIES College of Arts, Science & Commerce (Autonomous)

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: 2024 – 2025**

**Revised Syllabus under NEP**
**Choice Based Credit System (CBCS)**
**Approved by the Board of Studies in Zoology**
**Effective from Academic year: 2024-25**

## *Preamble*

*"Where the mind is without fear and the head is held high ...."*

*A poem written by Nobel Laureate Rabindranath Tagore (Nobel Prize in Literature in 1913), the poem represents Tagore's vision of a new and awakened India (it is quoted in this preamble in the context of National Education Policy).*

*Our institution was one of the lead colleges, affiliated to University of Mumbai in implementing India's National Education Policy 2020 (NEP 2020) in academic year 2023-24. Moreover, we were also conferred with 'Empowered Autonomous Status' in 2023-24, which becomes all the more relevant, in terms of our contribution as an educational institution to fulfill the visionary and transformative objectives of National Education Policy. 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. Thus, in addition to enable students to acquire an in depth knowledge of the Core/Mandatory subject, the current syllabus also attempts to integrate a few courses under Department Specific Electives, which will help students to be equipped with the necessary skills to enhance their core competencies in understanding synergism of pure and applied sciences, in order to make them self-sufficient and build a future.*

*Some of the key features of this revised syllabus with specialization in Animal Physiology are as follows:*

- ✓ *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.*
- ✓ *Physical, Chemical and Biological Oceanography – to familiarize students the nature of life in the sea and our relationship to that life; to familiarize students with physical aspects of Oceanography such as tides, waves and currents that not only influence aquatic life but also life on the terrestrial realm.*
- ✓ *Aquaculture methods and practices – to introduce to the students the field of aquaculture and know its immense potential for generating employment; to acquire knowledge for wise management of aquatic resources to minimize production costs and gain profit; to consider aquaculture as a subsidiary in the income of someone having a taste for it and also to inculcate an entrepreneurial culture.*
- ✓ *Marine Fisheries – to give students knowledge of marine finfish and shell fish resources that opens an avenue for bioeconomics; to give them insights about current trends in global as well as national capture fishery; to make them aware of the significance of fishermen communities, agencies which focus on development of fish farmers and fishery extension programs.*
- ✓ *Fishery Science and Fish Processing Technology – to impart knowledge of the vast array of opportunities offered by fish processing industry by acquainting them to various methods of fish processing; to make the students familiar and get acquainted with different methods and materials required in traditional and recent methods in fish processing.*
- ✓ *Department Specific Electives in the form of Marine Biodiversity & Conservation; Marine Biotechnology & Toxicology – A course which has been restructured, whereby, it will make students aware of the fact that the ultimate measure of our wisdom in managing the environment of our planet will be, how well we have collectively done in maintaining the biodiversity and unique character of life in our oceans; to make the students understand the principles of toxicology, various toxicants, and their adverse effects on marine environment; to familiarize learners with promising marine bioactive compounds and their immense potential in various fields of sciences.*

*This revised syllabus is a collective and constructive effort of the faculty, experts from research institutions, alumni and the board members whose valuable suggestions and expertise were instrumental in materializing this syllabus. The comments and recommendations of the contributors and reviewers have been carefully considered and incorporated wherever feasible.*

*For effective teaching-learning, teachers are advised not to follow the syllabus too rigidly, but to exercise their professional discretion and judgment in implementing it. After all teaching is also about creating a conducive environment for learners to sustain enthusiasm about the subject. We sincerely hope that this revised syllabus will encourage critical thinking, instill analytical skills, besides inculcating interdisciplinary approach amongst student's to make learning more meaningful, thereby pursuing academic excellence. To conclude, especially in the context of Oceanography, let me quote French Oceanographer, Filmmaker & Writer, Jacques Yves Cousteau*

*"The sea, the great unifier, is man's only hope. Now, as never before, the old phrase has a literal meaning:*
*We are all in the same boat" – Jacques Yves Cousteau*

*(1910-1997; Co-invented the first successful Aqua-Lung, SCUBA: Self-Contained Underwater Breathing Apparatus).*

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*Chairman*
*Board of Studies in the subject of Zoology*
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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)*

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**M.Sc. Part II – Zoology (Animal Physiology) Syllabus (Autonomous)**
**Semester III**
**Credit Based Semester and Grading System (With effect from academic year 2024-25)**

| THEORY | | | |
|---|---|---|---|
| **Course name and code** | **Unit** | **Topic Headings** | **Credits** |
| **SEMESTER III** | | | |
| **A) Major** | | | |
| **a) Mandatory Papers** | | | |
| **Paper 1: Core Course 1: Principles of Animal Physiology and Physiological Processes I** | | | |
| **SIPZOCC611** | 1 | Physiology of Digestion and Absorption | **4** |
| | 2 | Cardiovascular Physiology | |
| | 3 | Physiology of Respiration | |
| | 4 | Physiology of Reproduction | |
| **Paper 2: Core Course 2: Principles of Animal Physiology and Physiological Processes II** | | | |
| **SIPZOCC612** | 1 | Physiology of Excretion and Osmoregulation | **4** |
| | 2 | Basics of Neurophysiology | |
| | 3 | General Endocrinology | |
| | 4 | Mammalian Endocrinology | |
| **b) Electives** | | | |
| **Paper 3: Department Specific Elective: Diet and Nutrition** | | | |
| **SIPZOEL611** | 1 | Fundamentals of Nutrition and Food Science | **3** |
| | 2 | Nutritional Disorders and Deficiencies | |
| | 3 | General and Therapeutic Nutrition | |
| **B) Research Project** | | | |
| **Paper 4: Research Project** | | | |
| **SIPZORP611** | | **No Theory Paper** | **6** |
| **PRACTICAL** | | | |
| **SIPZOCCP611** | | Based on Core Course 1 | **2** |
| **SIPZOCCP612** | | Based on Core Course 2 | **2** |
| **SIPZOELP611** | | Based on Department Specific Elective | **1** |
| | | **Total** | **22** |

**M.Sc. Part II – Zoology (Animal Physiology) Syllabus (Autonomous)**
**Semester IV**
**Credit Based Semester and Grading System (With effect from academic year 2024-25)**

| THEORY | | | |
|---|---|---|---|
| **Course name and code** | **Unit** | **Topic Headings** | **Credits** |
| **SEMESTER IV** | | | |
| **A) Major** | | | |
| **a) Mandatory Papers** | | | |
| **Paper 1: Core Course 1: Neuroscience, Immunology and Physiological Adaptations in Animals** | | | |
| **SIPZOCC621** | 1 | Recent Trends in Neurobiology | **4** |
| | 2 | Sensory Physiology | |
| | 3 | Immunology | |
| | 4 | Environmental Physiology of Animals | |
| **Paper 2: Core Course 2: Transduction Pathways, Cancer Biology and Applied Medical Techniques** | | | |
| **SIPZOCC622** | 1 | Cell signaling and cell communication | **4** |
| | 2 | Cancer Biology | |
| | 3 | Assisted Reproductive Technology | |
| | 4 | Tools and Techniques for Clinical diagnostics | |
| **b) Electives** | | | |
| **Paper 3: Department Specific Elective: Physiology of Movement and Locomotion, Sports Physiology and Electrophysiology and Radiation Biology** | | | |
| **SIPZOEL621** | 1 | Physiology of Movement and Locomotion | **3** |
| | 2 | Sports Physiology | |
| | 3 | Electrophysiology and Radiation Biology | |
| **B) Research Project** | | | |
| **Paper 4: Research Project** | | | |
| **SIPZORP621** | | **No Theory Paper** | **6** |
| **PRACTICAL** | | | |
| **SIPZOCCP621** | | Based on Core Course 1 | **2** |
| **SIPZOCCP621** | | Based on Core Course 2 | **2** |
| **SIPZOELP621** | | Based on Department Specific Elective | **1** |
| | | **Total** | **22** |

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

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

*"Tell me and I forget, teach me and I may remember, Involve me and I learn."*
*- Benjamin Franklin*

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 *(Skill Level)* | **Problem Solving Ability *(U, Ap)*** • Apply the knowledge of various courses learned under a program to break downcomplex problems into simple components. • Adopt and assimilate problem-based learning models and apply one's learning tosolve real life problem situations. |
| PO2 *(Skill Level)* | **Critical Thinking *(U, An, E)*** • 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 behindconcepts, ideas, and perspectives. |
| PO3 *(Skill Level)* | **Effective Communication Skills *(Ap, C)*** • 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 andreceive instructions clearly. • Develop presentation skills to present complex information in a clear, lucid andconcise manner. |
| PO4 *(Skill Level)* | **Proficiency with Information and Communication Technology *(U, An, E)*** • 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 *(Skill Level)* | **Leadership Skills and Team Work *(U, Ap, An, C)*** • 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 takings tasks to their logicalconclusion. • Inculcate the ability to facilitate coordinated effort as a group or team in theinterests of common cause and recognize the contribution of team members. |
| PO6 *(Attitude Level)* | **Self-directed and Lifelong Learning *(U, Ap, An)*** • 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<br>*(AttitudeLevel)* | **Ethical Values and Environmental Concerns *(U, Ap, E)***<br>• Embrace moral or ethical values in conducting one's life and implement ethicalpractices in all aspects of life.<br>• Create awareness and concern for environmental and sustainability issues.<br>• Understand and realize the significance and relevance of co-habitation and co-evolution in attaining the needs of sustainable development. |
| PO8<br>*(AttitudeLevel)* | Gender Sensitization and Community Service *(U, Ap, An)*<br>• Respect gender sensitivity, gender equity and gender justice.<br>• Encourage mutual understanding and express empathetic social concern towards different value systems and different strata of society.<br>• Engage in community service through Institutional Social Responsibility. |

| **Serial Number** | **Details of Programme Specific Outcomes (PSOs)<br>(Animal Physiology)** |
|---|---|
| PSO1 | **Conceptual Understanding and Emerging Applications *(R, U, Ap, An)***<br>• Inculcate conceptual and coherent understanding of Animal Physiology, and demonstrate a broad understanding of different aspects of Animal Physiology and to learn about the general features of the earth's surface under water. With reference to animal physiology, understand the detailed concepts of cell biology, cell signaling, and communication, general endocrinology, immunology, neurobiology, biochemistry, cancer biology, physiological processes in animals, ecology, so as to recognize the relationships between structure and functions at different levels of biological organization for the major groups of animals.<br>• Analyze the scope of emerging applications of animal physiology in medicine, sports, nutrition, wild life, etc. and apply appropriate methodologies with cutting edge tools/techniques to seek solutions to emerging problems faced by mankind<br>• Demonstrate the relevance of the procedural subject knowledge that creates different types of professionals related to the disciplinary/subject area of zoology,<br>including professionals engaged in research and development, teaching and government/public service. |
| PSO2 | **Analytical reasoning and Scientific Inquiry *(U, An, E)***<br>• Inculcate a sense of inquiry and capability for asking relevant or appropriate questions, articulating problems or concepts or questions.<br>• 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.<br>• 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.<br>• 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<br>while relating the conclusions/ findings to relevant theories of zoology. |
| PSO3 | **Laboratory Skills and Fieldwork *(R, U, E, C)***<br>• 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.<br>• Demonstrate awareness regarding animal ethics, human ethics, conservation of flora and fauna, so as to promote safe environment and ecosystem, in the pursuit of disciplinary knowledge. |
| PSO4 | **Research Aptitude and Interdisciplinary Approach *(Ap, An, E, C)***<br>• 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.<br>• 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, andapplication of research tools for analysis and interpretation of data.<br>• 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**

**Core Course 1 (Paper 1): Principles of Animal Physiology and Physiological Processes-I**
**Course Code: SIPZOCC611**
The study of this course will accomplish the following outcomes:

**Unit 1**: **Physiology of Digestion and Absorption**

| Course Outcomes (CO) | Cognitive Level | Affinity with PO/ PSO |
|---|---|---|
| **CO1:**<br>• Identify the locations and primary secretions involved in the chemical digestion of carbohydrates, proteins, lipids, and nucleic acids.<br>• Compare and contrast the feeding mechanisms and gut structure in animals. | *R, U, An* | *PO1, PO6*<br>*PSO1, PSO2* |

**Unit 2: Cardiovascular Physiology**

| Course Outcomes (CO) | Cognitive Level | Affinity with PO/ PSO |
|---|---|---|
| **CO2:**<br>• This course deals with the heart and the circulation system in different animal forms.<br>• 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.<br>• The student will be introduced to the physics of haemodymics and the regulation of circulation. | *R, U, An* | *PO1, PO2, PO6*<br>*PSO1, PSO2* |

**Unit 3: Physiology of Respiration**

| Course Outcomes (CO) | Cognitive Level | Affinity with PO/ PSO |
|---|---|---|
| **CO3:**<br>• The basic principles of gas exchange in health, mechanisms of altered gas exchange in disease, how the body compensates for abnormal gas exchange. | *R, U, An* | *PO1, PO2*<br>*PSO1, PSO2* |

| | | |
|---|---|---|
| • To gain knowledge and compare respiratory structures and mechanism from invertebrates to vertebrates. | | |
| **Unit 4: Physiology of Reproduction** | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
| **CO4:**<br>• Understanding of structural and functional aspects of male and female reproductive system.<br>• Knowledge about various pathophysiological consequences in spermatogenesis and oogenesis.<br>• Knowledge about endocrine regulation of spermatogenesis and ovulation, fertilization and pregnancy. | *R, U, An* | *PO1, PO2*<br>*PSO1, PSO2* |

| | | |
|---|---|---|
| **Core Course 2 (Paper 2): Principles of Animal Physiology and Physiological Processes-II**<br>**Course Code: SIPZOCC612**<br>The study of this course will accomplish the following outcomes: | | |
| **Unit 1: Physiology of Excretion and Osmoregulation** | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
| **CO1:**<br>• An introduction to the mechanisms of how the body works concentrating on osmoregulation, excretion and different structures to maintain homeostasis of the body. | *R, U, An* | *PO1, PO2*<br>*PSO1, PSO2* |
| **Unit 2: Basics of Neurophysiology** | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
| **CO2:**<br>• Knowledge of the organization of the nervous system and nerve conduction<br>• Students will learn fundamental information about the cellular biology and electrophysiological properties of neurons, neuroanatomy, and how the activity of neurons can yield sensory perception, motor control, and complex behavioural/psychological functions such as learning and motivation**.** | *An, U, R* | *PO1, PO2*<br>*PSO1, PSO2* |
| **Unit 3: General Endocrinology** | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
| **CO3:**<br>• The course is specially designed to improve the understanding of students about different dimensions of endocrinology starting from glands of the body, hormones secreted by endocrine glands, structure of glands and their different functions, signal transduction, different types of pathways of hormonal regulation and hormones in homeostasis. | *An, U, R* | *PO1, PO2*<br>*PSO1, PSO2* |
| **Unit 4: Mammalian Endocrinology** | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |

| | | |
|---|---|---|
| **CO4:**<br>• Knowledge about basic concepts of neurosecretion, neuroendocrine system and neurosecretory cells in vertebrates.<br>• Understanding of hypophyseal structures and functions among vertebrates.<br>• Understanding of peripheral endocrine glands structure and functions in vertebrates.<br>• Know about evolutionary consequences in neurosecretory and endocrine glands in animal systems. | *An, U, R* | *PO1, PO2*<br><br>*PSO1, PSO2* |

| **Department Specific Elective (Paper 3): Diet and Nutrition**<br>**Course Code: SIPZOEL611**<br>The study of this course will accomplish the following outcomes: | | |
|---|---|---|
| **Unit 1: Fundamentals of Nutrition and Food Science:** | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
| **CO1:**<br>• To enable students to identify the major chemical components of food<br>• To educate about basic sensory analysis of food.<br>• To educate students about holistic nutrition, life style, wellness, and healthy living. | *An, U, R* | *PO1, PO2, PO6*<br><br>*PSO1, PSO2* |
| **Unit 2: Nutritional Disorders and Deficiencies** | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
| **CO2:**<br>• Identify what foods are good sources for what nutrients<br>• Apply knowledge of the role of nutrition and healthy eating for disease prevention and wellness | *An, U, R* | *PO1, PO2, PO6*<br><br>*PSO1, PSO2* |
| **Unit 3: General and Therapeutic Nutrition** | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
| **CO3:**<br>• To acquire basic knowledge of nutrient requirements, recommended dietary allowances, and dietary modification under different physiological conditions. | *An, U, R* | *PO1, PO2, PO6*<br><br>*PSO1, PSO2* |

| **Research Project (Paper 4)**<br>**Course Code: SIPZORP611**<br>The study of this course will accomplish the following outcomes: | | |
|---|---|---|
| **NO THEORY PAPER** | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |

| | | |
|---|---|---|
| • To inculcate research aptitude and develop an open, inquiring mind amongst the students.<br>• To encourage students to explore new territories and learn new things.<br>• To encourage the spirit of curiosity of students and to think of research as potential career option.<br>• To motivate and inspire students to come up with solutions for real life problems facing the society and nation. | *R, U, An, Ap, E, C* | *PO1, PO2, PO3, PO4, PO5, PO6*<br><br>*PSO1, PSO2, PSO3, PSO4* |

**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 wellas 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**<br>**Semester III – Practical** | | |
|---|---|---|
| **Practical I based on Core Course 1 SIPZOCC611**<br>**Course Code: SIPZOCCP611**<br>The study of this course will accomplish the following outcomes: | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
| • Students will learn about the factors affecting the activity of enzyme and the mechanisms of enzyme regulation.<br>• Students will learn the theories of enzyme kinetics<br>• To gain knowledge on effect of change in Physico-chemical parameters of water on respiratory rate of fish.<br>• To gain knowledge on effect of hypoxia on anaerobic metabolism in fish<br>• This study will aim to compare hematological parameters amongst different animal groups and their clinical significance.<br>• Students will learn about sphygmomanometers and their use in for the monitoring of vital signs, specifically blood pressure, heart rate and rhythm, heart sounds, and breath sounds. | *R, U, An, Ap, E, C* | *PO1, PO2, PO3, PO5, PO6*<br><br>*PSO1, PSO2, PSO3, PSO4* |
| **Practical II based on Core Course 2 SIPZOCC612**<br>**Course Code: SIPZOCCP612**<br>The study of this course will accomplish the following outcomes: | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
| • To learn about osmoregulation and adaptive behavior in fish<br>• Students will learn to identify major endocrine glands and its location.<br>• Students will learn the concept of gametogenesis in animal<br>• To gain knowledge on various disorders associated with endocrine system<br>• To learn and analyze the urine tests using commercially available kits | *R, U, An, Ap, E, C* | *PO1, PO2, PO3, PO5, PO6*<br><br>*PSO1, PSO2, PSO3, PSO4* |
| **Practical III based on Department Specific Elective SIPZOEL611**<br>**Course Code: SIPZOELP611**<br>The study of this course will accomplish the following outcomes: | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |

| | | |
|---|---|---|
| • Practically gain knowledge to plan diet for each stage of life according to the guidelines for dietary needs<br>• Gain knowledge on changes during various stages of growth and development throughout lifecycle. This course will enable the students to be familiar with changes occurring in the foods as a result of cooking and processing<br>• Evaluate and predict ways in which complex interactions of components of the food system influence human health and nutrition.<br>• Demonstrate an understanding of public health. | *R, U, An, Ap, E, C* | *PO1, PO2, PO3, PO5, PO6*<br><br>*PSO1, PSO2, PSO3, PSO4* |

| **Animal Physiology**<br>**Semester IV – Theory** | | |
|---|---|---|
| **Core Course 1 (Paper 1): Neuroscience, Immunology and Physiological Adaptations in Animals**<br>**Course Code: SIPZOCC621**<br>The study of this course will accomplish the following outcomes: | | |
| **Unit 1: Recent trends in Neurobiology** | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
| **CO1:**<br>• Learners will gain insights about the creation of sophisticated neuroimaging methods which is one of the main areas of advancement in neuroscience.<br>• Understand the pathogenesis and management of common and important neurological diseases. | *R, U, An, Ap* | *PO1, PO2*<br><br>*PSO1, PSO2* |
| **Unit 2: Sensory Physiology:** | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
| **CO2:**<br>• To gain insights into how animals detect, process, and respond to sensory stimuli such as light, odours, sound, and temperature.<br>• Students will learn about the molecular mechanisms and neural systems used by vertebrates and invertebrates to sense the external and internal world.<br>• The comparative approach emphasizes common principles of sensory coding as well as the unique strategies employed to address specific biological needs. | *An, R* | *PO1, PO2*<br><br>*PSO1, PSO2* |
| **Unit 3: Immunology:** | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
| **CO3:**<br>• This course aims to provide students with an understanding of the immune system and its components, the defence mechanisms that can establish a state of immunity against infection, and Immune-related diseases. | *An, U, R* | *PO1, PO2*<br><br>*PSO1, PSO2* |
| **Unit 4: Environmental Physiology of Animals** | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |

| | | |
|---|---|---|
| **CO4:**<br>• To educate students on physiological adaptations that allow animal life to survive in diverse environments<br>• To gain knowledge on principles of environmental physiology and animal adaptation with emphasis on mechanisms of temperature and salt regulation. | *U, R, Ap* | *PO1, PO2, PO7*<br><br>*PSO1, PSO2, PSO3* |

| **Core Course 2 (Paper 2): Transduction Pathways, Cancer Biology and Applied Medical Techniques**<br>**Course Code: SIPZOCC622**<br>The study of this course will accomplish the following outcomes: | | |
|---|---|---|
| **Unit 1: Cell signaling and cell communication:** | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
| **CO1:**<br>• 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. | *An, E* | *PO1, PO2*<br><br>*PSO1, PSO2 PSO4* |
| **Unit 2: Cancer Biology:** | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
| **CO2:**<br>• To understand the basics of cancer and its types.<br>• To learn the role of genetic engineering in cancer therapy.<br>• Know and understand the molecular biology behind the cause of cancer. | *U, R, An* | *PO1, PO2*<br><br>*PSO1, PSO2 PSO3* |
| **Unit 3: Assisted Reproductive Technology** | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
| **CO3:**<br>• Students will acquire knowledge regarding:<br>• The causes of female and male infertility and infertility associated disorders.<br>• The different treatments for managing male and female infertility<br>• The genetic basis of infertility.<br>• Techniques associated with infertility and ART. | *U, R, Ap* | *PO1, PO2, PO7*<br><br>*PSO1, PSO2 PSO3* |
| **Unit 4: Tools and Techniques for Clinical diagnostics** | | |
| **Course Outcomes (CO)** | **Cognitive Level** | **Affinity with PO/ PSO** |
| **CO4:**<br>• This course introduces students to the field of diagnostic immunology techniques and enzymes as biomarkers used for the identification of various pathological conditions<br>• To gain knowledge related to clinical diagnostics for different physiological functional tests associated with different diseases. | *Ap, E* | *PO1, PO2*<br><br>*PSO1, PSO2, PSO3, PSO4* |

**Department Specific Elective (Paper 3): Physiology of Movement and Locomotion, Sports Physiology and Electrophysiology and Radiation Biology**
**Course Code: SIPZOEL621**
The study of this course will accomplish the following outcomes:

**Unit 1: Physiology of Movement and Locomotion:**

| Course Outcomes (CO) | Cognitive Level | Affinity with PO/ PSO |
|---|---|---|
| **CO1:**<br>• To gain knowledge with respect to comparative studies in locomotory behavior.<br>• Students get to learn the different types of movement, its adaptive role and different types of regulation necessary for contraction and relaxation of muscle fibres.<br>• Students will also learn about the sliding filament theory which is the basis for understanding the process of muscle contraction. | *U, R* | *PO1, PO2*<br>*PSO1, PSO2* |

**Unit 2: Sports Physiology:**

| Course Outcomes (CO) | Cognitive Level | Affinity with PO/ PSO |
|---|---|---|
| **CO2:**<br>• To understand the physiological adaptation and metabolic changes during exercise at varying intensities. It also enables the students to gain an overall understanding of human body functioning during exercise.<br>• To learn about physiology of endurance performance.<br>• To learn the changes in human body systems due to exercise and sporting activities in an integrated manner.<br>• To gain knowledge about sports training.<br>• To learn about components of physical fitness.<br>• Students will learn about the physiological basis of the components of physical fitness.<br>• Students will learn about the muscular system, muscle anatomy, organization of muscles, and how they work together. | *U, R* | *PO1, PO2*<br>*PSO1, PSO2* |

**Unit 3: Electrophysiology and Radiation Biology:**

| Course Outcomes (CO) | Cognitive Level | Affinity with PO/ PSO |
|---|---|---|
| **CO3:**<br>• 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) and a relatively good understanding of various cardiac arrhythmias.<br>• This course also introduces students to the field of Radiation Biology and the effects of ionizing radiation on biological tissues and living organisms. | *U, R, Ap* | *PO1, PO2, PO7*<br>*PSO1, PSO2*<br>*PSO3* |

**Research Project (Paper 4)**
**Course Code: SIPZORP621**
The study of this course will accomplish the following outcomes:

**NO THEORY PAPER**

| Course Outcomes (CO) | Cognitive Level | Affinity with PO/ PSO |
|---|---|---|
| • To inculcate research aptitude and develop an open, inquiring mind amongst the students.<br>• To encourage students to explore new territories and learn new things.<br>• To encourage the spirit of curiosity of students and to think of research as potential career option.<br>• To motivate and inspire students to come up with solutions for real life problems facing the society and nation. | *R, U, An, Ap, E, C* | *PO1, PO2, PO3, PO4, PO5, PO6*<br><br>*PSO1, PSO2, PSO3, PSO4* |

**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 IV – Practical**

**Practical I based on Core Course 1 SIPZOCC621**
**Course Code: SIPZOCCP621**
The study of this course will accomplish the following outcomes:

| Course Outcomes (CO) | Cognitive Level | Affinity with PO/ PSO |
|---|---|---|
| • The study will help students to do comparative analysis of different brain structures and their physiological role.<br>• Students will learn about serological techniques used in detection of antigen antibody interactions.<br>• The study will help students to analyse how organisms regulate their osmotic balance. | *R, U, An, Ap, E, C* | *PO1, PO2, PO3, PO5, PO6*<br><br>*PSO1, PSO2, PSO3, PSO4* |

**Practical II based on Core Course 2 SIPZOCC622**
**Course Code: SIPZOCCP622**
The study of this course will accomplish the following outcomes:

| Course Outcomes (CO) | Cognitive Level | Affinity with PO/ PSO |
|---|---|---|
| • Students will learn how to diagnose various pathophysiological conditions by analysing reports.<br>• Students will learn various biomarkers from early manifestations in disease diagnosis. | *R, U, An, Ap, E, C* | *PO1, PO2, PO3, PO5, PO6*<br><br>*PSO1, PSO2, PSO3, PSO4* |

**Practical III based on Department Specific Elective SIPZOEL621**
**Course Code: SIPZOELP621**
The study of this course will accomplish the following outcomes:

| Course Outcomes (CO) | Cognitive Level | Affinity with PO/ PSO |
|---|---|---|
| • The study will help students to learn various muscle types, structure and basic muscles contraction physiology.<br>• The study will help students to learn cardiovascular problems with help of ECG reports. | *R, U, An, Ap, E, C* | *PO1, PO2, PO3, PO5, PO6*<br><br>*PSO1, PSO2, PSO3, PSO4* |

**Animal Physiology**
**Semester III – Theory**

**Core Course 1 (Paper 1): Principles of Animal Physiology and Physiological Processes-I**
**Course Code: SIPZOCC611**

**Learning Objectives:**

- ✓ *To acquire deep understanding the ways in which organs work together to digest food and absorb nutrients.*
- ✓ *To appreciate the transformation of the transport system (circulatory system) found in animals as they became more complex in their anatomy.*
- ✓ *To orient learners about the physiology of gas exchange.*
- ✓ *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 Digestion and Absorption** | **15 Lectures** |
|---|---|

1.1**:** Classification of feeding mechanisms in animals: Suspension feeding, Manipulative feeding, pumping mechanism for fluid feeding, Mechanism of direct nutrient absorption, *Need and specialization of digestive tract, advantages and disadvantages of Intracellular digestion, Extracellular digestion.

1.2: *****Generalized structure of gut (molluscan), Crop in insects and birds, Gizzard in rotifers, earthworm and cockroach, Reception region, Mechanical digestion in Mid gut and Hind gut.

1.3: Digestion and Absorption:

1.3.1: Digestion and absorption of macronutrients

1.3.2: Gut movements (peristalsis and segmentation)

1.3.3: Hormonal and neural regulation of gastrointestinal function.

| **Unit 2: Cardiovascular Physiology** | **15 Lectures** |
|---|---|

2.1: General plan of circulatory system: Open circulation, Closed circulation, Circulating fluids- Cytoplasm, Hydrolymph, Hemolymph, Lymph and Blood.

2.2 *Physiological types of hearts with special reference to arthropods, annelids, mollusca, tunicates.

2.3: Properties of cardiac muscle, Neurogenic and Myogenic Heart

2.4: Cardiac Action Potential, Origin and conduction of cardiac impulse, Regulation of heart beat, Cardiac cycle, cardiac output, Regulation of cardiac output, Blood Pressure and Microcirculation.

2.5: Receptors in cardiovascular system (Baroreceptors and Chemoreceptors), Control mechanism in circulatory function (Autonomic neural control of the circulatory system, integrated supramedullary cardiovascular control, hormonal control of the cardiovascular system, short-term and long-term control of blood pressure).

| **Unit 3: Physiology of Respiration** | **15 Lectures** |
|---|---|

3.1:*Respiratory structures in Invertebrates: Spiracles in insect, Book lungs in arachnid, Ctenidia in Mollusca, Cutaneous respiration in earthworm, Respiratory tree in Holothurian

3.2: Gas exchange in water via gills, Respiration in lung fishes, swim bladders in fishes, and Air breathing fishes.

3.3: Respiration in frog (Branchial, Cutaneous, Buccal and Pulmonary)

3.4: Pulmonary respiration in birds and air sacs in birds, Gaseous exchange in cleidoic eggs.

3.5: Physiology of respiration in human: Organization of Respiratory system.

3.5.1: Pulmonary Ventilation and Breathing patterns (Eupnea, Hyperventilation, Hypoventilation, Hyperpnea, Apnea, Dyspnea, Polypnea). Mechanism of ventilation of lungs.

3.5.2: Pulmonary circulation, Exchange of Oxygen and Carbon Dioxide, Transport of Oxygen and Carbon Dioxide, Chemical and neural regulation of Respiration.

| **Unit 4: Reproductive Physiology** | **15 Lectures** |
|---|---|

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

4.2: Sexual reproduction: Gametogenesis

4.2.1: Reproductive cycles: Estrous cycle, Menstrual cycle, Control of seasonal reproductive cycle- Photoperiod and temperature, food supply

4.2.2: Regulation of ovarian function: Follicular development and selection, Regulation of Steroidogenesis, Oocyte maturation and corpus luteum formation, Mechanism of ovulation, Hormonal and molecular changes during pre-ovulatory period, Factors involved in follicular rupture, Follicular atresia.
4.2.3: *Molecular events in fertilization
4.2.4: Implantation: Process types and hormonal control
4.2.5: Pregnancy: Length of gestation and hormonal control
4.2.6: Hormonal control of parturition and lactation
4.2.7: Impact of age on reproduction: Menopause and Andropause

***Topics marked with '*' are to be prepared and presented by the students as a part of internal assessment***

**Core Course 2 (Paper 2): Principles of Animal Physiology and Physiological Processes-II**
**Course Code: SIPZOCC612**

**Learning Objectives:**

- ✓ *To gain an understanding of renal physiology.*
- ✓ *To develop an in-depth knowledge of principles of neurophysiology.*
- ✓ *To study hormone-receptor interactions in different physiological functions, hormone functions and gland roles in communication throughout the body.*
- ✓ *To learn the principles of the endocrine system to homeostasis and discuss the chemical composition of hormones and the mechanisms of hormone action. Summarize the site of production, regulation, and effects of the hormones of various glands.*

| **Unit 1: Physiology of Excretion and Osmoregulation** | **15 Lectures** |
|---|---|

1.1:*Structures involved in Excretion and osmoregulation in animals: Contractile vacuole, coelomoducts, flame cells, green gland, Malpighian tubules, nephridia
1.2: Functional anatomy of Kidney
1.3: Urine formation: Renal Blood Flow, Glomerular Filtration and their control, Tubular function
1.4: Production of Dilute and Concentrated Urine
1.5: Hormonal regulation of renal function
1.6: Renal failure and principles of Dialysis
1.7: Acid–base homeostasis

| **Unit 2: Basics of Neurophysiology** | **15 Lectures** |
|---|---|

2.1: Organization of nervous system:
2.1.1: Brain structure
2.1.2: Neurons and glia
2.1.3: Neuronal system: limbic and extrapyramidal
2.1.4: Blood brain barrier
2.2**:** Axonal and synaptic transmission
2.2.1: Membrane potential, action potential, transmission of nerve impulse
2.2.2: Types of synapses
2.2.3: Excitatory and inhibitory post-synaptic potential
2.2.4: Chemical transmission, neurotransmitters (acetylcholine, catecholamines, serotonin and GABA), neuropeptides and endorphins
2.3: *Learning and memory
2.3.1: Types
2.3.2: Working mechanism of Learning and memory.

| **Unit 3: General Endocrinology** | **15 Lectures** |
|---|---|

3.1: Endocrine Glands
3.2: Classification of hormones
3.3: Storage, secretions and delivery of hormones
3.4: Hormone-Receptor Interactions:
3.4.1: Membrane bound receptors

3.4.2: Intracellular receptors
3.4.3: Genomic and non-genomic effects of hormones
3.4.4: Second messengers in hormone action: cAMP, cGMP, calcium ions, inositol triphosphate (IP3) and protein kinase cascade
3.5: Control of hormone secretion and *Measurement of hormone concentrations in blood.

| **Unit 4: Mammalian Endocrinology** | **15 Lectures** |
|---|---|

4.1: Anterior Pituitary Gland and Hypothalamus:
4.1.1: The pituitary gland and its relation to the hypothalamus
4.1.2: Control of pituitary secretion by hypothalamus
4.1.3: Physiological functions and regulation of adenohypophysis
4.2: Posterior Pituitary Gland and Hypothalamus:
4.1.1 Posterior pituitary gland and its relation to the hypothalamus
4.1.2 Physiological functions and regulation of neurohypophysis
4.3: Thyroid Gland:
4.3.1: Physiological anatomy of thyroid glands, Biosynthesis and secretion of thyroid hormones, functions of thyroid hormones, Regulation of thyroid hormones, Antithyroid substances
4.4: Parathyroid Gland:
4.4.1: *Physiological anatomy of parathyroid glands, Effect of parathyroid hormone on calcium and phosphate metabolism, Regulation of parathyroid secretions
4.4.2: Vitamin D, Calcitonin and its control on calcium ion concentration.
4.5: Adrenal Glands: Physiological anatomy of Adrenal glands
4.5.1: *Functions and regulation of Adrenocortical hormones
4.5.2: Adrenal Medulla: Catecholamines biosynthesis and metabolism, Physiological effects of catecholamines
4.6: Pancreatic islets:
4.6.1: Cell types in the Pancreatic Islets
4.6.2: Glucose homeostasis - Physiological actions, secretion and regulation: Glucagon, Insulin, Somatostatin.

***Topics marked with '*' are to be prepared and presented by the students as a part of internal assessment***

**Department Specific Elective (Paper 3): Diet and Nutrition**
**Course Code: SIPZOEL611**

**Learning Objectives:**
- ✓ *To learn fundamentals of nutrition and food science, nutritional biochemistry, various nutritional disorders and deficiencies.*
- ✓ *To equip the learners with general and therapeutic nutrition.*

| **Unit 1: Fundamentals of Nutrition and Food Science:** | **15 Lectures** |
|---|---|

1.1: Optimum Nutrition, balanced diet
1.2: Structure, Physical and Chemical properties of different types of food constituents - Cereals and grains, pulses and legumes, millets, vegetables and fruits, nuts and oilseed, milk.
1.3: Different food processing and preservation methods - roasting, frying, baking, fermentation, germination, drying, freezing, Food regulation- laws, standard and agencies.

| **Unit 2: Nutritional Disorders and Deficiencies** | **15 Lectures** |
|---|---|

2.1: Major nutritional problems- Protein energy malnutrition, Kwashiorkor, marasmus, anemia, Vitamin A deficiency, Iodine disorders
2.2: Minor nutritional problems - Scurvy, beri-beri, pellagra, rickets, osteoporosis
2.3: Introduction to causative agents and clinical manifestations of: Phenylketonuria, hypertyrosinemia, homocystinuria, hypervalemeia (Disorders of amino acid metabolism), Pentosuria, galactosaemia (Disorders of carbohydrates metabolism) hyperchylomicronemia (Lipid metabolism)

| **Unit 3: General and Therapeutic Nutrition** | **15 Lectures** |
|---|---|

3.1: Diet counseling of Pregnant, lactating women and infants
3.2: Diet counseling of Cardiac patients and hepatic patients
3.3: Diet counseling of patients suffering from renal and endocrinological disorders.

**Animal Physiology**
**Semester III – Practical**

**Practical I based on Core Course 1 SIPZOCC611**
**Course Code: SIPZOCCP611**

1. Study of effect on amylase activity: pH, temperature, activator, inhibitor.
2. Determination of Substrate variation and Km of amylase.
3. Differential WBC, Total WBC and Total RBC count: A comparative study of Chicken & Human blood
4. Determination of hemoglobin content in human blood using Sahli's haemoglobinometer method.
5. Determination of heamin crystals in given blood samples (human/chicken/fish)
6. Determination of blood pressure using sphygmomanometer (Under various physiological conditions)
7. Observation of decreasing *P*O2 of water on the respiratory rate of fish.
8. Study of spermatogenesis using histological slides of testis
9. Study of oogenesis using histological slides of ovary

**Practical II based on Core Course 2: SIPZOCC612**
**Course Code: SIPZOCCP612**

1. Effect of different concentrations of sodium chloride on the diameter of RBCs and determination of concentration isotonic to blood.
2. Determination of urea, creatinine, uric acid in human blood/urine sample
3. To study the permanent slides of some endocrine glands: Pituitary gland, Thyroid, Parathyroid, Pancreas, Thymus, Mammary gland, Adrenal gland, Testis and Ovary.
4. To demonstrate the abnormalities of Pituitary Gland: Dwarfism, Gigantism and Acromegaly.
5. To demonstrate the abnormalities related to Thyroid Gland: Hyperthyroidism Exophthalmos, Goiter and Grave's disease; Hypothyroidism, Myxedema, Cretinism.
6. To demonstrate the abnormalities of Adrenal Gland: Addison's Disease, Cushing Syndrome.

**Practical III based on Department Specific Elective SIPZOEL611**
**Course Code: SIPZOELP611**

1. Estimation of calcium in milk by using EDTA by titrimetric method
2. Estimation of Ascorbic acid by titrimetric method
3. To demonstrate the abnormalities associated with vitamins and minerals
4. Detection of benzoic acid and salicyclic acid in the given milk sample
5. Preparation of fruit & vegetable preserved product (jelly, pickle, sauce, squash, dehydration, freezing etc.)
6. Estimation of protein content in: a) Muscle/liver of fresh and preserved fish
   b) Different egg varieties

**Practical IV based on Research Project**
**Course Code: SIPZORP611**

**Research Project Component based on Animal Physiology/Interdisciplinary topic:**

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

1) The students will prepare a Research proposal based on Oceanography/Fishery Science/Interdisciplinary topic under Zoology in Semester III.
2) A teacher from the department will act as a project mentor to the student.
3) It will be the duty of the mentor to assign to the group a topic related to a particular theme covered in the syllabus/interdisciplinary topic.
4) The mentor will prepare, guide, and supervise the group by giving orientation/instructions about writing the project proposal.
5) 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 1 in the subject of Zoology).

Evaluation of the Research Project Proposal during the practical examination for Semester III will be as follows:

1) The examiner will evaluate the **'Research Proposal'** for the research project by taking into the account of the evaluation criteria given below:

| Title |
|---|
| Literature review/search |
| Introduction |
| Objectives, Purpose, and Rationale |
| Materials and Methods |
| Expected outcomes/results |
| Relevance of work |
| Bibliography |

2) The examiner will evaluate the **'PowerPoint Presentation'** for the research proposal by taking into the account of the evaluation criteria given below:

| Title |
|---|
| Content of the presentation |
| Quality of the presentation |
| Presentation skills |
| Viva/ Question- Answer session |

**Animal Physiology**
**Semester IV – Theory**

**Course Code: SIPZOCC621**
**Core Course 1 (Paper 1): Neuroscience, Immunology and Physiological Adaptations in Animal**

**Learning Objectives:**

- ✓ *To develop a broad understanding of the structure and function of the nervous system with a depth of knowledge in cellular/molecular or behavioral/cognitive perspectives.*
- ✓ *In addition to examining the normal development and activity of the nervous system, neuroscience studies diseases, disorders, and injuries that affect parts of the nervous system, how it develops, and how well it functions.*
- ✓ *The purpose of immunology is to better understand how the immune system functions, with better understanding, more effective medications, therapies, and scientific techniques can be developed to diagnose and treat immune-mediated diseases.*
- ✓ *Students will learn the importance of adaptations to humans and animals, explore various adaptations that animals have to meet their survival.*

| **Unit 1: Recent Trends in Neurobiology** | **15 Lectures** |
|---|---|

1.1: Brain imaging:
- 1.1.1: CAT
- 1.1.2: PET
- 1.1.3: MRI

1.2: Brain aging:
- 1.2.1: Structural alterations
- 1.2.2: Functional changes
- 1.2.3: Neurogenesis and Neuroplasticity,
- 1.2.4:*Neurodegeneration and Neuroprotection

1.3: Neuropathology:
- 1.3.1: Strokes

1.3.2: Epilepsy
1.3.3: Alzheimer's disease
1.3.4: Huntington's disease
1.3.5: Parkinson's disease.

| **Unit 2: Sensory Physiology** | **15 Lectures** |
|---|---|

2.1: Sensory system:
- 2.1.1: Types of sensations
- 2.1.2: Classification of Receptors

2.2: Photoreception:
- 2.2.1: Photoreceptor organs in invertebrates (Euglena, Planaria, Slug and Insect)
- 2.2.2: Structure of human eye.
- 2.2.3: Physiology of vision in human
- 2.2.4: Electroreception in predatory fishes

2.3: Mechanoreception:
- 2.3.1:*Invertebrate mechanoreceptors (Trichoid sensilla in crickets, Scolopidium in insects, Statocysts).
- 2.3.2: Structure of human ear and mechanism of hearing in humans.

2.4: Chemoreception:
- 2.4.1: Olfaction
- 2.4.2: Gustation

| **Unit 3: Immunology** | **15 Lectures** |
|---|---|

3.1: Basic concepts of Immunology, Historical background of Immunology
3.2: Concept of clonal selection and Types of immunity, Immune cells: types and production, Lymphoid organs, Innate Immunity, Anatomical Barriers, Chemical mediators, Toll-like receptors,
3.3: Complement system, Humoral immunity, Antigen and hapten, Antibody: types, structure and functions, Primary and secondary responses, Generation of antibody diversity, Class switching, somatic hypermutation,
3.4: Cell mediated immunity, T cell receptors, Major Histocompatibility Complex (MHC), Antigen: processing and presentation, T helper cell and lymphocyte activation
3.5: Role of cytotoxic T cell, perforin and granzymes
3.6: Hypersensitivity and Autoimmunity
3.7: *Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) Infections
3.8: *Congenital and acquired immune deficiencies.

| **Unit 4: Environmental Physiology of Animals** | **15 Lectures** |
|---|---|

4.1: Nature and levels of adaptation, Mechanism of adaptation, Concept of stress and strain in animals
4.2: Thermal adaptation
- 4.2.1: Biochemical and physiological effects of temperature
- 4.2.2: Regulation of heat gain and heat loss
- 4.2.3: Role of nervous system and endocrine system in thermal biology
- 4.2.4: Homeoviscous adaptation of membrane

4.3: Salinity adaptation
- 4.3.1: Biochemical and physiological effects of salinity
- 4.3.2: Regulation and movements of water and solute
- 4.3.3: Role of membranes in osmoregulation
- 4.3.4: *Strategies and mechanism in physiological adaptation with reference to marine life, estuarine life, freshwater life, terrestrial life.

4.4: Physiological and morphological adaptation of the animals living in challenging environments

***Topics marked with '*' are to be prepared and presented by the students as a part of internal assessment***

**Core Course 2 (Paper 2): Transduction Pathways, Cancer Biology and Applied Medical Techniques**
**Course Code: SIPZOCC622**

**Learning Objectives:**

- ✓ *Students will learn about signal transduction pathways that define cellular communication networks*

*that allow cells to communicate with other cells and with the extra cellular environment via cell surface receptors.*

- ✓ *Critically analyse the importance of understanding the DNA damage repair response for cancer research and treatment*
- ✓ *Evaluate how in-depth knowledge of tumour characteristics can be utilised in targeting cancer therapy*
- ✓ *Critically discuss the application of principles of immunology when studying and developing treatments for cancer*
- ✓ *Conduct, and explain the principles behind, essential experimental techniques required in modern cancer science*
- ✓ *Demonstrate originality in the application of existing knowledge and established techniques to create and interpret new developments in cancer science*
- ✓ *Discuss the challenges of translating new discoveries in therapeutics for clinical use.*
- ✓ *Apply the scientific method to address research questions within the field of cancer science*
- ✓ *Gain an understanding of the methods for obtaining various biomedical signals from biological systems and processing the signals for estimating various biological parameters.*
- ✓ *To gain knowledge about causes, treatment of infertility and to understand the techniques and ethical considerations of Assisted Reproductive Technique.*

| **Unit 1: Cell signaling and cell communication** | **15 Lectures** |
|---|---|

1.1: Signaling through cell surface receptors: G protein coupled receptors: signaling via cAMP, PKA IP3, $Ca^{2+}$/calmodulin, PKC, CaMK, ion channels, photo-transduction
1.2: Enzyme linked receptors:
  1.2.1: Receptor tyrosine kinase (RTK), Ras-MAPK and PI3K signaling pathways
  1.2.2: Tyrosine kinase associated receptors: JAK-STAT signaling pathway
  1.2.3: Receptor serine/threonine kinase (TGFβR), Receptor guanylyl cyclase: signaling via cGMP, PKG
1.3: *The Hedgehog, Wnt and Notch Pathways
1.4: Signaling by nitric oxide
1.5: Termination of signaling
1.6: General principles of cell communication:
  1.6.1: Cell adhesion and role of different cell adhesion molecules.,
  1.6.2:*Gap junctions, Tight junction, Plasmodesmata,
  1.6.3: Anchoring Junctions: Adherens junction, desmosome, and hemi-desmosomes.

| **Unit 2: Cancer Biology** | **15 Lectures** |
|---|---|

2.1: Terminology and Classification – Benign Vs Malignant Tumors
2.2: Introduction to types of cancer- Head and Neck, Breast, lung, colorectal, prostate, skin cancer, Endocrine Cancers (Thyroid gland, adrenal glands, pituitary gland) and Neuroendocrine cancers (Gastrointestinal tract, Pancreatic neuroendocrine tumors (islet cell cancer)
2.3: Hallmarks of cancer- Next generation.
2.4: Causes of cancer: Physical, Chemicals & Biological carcinogens, Role of bacteria and viruses in cancer. Diet / Physical Exercise and Cancer
2.5: Proto-oncogene and oncogene, Tumor Suppressor Genes, Steps, theory of Invasion and Metastasis, Tumor microenvironment, Metastatic cascade, Basement Membrane disruption.
2.6: Treatment: Surgery, Chemotherapy, Radiotherapy. Combination therapy, Metronomic therapy – Challenges in treatment & importance of Multimodal Treatment,
2.7: *Immunotherapy for cancer
2.8 : Biomarkers of Cancer

| **Unit 3: Assisted Reproductive Technology** | **15 Lectures** |
|---|---|

3.1: Male and Female Infertility:
  3.1.1: 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
  3.1.2: 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). Infertility

associated disorders: Endometriosis, Polycystic Ovarian syndrome (PCOS), Primary ovarian failure (POF), STDs; Antibodies to sperm; Genetic causes – Recurrent abortions; *Role of endocrine disruptors.

3.2: Treatment of Infertility:
- 3.2.1: Removal/ reduction of causative environmental factors
- 3.2.2: Surgical treatment
- 3.2.3: Hormonal treatment – Fertility drugs
- 3.2.4: Sperm banks
- 3.2.5: Surrogacy

3.3: 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)

| **Unit 4: Tools and Techniques for Clinical diagnostics** | 15 Lectures |
|---|---|

4.1: Diagnostic Immunology:
- 4.1.1: Methods based on precipitation: ODD, CIE, IEP
- 4.1.2: *Immunofixation and immunoblotting.
- 4.1.3: RE, Immunonephelometry.

4.2: Methods based on Agglutination:
- 4.2.1: Direct, indirect, passive; CFT.

4.3: Labeled assays:
- 4.3.1: FISH, IFT
- 4.3.2: Diagnostic evaluation of lymphocytic hemagglutination inhibition,

4.4: Monoclonal antibodies as diagnostic tools:
- 4.4.1: Detection of HCG, Diagnosis of STD

4.5: Organ Function Tests as diagnostic tools:
- 4.5.1: Liver and Gastric function tests

4.6: Enzyme in diagnosis:
- 4.6.1: Myocardial infarction
- 4.6.2: Liver diseases
- 4.6.3: Enzymes in Cancer.
- 4.6.4 Diagnostic importance of LDH

***Topics marked with '*' are to be prepared and presented by the students as a part of internal assessment***

**Department Specific Elective (Paper 3): Physiology of Movement and Locomotion, Sports Physiology and Electrophysiology and Radiation Biology**
**Course Code: SIPZOEL622**

**Learning Objectives:**
- ✓ *Comprehend the normal disposition, inter-relationships, gross, functional and applied anatomy of the musculoskeletal system, locomotion, posture, gait and various organs in the body. Comprehend the basic structure and connections between the various parts of the central nervous system so as to analyze the integrative and regulative functions of the organs and systems.*
- ✓ *To understand physiology of movement and locomotion, one of the characteristics that separate animal kingdom from the plant kingdom*
- ✓ *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.*

| **Unit 1: Physiology of Movement and Locomotion** | **15 Lectures** |
|---|---|

1.1 Essentials of skeletal muscle contraction,
1.2 Mechanism of muscle contraction (Sliding filament theory)
1.3 Energetics of muscle contraction
1.4 Regulation of muscle contraction (ionic control, neuronal control)

| Unit 2: Sports Physiology | 15 Lectures |
|---|---|
| 2.1: Components of physical fitness – Endurance, Strength, Speed, Flexibility, Coordination, Agility, Cardiovascular Adaptations to Endurance and Strength Training.<br>2.2: Hypertrophy and Cardiomyopathy in Young and Older Athletes.<br>2.3: Adaptations of respiratory system to endurance and strength training.<br>2.4: Muscular and Neural mechanisms in aerobic endurance training,<br>2.5: Concept of Overloading and Overtraining<br>2.6: Fatigue and Staleness, Symptoms and Causes of Fatigue, Types of Fatigue, Theories associated with Fatigue and Overtraining Syndrome<br>2.7: Oxygen Debt Theory, Recovery Oxygen Uptake or Excess Post-exercise Oxygen Consumption (EPOC), Implications of EPOC for Exercise and Recovery,<br>2.8: Optimal Recovery from Steady-Rate Exercise and Non–Steady-Rate Exercise, Intermittent Exercise and Recovery<br>2.9: Role of Warm-up and Cool Down. | |
| **Unit 3: Electrophysiology and Radiation Biology** | **15 Lectures** |
| 3.1 Electrocardiogram: Working and Clinical Applications<br>3.2 Arrhythmias with respect to ECG<br>3.3 Electroencephalogram: Working and Clinical Applications<br>3.4 Radiation Biology: Types of radiation- X ray, UV rays, γ rays and microwaves<br>3.5 Effects of radiation on DNA and chromosomes<br>3.6 Radiosensitivity of cells, cell survival curve<br>3.7Acute effects of irradiation<br>3.8 Long term effects of radiation | |

| **Animal Physiology**<br>**Semester IV – Practical** |
|---|
| **Practical I based on Core Course 1 SIPZOCC621**<br>**Course Code: SIPZOCCP621** |
| 1. Study of brains of: Fish, Chicken, Rat/Goat.<br>2. Mounting of statocyst from prawns<br>3. Mounting of prawn ommatidi<br>4. Estimation of salt loss and gain in an aquatic animal<br>5. Determination of salinity (chlorides) in given water samples<br>6. Performance of Ouchterlony technique to demonstrate immunodiffusion.<br>7. Demonstration of single radial immunodiffusion of antibody and antigen<br>8. Study of glands of immunological significance using histological slides (Thymus, Spleen, and Lymph gland) |
| **Practical II based on Core Course 2 SIPZOCC622**<br>**Course Code: SIPZOCCP622** |
| 1. Effect of Carbon tetrachloride/Paracetamol on the levels of ACP, ALP, GPT, GOT, SDH and LDH<br>2. Estimation of total cholesterol, HDL-cholesterol and triacyl glycerol in blood sample.<br>3. To demonstrate the presence of albumin, sugar and ketone bodies in given urine sample<br>4. Semen analysis with the help of reports.<br>5. Analysis of hormone assay reports of PCOD patients<br>6. Analysis of pre diabetic and diabetic biomarkers with help of pathological reports.<br>7. Analysis of routine urine tests using pathological laboratory reports |
| **Practical III based on Department Specific Elective SIPZOEL621**<br>**Course Code: SIPZOELP621** |
| 1. Mounting and identification of cardiac, striated & smooth muscle fibres<br>2. Preparation of glycerinated muscle fiber and study of its properties<br>3. Effect of decreasing *P*O2 of water on the lactic acid content in muscle.<br>4. To analyse various planes and axes of the body.<br>5. Determination of Human Gait pattern |

6. Study of normal ECG and patients with arrhythmia

**Practical IV based on Research Project**
**Course Code: SIPZORP621**

**Research Project Component based on Animal Physiology/Interdisciplinary topic:**

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

1) 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.
2) 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.
3) The mentor for the respective group will keep a track of the actual execution of the project.
4) 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.
5) The student will also give a '**PowerPoint presentation**' for the research project.

Evaluation of the Research Project Proposal during the practical examination for Semester III will be as follows:

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

| Title |
|---|
| Abstract/ synopsis |
| Materials and Methods |
| Observations |
| Interpretation of results |
| Conclusion and Discussion |
| Relevance of work |
| Abstract/ synopsis |

2) The examiner will evaluate the **'PowerPoint Presentation'** for the research project by taking into the account of the evaluation criteria given below:

| Title |
|---|
| Content of the presentation |
| Quality of the presentation |
| Presentation skills |
| Viva/ Question- Answer session |

**References**


1. Kuby: Immunology, 7thed, 2007, Freeman.
2. Kenneth et al: Janeway Immunobiology, 8thed, 2012, Garland.
3. David, M., Jonathan, B., David, R. B. and Ivan R. (2006). Immunology, VII Edition, Mosby, Elsevier Publication.
4. Lodish *et al*: Molecular Cell Biology (6th ed 2007, Freeman and Company)
5. Kindt *et al:* Kuby's Immunology (2007, Freeman)
6. Voet and Voet: Biochemistry (2004, John Wiley)
7. Berg et al: Biochemistry (6th ed 2007, Freeman)

8. Nelson *et al:* Lehninger Principles of Biochemistry (3rd ed 2006, Brooks/Cole
9. Cowell: Molecular Genetics of Cancer (2001, Bios)
10. Ehrlich, DNA Alterations in Cancer (2000, Eaton) Hadley, M.C.: Endocrinology, Prentice Hall, International Edition, 2000
11. Wilson and Foster, Williams Text Book of Endocrinology 10th edition, W.B. Saunders Company Philadelphia, 2005
12. Neuroendocrinology: Charles B. Nemeroff, CRC, US
13. An Introduction to Neuroendocrinology: Richard E. Brown, 2005, Cambridge University Press
14. Bolander: Molecular Endocrinology (3rd ed 2006, Elsevier)
15. DeGroot and Jameson: Endocrinology (5th ed 2006, Vol 1, Elsevier-Saunders)
16. Brooks and Marshall: Essentials of Endocrinology (1995, Blackwell Science)
17. Norris and Lopez: Vertebrate Endocrinology (5th ed, Vol 5, 2011, Academic press)
18. Knobil & Neill: The Physiology of Reproduction, Vol. I & II (1994 Raven Press)
19. Cooper (2007). The Cell: A molecular Approach. ASM Press
20. Ganong: Review of Medical Physiology (22nd Ed 2005, Lang Medical Publications)
21. Guyton and Hall: Text Book of Medical Physiology (11th Ed 2006, W.B. Saunders)
22. Shepherd: Neurobiology (1994, Oxford Univ Press)
23. Encyclopedia of Reproduction: Ernst Knobil and Jimmy D. Neill, Volumes 1-4, Academic Press
24. Keel et al: Samson Wright's Applied Physiology (13th Ed1989, Oxford Press)
25. Murray et al: Harper's Illustrated Biochemistry (27th Ed 1989, Appleton & Lange)
26. West: Best and Taylor's Physiological Basis of Medical Practice (11th Ed 1981, Williams and Wilkins)
27. Neurobiology: Squire et al: Fundamental Neuroscience (2003, Academic Press)
28. Eric Kandel: Principles of Neural Science (2000, Mc Graw Hill)
29. Thakur and Rattan: Brain Aging (2014, Springer)
30. Adashi *et al:* Reproductive Endocrinology, Surgery and Technology (1996, Lippincott- Raven publishers)
31. Singh, Shio Kumar: Mammalian endocrinology and male reproductive biology (2016, CRC Press/Taylor & Francis group).
32. Setchell: The Mammalian Testis (1992, Cornell University Press)
33. Mann &Lutwak-Mann: The Male Reproductive Function and Semen (1998, Springer)
34. Paulson et al: Andrology: Male Fertility and Sterility (1986, Academic Press)
35. Hill, R.W., G. A. Wyse, M. Anderson (2016) Animal Physiology, Sinauer,4th Edition, USA
36. Moyes, C.D., P.M. Schulte (2016) Principles of Animal Physiology, Pearson Education India, 2nd Edition, Campbell, A.M., C. J. Paradise (2016) Animal Physiology, Momentum Press, USA.
37. Sherwood, L., Klandrof, H., P. Yancy (2012) Animal Physiology: From genes to organisms, Cengage learning, Hall, J. E. 2015.
38. Guyton and Hall Text book of Medical Physiology, 13thEdition, Relx India Pvt. Ltd.
39. Verma, P.S., B.S. Tyagi, V. K. Agarwal, 2000.
40. Animal Physiology, S. Chand & Co. India.
41. Rastogi, S. L. 1997. Essential of Animal Physiology, New Age International Publishers, India.
42. Handbook of Cell signaling by Ralph. A. Bradshaw, Edward A. Dennis
43. Cell signaling by John. T. Hancock Bruce Albert - Molecular biology of the cell.
44. Basic Neurochemistry by M. P. Spiegel.
45. Cell Biology of the Axon, Series: Results and Problems in Cell Differentiation, Vol. 48. Koenig, Edward (Ed.) 2009, 350 p.
46. Principles of neural Sciences. Eric Kendel, J. H. Schwartz, T. Jessel.
47. Alemany, R. Viruses in cancer treatment. Clin Transl Oncol 15, 182–188 (2013).
48. Hanahan, D. and Weinberg, R.A., 2011. Hallmarks of cancer: the next generation. cell, 144(5), pp.646-674.
49. Fouad, Y.A. and Aanei, C., 2017. Revisiting the hallmarks of cancer. American journal of cancer research, 7(5), p.1016.
50. Arneth, B., 2019. Tumor microenvironment. Medicina, 56(1), p.15.
51. Xiao, Y. and Yu, D., 2021. Tumor microenvironment as a therapeutic target in cancer. Pharmacology & therapeutics, 221, p.107753.
52. Shen, M. and Kang, Y., 2020. Stresses in the metastatic cascade: molecular mechanisms and therapeutic opportunities. Genes & development, 34(23-24), pp.1577-1598.
53. International Atomic Energy Agency Vienna, 2010: Radiation Biology: A Handbook for Teachers and Students. Basic Radiobiology: http://wwwnaweb.iaea.org/nahu/dmrp/documents/chapter14.pdf
54. George N. Somero., Brent L Lockwood., Lars Tomanek. - Biochemical Adaptations- Response to

environmental challenges from life's origins to the Anthropocene.
55. Randall D., Burggren W., French K. and Fernald R., 2002. Animal Physiology: Mechanisms and Adaptations, 5th Ed. W.H. Freeman and company, NY.
56. Food Theory and Application (2ndEd), New York: Maxwell MacMillan International Edition.
57. Manay, N. and Sharaswamy, S. (1997). Foods: Facts and Principles New Delhi: New Age Publishers McWilliams, M (2007).
58. Bamji, M.S., Rao, N.P & Reddy, V. (1996). Textbook of Human Nutrition. Oxford & IBH Publishing Co. (P). Ltd. Delhi.
59. Gopalan, G. Rama Shastri B.V & Balasubramanian, S.C. (2000). Nutritive Value of Indian Foods. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad 500-007, India.
60. Sri Lakshmi, B. (2000). Nutrition Science. New Age International (P) Ltd. Pub. New Delhi
61. Swaminathan, M. (2009). Textbook of Food and Nutrition. Bappco publishers, Bangalore.
62. Meyer, L.H (1987). Food Chemistry. CBS Publishers.
63. Anderson, L, Dibble, M.U. &Turkki. (1982). Nutrition in Health and Disease. JB Lippincott Co. Toronto.
64. Damodaran, S., Parkin, K.L. and Fennema, O. R. (2007). Fennema's Food Chemistry, fourth edition, published by CRC Press.
65. Meyer L.H. (2003). Food Chemistry, Reinhold Pub. Corp.
66. Nielsen, S.S. (2003). Food Analysis, Third Ed., Kluwer Academic/Plenum Publishers, New York.
67. Mahan, L.K. & Escott Stump, S. (2000). Krause's Food Nutrition and Diet Therapy 10th Ed., WB Saunders & Co. London.
68. Shils. M.E. (2006). Modern Nutrition in Health and Disease. Lippincot, Williams & Williams, USA.
69. Passmore, R. & Eastwood, M. A. (1986). Human Nutrition & Dietetics. ELBS Churchill Livingstone.
70. Fellows, P. J. (2016). Food Processing Technology: Principles and Practice, Fourth Edition, Woodhead Publishing.
71. Kiron Prabhakar (2016). A Practical Guide to Food Laws and Regulations, Bloomsbury Professional, India.
72. Environmental Physiology of Animals, second edition, by Pat Willmer, Graham stone and Ian Johnston, 2004
73. Subbulakshmi, G and Udipi, S. A. (2001). Foods Processing and Preservation, New Delhi: New Age International Ltd. Publishing
74. Swaminathan, M. (1995). Food Science Chemistry and Experimental Food. The Bangalore Printing and Publishing Co.Ltd
75. Vacklavick, V. and Christian, E. (2003). Essentials of Food Science. New York: Kluwer Academic/ Plenum Exercise and Sports Physiology by Kim Henige
76. Human Anatomy and Physiology (10th edition) by Elaine N Marieb, Katja N Hoehn.
77. Principle of Human Anatomy (10th Edition) by Gerard J. Tortora.
78. Gray's Anatomy: Anatomical Basis of Clinical Practice by Standring, Susan. Borley, Neil R. Gray Henry.
79. Human Physiology by C.C. Chatterjee.
80. Chowdhary Medical Physiology by S K Chowdhary.
81. Clinical Mechanics and Kinesiology with web Resource, Human Kinetics, by Janice Loudon, Robert Manske, Michael Reiman.
82. Biomechanics and Kinesiology of Exercise – 2013 by Michael Yessis.
83. A Textbook of Sports & Exercise Physiology by Swapan Kumar Dey
84. Exercise physiology: nutrition, energy and human performance by William D McArdle, Frank I Katch, Victor L Katch, 2010. 7th edition, Philadelphia, Pa.; London: Wolters Kluwer/Lippincott Williams & Wilkins, c2010.
85. Cynthia C. Norkin, Pamela K. Levangie: Joint structure & function- A comprehensive analysis 2nd edition.
86. Physiology of Sport and Exercise 6th Edition with Web Study Guide-Loose-Leaf Edition by W. Larry Kenney, Jack Wilmore, David Costill.
87. Periodization-6th Edition Theory and Methodology of Training by Tudor Bompa, Carlo Buzzichelli. Physiological Aspects of Sport Training and Performance, 2nd Edition,
88. Human Kinetics by Jay Hoffman. Shaun Phillips (2015) Fatigue in Sport and Exercise.
89. Routledge, NY Roy J. Shephard and Henry S. Miller, Jr. (1999) Exercise and the Heart in Health and Disease.
90. Marcel Dekker Shephard, R.J. and Astrand, P.-0. (1992) Endurance in sport. Blackwell Science Ltd, USA
91. McArdle, W.D., Katch, F.I., Katch, V.L. (2006) Essentials of Exercise Physiology.

92. Christopher B. Cooper and Thomas W. Storer (2004) Exercise testing and interpretation- A practical approach. Cambridge University Press.
93. K. Wasserman, J Hansen, D Sue, W Stringer, B Whipp, eds (2004) Principles of Exercise Testing and Interpretation, 4th edn. Lippincott Williams & Wilkins, Philadelphia, USA.
94. Christopher Bell. Cardiovascular Physiology in Exercise and Sport. 1st Edition. 2008; Churchill Livingstone Michael G. Levitzky. Pulmonary Physiology, 8e. 2013; Lange. The McGraw-Hill Companies.
95. Denise L. Smith and Bo Fernhall (2011) Advanced cardiovascular exercise physiology. Human Kinetics
96. Hallmarks of Cancer: New Dimensions. Hanahan D.Cancer Discov. 2022 Jan;12(1):31-46. doi: 10.1158/2159- 8290.CD-21-1059. PMID: 35022204 Review.
97. Beatty, G. L., & Gladney, W. L. (2015). Immune escape mechanisms as a guide for cancer immunotherapy. Clinical Cancer Research, 21(4), 687-692
98. Liu, Y., Wang, Y., & Lu, X. (2017). Crosstalk between cancer and immune cells: role of tumor-associated macrophages in the tumor microenvironment. Cancer medicine, 6(3), 470-481.
99. Weinberg, R. A. (2013). The biology of cancer. Garland science
100. Gupta, G. P., & Massagué, J. (2006). Cancer metastasis: building a framework. Cell, 127(4), 679-695.
101. Dowsett, M., and Dunbier, A. K. (2008). Emerging biomarkers and new understanding of traditional markers in personalized therapy for breast cancer. Clinical Cancer Research, 14(24): 8019–26.
102. Cancer biology Roger J B King and Mike W Robins, 3rd edition, Pearson Education Limited Edinburgh Gate Harlow Essex CM20 2JE England.

## Scheme of Examination

The performance of learners will be evaluated in two parts for the Theory component of the Course:

1. Internal Assessment
2. Semester End Examination (written)

The Practical component of the Course will be evaluated by conducting Semester End Practical Examination.

### Internal Assessment

It is the assessment of learners on the basis of continuous evaluation as envisaged in the Choice Based Credit System (CBCS) by way of participation of learners in various academic and correlated activities in the given semester of the program.

**For Core Course (CC) 1 and 2:**
**Total marks: 40**
**Seminar Marks: 20**
Evaluation will be conducted on the basis of Seminar/ Presentation given by the student on a topic chosen from the syllabus for each paper. The marking scheme shall be:

- Content of Presentation: **05 marks**
- Quality of Presentation: **05 marks**
- Presentation skills: **05 marks**
- Question-Answer discussion: **05 marks**

**Assignment Marks: 20**
Evaluation will be conducted on the basis of Research paper review / Book review / Poster presentation / Abstract writing / Preparation of Standard Operating Procedure or Calibration of Instruments / Role play or Skit on topic relevant to the paper / Report on Industry or Field Visit or Writing an article relevant to the paper etc.

**For Department Specific Elective (DSE):**
**Total marks: 25**
**Assignment marks: 25**
Evaluation will be conducted on the basis of Research paper review / Book review / Poster presentation / Abstract writing / Preparation of Standard Operating Procedure or Calibration of Instruments / Role play or Skit on topic relevant to the paper / Report on Industry or Field Visit or Writing an article relevant to the paper etc.

**For Research Project (RP):**
**Total marks: 50**
A continuous evaluation based on the performance will be conducted throughout the semester which will consist of punctuality, regular reporting to the concerned faculty about the progress, literature review for drafting the research proposal etc. (Semester III)
A continuous evaluation based on the performance will be conducted throughout the semester which will consist of punctuality, regular reporting to the concerned faculty about the progress, literature review and all the other activities related to the research project. (Semester IV)

### Semester End Assessment Theory

**For Core Course 1 and 2:**
**Marks: 60**
**Duration: 2.5 hours**
**Theory question paper pattern:**

- There shall be five questions of 12 marks each. On each unit there will be one question and the 5$^{th}$ question will be based on the entire paper.

**OR**

- There shall be four questions of 15 marks each, each question based on one unit.

- All questions are compulsory with internal choice within the questions.
- Questions may be subdivided and the allocation of marks depends on the weight age of the topic and by considering the Blooms Taxonomy for evaluation.

**For Department Specific Elective (DSE):**
**Marks: 50**
**Duration: 2 hours**
**Theory question paper pattern:**

- There shall be three questions of 12 marks each, each question on one unit.
- All questions are compulsory with internal choice within the questions.
- The 4th question will be based on the entire paper with internal choice within the questions.

**For Research Project (RP): NO THEORY EXAM**

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