



The Kelkar Education Trust's  
**Vinayak Ganesh Vaze College of Arts, Science & Commerce**  
**AUTONOMOUS**

Mithagar Road, Mulund East, Mumbai-400081, India

College with Potential for Excellence

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## **Syllabus for M. Sc. Part-II**

### **Programme:**

### **Zoology (Specialization Animal Physiology)**

Syllabus as per Choice Based Credit System (NEP-2020)

**(June 2024 Onwards)**

#### **Submitted by**

#### **Department of Zoology**

**Vinayak Ganesh Vaze College of Arts, Science and Commerce**

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❖ Syllabus as per Choice Based Credit System (NEP 2020)

## Syllabus for Approval

### Zoology (Specialization Animal Physiology)

Sr. No.	Heading	Particulars
1	Title of Programme	M.Sc. Zoology : Semester III and IV
2	Eligibility for Admission	The B.Sc. degree examination of this university with zoology 6 units or degree of any other university recognized as equivalent thereto.
3	Passing marks	Minimum D Grade or equivalent minimum marks for passing at the Graduation level.
4	Ordinances/Regulations (if any)	---
5	No. of Years/Semesters	One year/Two semester
6	Level	P.G. part-II : Level-6.5
7	Pattern	Semester
8	Status	Revised
9	To be implemented from Academic year	2024-2025

Date:.....

Signature:

BoS Chairperson: Prof. (Dr.) Vinod R. Ragade

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## Post Graduate Program in Zoology (Animal Physiology Specialization)

Year (2 Yr PG)	Level	Sem. (2 Yr)	Major		RM	OJT / FP	RP	Cum.Cr.	Degree
			Mandatory*	Electives Anyone					
2	6.5	Sem-III	<b>For Animal Physiology Specialization</b>		--	--	04	22	<b>PG Degree After 3-Yr UG</b>  <b>Or</b>  <b>PG Degree after 4-Yr UG</b>
			<b>Credits 14 (4+4+4+2)</b> Course 1 Credits 4 : Systems' Physiology (Invertebrates) I Course 2 Credits 4 : Systems' Physiology (Vertebrates) II Course 3 Credits 4 : Biochemical adaptation and Instrumentation Course 4 Credits 2 : <b>Practicals based on Systems' Physiology I, II &amp; Biochemical adaptation and Instrumentation</b>	<b>Credits 4 (2+2)</b> Course 1: Applied Physiology and <b>Practicals based on Applied Physiology</b> <b>OR</b> Course 2: Animal Biotechnology and <b>Practical based on Animal Biotechnology</b>					
		Sem-IV	<b>For Animal Physiology Specialization</b>		--	--	06	22	
			<b>Credits 12 (4+4+4)</b> Course 1 Credits 4 : Systems' Physiology III Course 2 Credits 4 : Systems' Physiology IV Course 3 Credits 4 : Recent Trends in Physiology	<b>Credits 4 (2+2)</b> Course 1: Dissertation and <b>Practical based on Dissertation</b> <b>OR</b> Course 2: Reproductive Physiology and <b>Practicals based on Reproductive Physiology</b>					
<b>Cum. Cr. for 1 Year PG Degree</b>			<b>26</b>	<b>8</b>	-	-	<b>10</b>	<b>44</b>	
<b>Cum. Cr. for 2 Year PG Degree</b>			<b>54</b>	<b>16</b>	<b>4</b>	<b>4</b>	<b>10</b>	<b>88</b>	
<b>2 Years - 4 Sem. PG Degree (80-88) credits after 3 Years UG Degree OR 1 Years - 2 Sem. PG Degree (40-44) credits after 4 Years UG Degree</b>									

# Proposed Draft Syllabus for M.Sc. Zoology Semester III and IV

## (Animal Physiology Specialization)

### Choice Based Credit System (NEP 2020)

(To be implemented from the academic year, 2024-2025)

#### Semester – III

#### Paper I

Course Code: VGVPSMAP301

Credits: 4

#### SYSTEMS' PHYSIOLOGY (INVERTEBRATES) I

Course Objectives
1. To familiarize the learner with nutritional physiology at various structural levels from membranes to systems.
2. To familiarize the learner to different structural elements in respiratory process and their operational mechanism.
3. To familiarize the learner to circulation of body fluids and types of circulation in various phyla of invertebrates
4. To familiarize the learner to organizational levels of osmo-regulatory and excretory structures in invertebrates and types of molecules generated as excretory product.

Unit I	Nutritive System	15H
	<ul style="list-style-type: none"><li>I. Membrane physiology: Functional consequences of molecular composition and arrangement of cell membrane</li><li>II. Transport across cell membrane Diffusion, active transport, pump; uniports, symports and antiport, co-transport by symporters and antiporters</li><li>III. Physiology of Food Capture and Processing in Invertebrate<ul style="list-style-type: none"><li>i. Nutritive Patterns – Origin of Nutritive types</li><li>ii. Feeding patterns<ul style="list-style-type: none"><li>a) Large particle feeding</li><li>b) Surface nutrient absorption</li></ul></li><li>iii. Modifications in the digestive system of invertebrates<ul style="list-style-type: none"><li>a) Arthropoda</li><li>b) Mollusca</li></ul></li></ul></li><li>IV. Dietary toxins and chemical defense strategies nematocyst, milk weed in monarch butterfly</li></ul>	
Unit II	Respiratory System	

	<p>I. Invertebrate transition from water to land</p> <p>II. Respiratory mechanisms in aquatic invertebrates</p> <ol style="list-style-type: none"> <li>i. Respiration across the cell membrane</li> <li>ii. Ostia</li> <li>iii. Gills – Crustacean and Echinoderms</li> <li>iv. Plastron</li> </ol> <p>III. Tracheal system</p> <ol style="list-style-type: none"> <li>i. Millipedes, Centipedes and insects</li> <li>ii. Tracheal ventilation</li> <li>iii. Gas exchange across tracheolar walls</li> </ol> <p>IV. Discontinuous or cyclic respiration</p> <p>V. Regulation of respiration</p> <p>VI. Respiratory pigments</p> <ol style="list-style-type: none"> <li>i. Chlorocruorin</li> <li>ii. Haemerythrin</li> <li>iii. Haemocyanin</li> <li>iv. Haemoglobin</li> </ol>	
<b>Unit III</b>	<b>Circulatory System</b>	<b>15 H</b>
	<p>I. Circulating Fluids</p> <ol style="list-style-type: none"> <li>i. Cytoplasm</li> <li>ii. Hydrolymph</li> <li>iii. Haemolymph</li> <li>iv. Lymph</li> <li>v. Blood</li> </ol> <p>II. Circulation of external fluid through an open body cavity – Sponge</p> <p>III. Circulation of internal fluid through an open circulatory system – Cockroach</p> <p>IV. Open circulatory system in Mollusca</p> <p>V. Circulatory mechanism and fluid compartments, movements of body fluids by somatic muscle</p> <p>VI. Physiological types of hearts with special reference to Arthropods, Annelids, Mollusca</p>	
<b>Unit IV</b>	<b>Osmoregulation and Excretory System</b>	<b>15 H</b>
	<p>I. Invertebrate excretory organs and physiology</p> <ol style="list-style-type: none"> <li>i. Epithelial exchange</li> <li>ii. Coelom</li> <li>iii. Coelomoducts</li> <li>iv. Malpighian tubules</li> <li>v. Protonephridia and metanephridia</li> <li>vi. Molluscan kidney</li> <li>vii. Antennal gland in crustacean</li> </ol> <p>II. Phylogenetic interpretations of excretory protein catabolism</p> <p>III. Ionic regulation in hyposmotic environment</p> <p>IV. Ionic regulation in hyperosmotic environment</p> <p>V. Invertebrate hormones regulating water and electrolytes</p>	

### References:

- 1) A. G. Giese: "Cell Physiology" (3rd Ed) Saunders, Toppan
- 2) Gerald Karp: "Cell Biology" McGraw Hill Kogakusha Ltd.
- 3) Biology of Animals --- Cleveland P. Hickman JR Larryds. Roberts
- 4) Darnell, Loddish, Baltimore: "Molecular Cell Biology" Scientific American Books.

- 5) C. A. Keil, E. Neil & E.N. Joeb (1982): “Samson Wright, Applied Physiology” Oxford Univ. \ Press.  
 6) R. Eckert & D. Randall (1982): “Animal Physiology: 2nd Ed.” W. H. Freeman & Co.

<b>Systems’ Physiology (Invertebrates) I</b>	<b>(Internal Assessment Pattern)</b>
	<b>Marks: 40</b>
1 Class Test	15 marks
2 Assignment: (Based on Theory Unit 1,2,3 and 4)	15 marks
3 Class Participation and Overall conduct	10 Marks

<b>Systems’ Physiology (Invertebrates) I</b>	<b>(Theory Paper Pattern)</b>
<b>Duration: 2.5 hrs</b>	<b>Marks: 60</b>
Q.1.A. Answer the following (Any one): Unit 1 A)  OR A)	06 Marks
Q.1. B) Attempt any two of the following: Unit 1 a) b) c)	06 Marks
Q.2.A. Answer the following: (Any one) Unit 2 A)  OR A)	06 Marks
Q.2. B) Attempt any two of the following: Unit 2 a) b) c)	06 Marks
Q.3.A. Answer the following: (Any one) Unit 3 A)  OR A)	06 Marks
Q.3. B) Attempt any two of the following: Unit 3 a) b) c)	06 Marks
Q.4.A. Answer the following: (Any one) Unit 4 A)  OR A)	06 Marks
Q.4. B) Attempt any two of the following: Unit 4 a) b) c)	06 Marks
Q.5. Write a note on (All questions are compulsory) a) Unit 1 b) Unit 2 c) Unit 3 d) Unit 4	12 Marks

<b>Course Outcome</b>
<b>After the completion of the course, students will able to</b>

**CO1** comprehend the molecular processes at membrane level and their significance in nutrition, food capture and processing, nutritive types and their correlation to variety of structures of nutritional apparatus in invertebrates.

**CO 2** discerns relationship of respiratory pigments, organization of membranes into structures like gills and trachea, mechanism of operation, patterns of respiration and their relationship to the habitat of invertebrates.

**CO3** study variety of circulatory fluids, patterns of circulation and physiological types of hearts in invertebrates.

**CO4** appreciate the relationship between increasing complexity of structure of excretory systems, the metabolic pathways generating the excretory waste products and the habitat of the invertebrates.

**Semester – III**

**Paper II**

**Course Code: VGVPSMAP302**

**Credits: 4**

**SYSTEMS' PHYSIOLOGY (VERTEBRATES) II**

**Course Objectives**

1. To familiarize the learner to different feeding patterns, variety of nutritional apparatus, process of digestion in the vertebrates and digestive system in human beings.
2. To introduce the learner to physico-chemical parameters of respiration in the vertebrates.
3. To introduce the learner to functional dynamics of circulatory systems in the vertebrates.
4. To enable the learner to become well versed with patterns of nitrogen metabolism, excretion of wastes, osmoregulation and applied aspects renal function in human beings.

Unit-1	Nutritive System	15 H
	I. Feeding mechanism in vertebrates <ul style="list-style-type: none"> <li>i. Filter feeding               <ul style="list-style-type: none"> <li>a) Pisces</li> <li>b) Flamingoes</li> <li>c) Tadpoles of frog</li> </ul> </li> <li>ii. Reptiles (Jacobson's organ)</li> </ul> II. Comparative study of Chemical digestion Absorptive adaptation of the Gut III. Micro-biome of human gut and its significance IV. Metabolic transition between meals <ul style="list-style-type: none"> <li>i. Hormonal control postprandial regulation of nutrient stores</li> <li>ii. Effect of prolonged food deprivation Balanced diet- a human perspectives</li> </ul> VI. Disorders of digestive system: <ul style="list-style-type: none"> <li>i. Acid reflux</li> <li>ii. Gall stones</li> <li>iii. Haemorrhoids</li> <li>iv. Dental Acidity</li> </ul>	

<b>Unit-2</b>	<b>Respiratory System</b>	<b>15 H</b>
	<p>I. Transition of vertebrates from water to land</p> <p>II. Comparative study of Respiratory system in vertebrates:</p> <ol style="list-style-type: none"> <li>i. Aquatic, terrestrial, gas exchange in terrestrial eggs</li> <li>ii. Respiration in lungfish</li> </ol> <p>III. Chemistry of respiration</p> <ol style="list-style-type: none"> <li>i. Composition of atmospheric and expired air</li> <li>ii. Aerodynamic Sub-division of air in the lungs</li> <li>ii. Regulation of lung breathing</li> <li>iv. Transport of gases in the blood</li> <li>v. Diffusion of gases in the lungs</li> <li>vi. Transport of CO<sub>2</sub> in the blood</li> <li>vii. Haldane effect- Partial pressure of gases</li> </ol> <p>IV. Dissociation of Oxyhaemoglobin and factors affecting it (temperature, electrolytes, CO<sub>2</sub> and Carboxyhaemoglobin)</p> <p>V. Acid-base balance:</p> <ol style="list-style-type: none"> <li>i. Measurements</li> <li>ii. Causes of disturbances</li> <li>iii. Metabolic Acidosis</li> <li>iv. Respiratory Acidosis</li> <li>v. Metabolic Alkalosis</li> <li>vi. Respiratory Alkalosis</li> </ol> <p>VI. Role of medulla oblongata in respiration</p> <ol style="list-style-type: none"> <li>i. Chemoreceptor</li> <li>ii. Mechanoreceptor and Ventilation reflexes</li> </ol>	
<b>Unit-3</b>	<b>Circulatory System</b>	<b>15 H</b>
	<p>I. Rheology:</p> <ol style="list-style-type: none"> <li>i. Viscosity, Poisuille</li> <li>ii. Hagen flow formula</li> <li>iii. Laminar and turbulent flow Resistance</li> <li>iv. Pressure, velocity and gravity</li> </ol> <p>II. Chordate circulatory system:</p> <ol style="list-style-type: none"> <li>i. Arterial system</li> <li>ii. Venous System</li> <li>iii. Lymphatic System</li> </ol> <p>III. Circulatory patterns in Vertebrates</p> <ol style="list-style-type: none"> <li>i. Lung fish</li> <li>ii. Amphibians</li> <li>iii. Reptiles</li> <li>iv. Birds</li> <li>v. Mammals</li> </ol> <p>IV. Regulation of cardiovascular system</p> <ol style="list-style-type: none"> <li>i. Heart</li> <li>ii. Cardiac output</li> <li>iii. Blood pressure</li> </ol> <p>V. The buffer system of the blood</p>	
<b>Unit-4</b>	<b>Osmoregulation and Excretory System</b>	<b>15 H</b>
	<p>I. Variation in vertebrate kidneys</p> <p>II. Nitrogen Metabolism: Formation of nitrogenous excretory products</p> <ol style="list-style-type: none"> <li>i. Amino-N Metabolism</li> <li>ii. Nucleic Acid Metabolism</li> <li>iii. Other nitrogenous waste products</li> </ol> <p>III. Regulation of Urine formation</p>	





Q.3.A. Answer the following: (Any one) Unit 3 A)  OR A)	06 Marks
Q.3. B) Attempt any two of the following: Unit 3 a) b) c)	06 Marks
Q.4.A. Answer the following: (Any one) Unit 4 A)  OR A)	06 Marks
Q.4. B) Attempt any two of the following: Unit 4 a) b) c)	06 Marks
Q.5. Write a note on (All questions are compulsory) a) Unit 1 b) Unit 2 c) Unit 3 d) Unit 4	12 Marks

<b>Course Outcome</b>
<b>After the completion of the course, students will able to</b>
<b>CO1</b> comprehend the comparative and specialized aspects of nutritional type, digestive systems, digestion as a metabolic process and neuro-hormonal regulation of nutrition.
<b>CO2</b> understand the role of microbes in digestion, balanced diet and disorders of digestive function which are applied aspects of nutrition, the study of which is an important take away for learners, which will help them in healthcare.
<b>CO3</b> comprehend change in physiology as an adaptive process in transition of vertebrates between aquatic and terrestrial mode of life.
<b>CO4</b> realize the clinical significance of simple diagnostic tests for estimation of blood parameters.
<b>CO5</b> gauge the evolutionary adaptations of the circulatory system and understand the control and coordination of circulation in the vertebrates.
<b>CO6</b> comprehend the applied aspects of circulatory system in the context of human health.
<b>CO7</b> discern the variations in metabolic waste products and their relationship to habitat, metabolic pathways of nitrogen metabolism in the vertebrates, role of renal functions in electrolyte balance, blood pressure and acid-base balance.
<b>CO8</b> introduce health effects of compromised kidney functions.

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**Semester – III**  
**Paper III**  
**Course Code: VGVPSMAP303**  
**Credits: 4**  
**BIOCHEMICAL ADAPTATION AND INSTRUMENTATION**

<b>Course Objectives</b>
1. To reinforce concepts of homeostasis and understand environmental stress.
2. To understand physiological adaptations to withstand the stress.

3. To familiarize the learner with various tools required to study animal physiology.

4. To familiarize the learner with techniques required to study animal physiology.

<b>Unit-1</b>	<b>Biochemical Adaptation, Oxygen &amp; Environmental Radiation</b>	<b>15 H</b>
	<p>I. Environmental Stress, Homeostasis and strategies of biochemical adaptations:</p> <ul style="list-style-type: none"><li>i. Basic concept of environmental stress<ul style="list-style-type: none"><li>a) Plastic and elastic strain</li><li>b) Stress resistance, stress avoidance and stress tolerance</li></ul></li><li>ii. Homeostasis and biochemical adaptation:<ul style="list-style-type: none"><li>a) External and internal environment</li><li>b) Multiple control system</li><li>c) Strategies of biochemical adaptations</li></ul></li></ul> <p>II. Oxygen as an environmental factor:</p> <ul style="list-style-type: none"><li>i. Oxygen and Origin of life</li><li>ii. Anoxia adaptations in invertebrates</li><li>iii. Adaptations of vertebrates during prolonged diving</li><li>iv. Oxygen debt in vertebrate muscle</li></ul> <p>III. Radiation as an environmental factor</p> <p>IV. Biomolecules involved in perception and trapping of solar radiations:</p> <ul style="list-style-type: none"><li>i. Chlorophyll</li><li>ii. Bacterio-rhodopsin</li><li>iii. Rhodopsin</li><li>iv. Vitamin A</li></ul>	
<b>Unit-2</b>	<b>Water, Temperature and Pressure</b>	<b>15 H</b>
	<p>I. Water and Solute problem:</p> <ul style="list-style-type: none"><li>i. Preservation of intracellular solvent capacity</li><li>ii. ATPase the model regulatory enzyme</li><li>iii. Key role of GDH reaction</li></ul> <p>II. Temperature as environmental factor</p> <ul style="list-style-type: none"><li>i. Thermal limits of survival</li><li>ii. Temperature and Structural effects with response to biological membrane</li><li>iii. Temperature and rate effects:<ul style="list-style-type: none"><li>a) Temperature dependent E~S affinity</li><li>b) Lipoprotein enzymes</li></ul></li></ul> <p>III. Thermal resistance of dormant and active cells</p> <ul style="list-style-type: none"><li>i. Ectothermy and endothermy</li><li>ii. Endothermy in invertebrates</li><li>iii. Biochemical adaptations of Ectothermy:<ul style="list-style-type: none"><li>a) Antifreeze substances</li><li>b) Heat shock proteins</li></ul></li></ul> <p>IV. Pressure as an environmental factor:</p> <ul style="list-style-type: none"><li>i. Fundamental effects of pressure on biological system</li><li>ii. Effect of pressure on weak bonds and the consequences for higher orders of molecular structures and process (transcription, translation and gene regulation)</li></ul> <p>V. Strategies of enzyme adaptations to pressure in marine organisms:</p> <ul style="list-style-type: none"><li>i. FDPase</li><li>ii. PK</li></ul>	
<b>Unit-3</b>	<b>Instrumentation - I</b>	<b>15 H</b>

	<p>I. Histochemical and Immunotechniques</p> <p>i. Detection of molecules using</p> <p>a) ELISA</p> <p>b) RIA</p> <p>c) Western blot</p> <p>d) Immunoprecipitation</p> <p>e) Flowcytometry</p> <p>f) Immunofluorescence microscopy</p> <p>ii. Detection of molecules in living cells, in situ localization by techniques such as FISH and GISH</p> <p>II. Chromatographic techniques: Principles and applications</p> <p>i. Gas chromatography</p> <p>ii. HPLC</p> <p>iv. HPTLC</p>	
<b>Unit-4</b>	<b>Instrumentation - I</b>	<b>15 H</b>
	<p>I. Biophysical Method: Molecular analysis</p> <p>i. UV/visible</p> <p>ii. Fluorescence</p> <p>iii. Circular dichroism</p> <p>iv. NMR</p> <p>v. ESR spectroscopy</p> <p>II. Molecular structure determination using X-ray diffraction and NMR</p> <p>III. Different types of mass spectrometry and surface plasma resonance methods.</p> <p>IV. Radiolabeling techniques:</p> <p>i. Detection and measurement of different types of radioisotopes normally used in biology</p> <p>ii. Incorporation of radioisotopes in biological tissues and cells</p> <p>iii. Molecular imaging of radioactive material, safety guideline</p>	

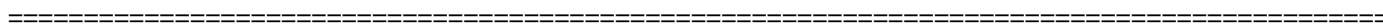
### References:

- 1) R. W. Hill (1978): "Comparative Physiology of Animals – An Environmental Approach" Harper & Row Publ.
- 2) P. W. Hochachka & G. M. Somero (1973): "Strategies of Biochemical Adaptation".
- 3) J. G. Philips (1975): "Environmental Physiology" Blackwell Scientific Publ.
- 4) J. R. Bernstein (1972): "Biochemical Responses to Environmental Stress" Academic Press
- 5) Harold Harper: "Review of Physiology Chemistry" 4th Ed. Maruzen Asian Ed. Lang Medical Publ
- 6) OECD guideline for testing of chemicals - [https://www.oecd-ilibrary.org/environment/test-no425-acute-oral-toxicity-up-and-down-procedure\\_9789264071049-en](https://www.oecd-ilibrary.org/environment/test-no425-acute-oral-toxicity-up-and-down-procedure_9789264071049-en)

<b>Biochemical Adaptation &amp; Instrumentation</b>	<b>(Internal Assessment Pattern)</b>
	<b>Marks: 40</b>
1 Class Test	15 marks
2 Assignment: (Based on Theory Unit 1,2,3 and 4)	15 marks
3 Class Participation and Overall conduct	10 Marks

<b>Biochemical Adaptation &amp; Instrumentation</b>		<b>(Theory Paper Pattern)</b>	
<b>Duration: 2.5 hrs</b>		<b>Marks: 60</b>	
Q.1.A. Answer the following (Any one): Unit 1 A)  OR A)		06 Marks	
Q.1. B) Attempt any two of the following: Unit 1 a) b) c)		06 Marks	
Q.2.A. Answer the following: (Any one) Unit 2 A)  OR A)		06 Marks	
Q.2. B) Attempt any two of the following: Unit 2 a) b) c)		06 Marks	
Q.3.A. Answer the following: (Any one) Unit 3 A)  OR A)		06 Marks	
Q.3. B) Attempt any two of the following: Unit 3 a) b) c)		06 Marks	
Q.4.A. Answer the following: (Any one) Unit 4 A)  OR A)		06 Marks	
Q.4. B) Attempt any two of the following: Unit 4 a) b) c)		06 Marks	
Q.5. Write a note on (All questions are compulsory) a) Unit 1 b) Unit 2 c) Unit 3 d) Unit 4		12 Marks	

<b>Course Outcome</b>
<b>After the completion of the course, students will able to</b>
<b>CO1</b> comprehend metabolic strategies to withstand environmental stress in the form of ambient oxygen availability and environmental radiation.
<b>CO2</b> comprehend physiological adaptations to withstand stress in the form of water, temperature and pressure as environmental factors.
<b>CO3</b> get acquainted with principles and procedures necessary to prepare samples for physiological studies.
<b>CO4</b> learn experientially through observing demonstration or hands on experience of analytical instruments.



**Semester – III**  
**Paper IV: Electives-1**  
**Course Code: VGVPSSELAP301**  
**Credits: 2**  
**APPLIED PHYSIOLOGY**

<b>Course Objectives</b>
1. To initiate the learner in the process of cellular signaling and communication as well as protein sorting.
2. To familiarize the learner to immune response and defense mechanisms in human systems.
3. To introduce the learner to development of cancer in terms of cell cycle and apoptosis.
4. To initiate the learner to fundamentals of exercise physiology.

<b>Unit-1</b>	<b>Cellular Physiology</b>	<b>15 H</b>
	I. Cell signaling: <ol style="list-style-type: none"> <li>i. Hormones and their receptors</li> <li>ii. Cell surface receptor</li> <li>iii. Signaling through G protein coupled receptors</li> <li>iv. Signal transduction pathways</li> <li>v. Secondary messengers</li> <li>vi. Regulation of signaling pathways</li> </ol> II. General principles of cell communication <ol style="list-style-type: none"> <li>i. Cell adhesion and roles of different adhesion molecules</li> <li>ii. Gap junctions</li> <li>iii. Extracellular matrix</li> <li>iv. Integrins</li> <li>v. Neurotransmission and its regulation</li> </ol> III. Protein sorting and transportation	
<b>Unit-2</b>	<b>Human Immune Response and Medical Application</b>	<b>15 H</b>
	I. Major Histocompatibility complex, antigen processing and presenting cells II. Tolerance and Autoimmunity Immunity to pathogens and vaccines III. The Complement System <ol style="list-style-type: none"> <li>i. Functions</li> <li>ii. Components</li> <li>iii. Activation and regulation of the complement</li> <li>iv. Biological consequences of the complement activation</li> </ol> IV. Lymphocyte Ontogeny and Membrane Markers V. Transplantation Immunology <ol style="list-style-type: none"> <li>i. Basis of graft rejection</li> <li>ii. Clinical manifestation of graft rejection</li> <li>iii. General and specific immunosuppressive therapy</li> <li>iv. Immune tolerance to allograft</li> <li>v. Clinical transplantation</li> </ol>	

	VI. Organ-Specific Autoimmune Diseases i. Systemic Lupus Erythematosus ii. Rheumatoid Arthritis	
<b>Unit-3</b>	<b>Cancer Cell Biology</b>	<b>15 H</b>
	I. Components of cell cycle and control system, Mitotic catastrophe II. Extracellular control of cell division i. Cell growth and apoptosis ii. Morphological and biochemical features of apoptosis iii. Necroptosis III. Caspases (effector molecules) i. Executioners of the apoptosis process ii. Extrinsic and intrinsic apoptotic pathway IV. Role of mitochondria in cell death i. Mechanism of mitochondrial outer membrane permeabilization (MOMP) ii. Cell death effectors released from mitochondria V. Poly – ADP –ribose Polymerase (PARP) proteolysis as an indicator of cell death VI. Autophagy and Role of autophagy in tumour survival, oncogenic genes that regulate Autophagy VII. Cancer treatment: Immunotherapy	
<b>Unit-4</b>	<b>Exercise Physiology</b>	<b>15 H</b>
	I. Exercise and Immune system: i. Exercise and resistance to infections ii. Risks of infections due to high intensity workout and environmental extremes II. Cell signaling and Hormonal response to exercise: i. Blood hormone concentration ii. Hormone receptor interaction iii. Muscle glycogen utilization iv. Blood glucose homeostasis during exercise v. Hormone substrate interaction III. Circulatory responses to exercise: i. Cardiac cycle ii. Changes in oxygen delivery to muscles during exercise IV. Role of nervous system exercise: i. Control and coordination of movements during exercise ii. Joint and muscle proprioceptors iii. Muscle chemoreceptors iv. Motor functions of the spinal cord	

### References:

- 1) Insect Endocrinology --- Lawrence I Gilbert, Academic Press
- 2) Sharma V.K. (1991) - Techniques in microscopy and cell biology, Tata-McGrawHill.
- 3) Bisen & Mathew - Tools and Techniques in Life Sciences – CBS Publishers & distributors.
- 4) Robert Braun - Introduction to Instrumental Analysis. McGraw Hill International Editions
- 5) Wilson and Walker – Principles and Techniques of Practical Biochemistry. Cambridge Univ.Press.
- 6) C. R. Kothari – Research Methodology, Methods and Techniques. Wiley Eastern Ltd. Mumbai.

<b>Applied Physiology</b>	<b>(Internal Assessment Pattern)</b>
	<b>Marks: 40</b>
1 Class Test	15 marks
2 Assignment: (Based on Theory Unit 1,2,3 and 4)	15 marks
3 Class Participation and Overall conduct	10 Marks

<b>Applied Physiology</b>	<b>(Theory Paper Pattern)</b>
<b>Duration: 2.5 hrs</b>	<b>Marks: 60</b>
Q.1.A. Answer the following (Any one): Unit 1 A)  OR A)	06 Marks
Q.1. B) Attempt any two of the following: Unit 1 a) b) c)	06 Marks
Q.2.A. Answer the following: (Any one) Unit 2 A)  OR A)	06 Marks
Q.2. B) Attempt any two of the following: Unit 2 a) b) c)	06 Marks
Q.3.A. Answer the following: (Any one) Unit 3 A)  OR A)	06 Marks
Q.3. B) Attempt any two of the following: Unit 3 a) b) c)	06 Marks
Q.4.A. Answer the following: (Any one) Unit 4 A)  OR A)	06 Marks
Q.4. B) Attempt any two of the following: Unit 4 a) b) c)	06 Marks
Q.5. Write a note on (All questions are compulsory) a) Unit 1 b) Unit 2 c) Unit 3 d) Unit 4	12 Marks

<b>Course Outcome</b>
<b>After the completion of the course, students will able to</b>
<b>CO1</b> envisage molecular processes involved in cellular signaling and communication.
<b>CO2</b> transport of proteins from their site of synthesis to the site of their action.
<b>CO3</b> comprehend various molecular defense mechanisms and immune response and their applications in healthcare in terms of therapeutics and organ transplantation.



**CO4** comprehend factors responsible for apoptosis, variations in cell cycle and their role in development of cancer.

**CO5** comprehend effect of exercise on various physiological parameters for molecular to systems level.

**Semester – III**  
**Paper IV: Electives-2**  
**Course Code: VGVPSSELAP302**  
**Credits: 2**  
**ANIMAL BIOTECHNOLOGY**

**Course Objectives**

1. To summarize the holistic approach of animal biotechnology and human therapies
2. To Interpret techniques involved in animal tissue culture
3. To Demonstrate handling of laboratory animals and their maintenance and care
4. To Analyze various animal models and instruments used for Animal tissue culture

<b>Unit-1</b>	<b>Laboratory Animals in Biotechnology</b>	<b>15 H</b>
	<p>I. Animal Care and Management of Laboratory Animals</p> <ol style="list-style-type: none"><li>a. Rat</li><li>b. Mouse</li><li>c. Rabbit</li><li>d. Guinea pig</li></ol> <p>II. Animal House – Necessities Design and maintenance: Infrastructure, Cages, Conditions and other requirements for Maintenance, Biology of four laboratory animals</p> <p>III. Breeding cycles and breeding and maintenance- Rat/ Mouse</p> <p>IV. Nutritional requirements for normal breeding and maintenance.</p> <p>V. Modifications for nutritional experimental work (at least two examples viz protein deficient diet and supplementation)</p> <p>VI. Animal ethics and associated laws and issues.</p> <p>VII. Physiological models and their use in drug testing</p> <p>VIII. Animal ethics and CPCACA guidelines.</p>	
<b>Unit-2</b>	<b>Testing for Endocrinological and Reproductive Biological studies</b>	<b>15 H</b>
	<p>I. In vivo studies of estrous cycle, implantation, pregnancy</p> <p>II. Gonadectomy, Adrenalectomy, Hypophysectomy, and Sham operated rats</p> <p>III. Drug induced liver toxicity- CCl<sub>4</sub> model, paracetamol model, cirrhosis model</p> <p>IV. Aging Models: Drug induced models (Galactosamine), Naturally aged animals</p> <p>V. Models for diabetes</p> <p>VI. Hypercholesterolemia Models</p> <p>VII. Thyroidectomized rat</p> <p>VIII. Models to study immunological phenomena</p>	
<b>Unit-3</b>	<b>Animal Tissue Culture</b>	<b>15 H</b>
	<p>I. Equipment and Materials for animal Cell Culture Technology</p> <p>II. Basic Aseptic Techniques</p> <p>III. Design of Tissue Culture Laboratory</p>	

	<p>IV. Equipment: Laminar Flow Hoods, Bio safety cabinets, CO2 incubator, Open and closed cultures, Microscopes, centrifuge, Refrigerators and Freezers, pipetting aids, Miscellaneous small items of Equipment, Materials, filters, Miscellaneous Items, Cryopreservatives.</p> <p>V. Characters of cells: Cells in primary culture, Established Cell lines, Tumor/cancer originated cells.</p> <p>VI. Nutritional Requirements of Cells and growth media- Basal salt solution (BSS), Minimum Essential Medium, Serum dependent defined media, Serum independent defined media, Natural and Artificial media, Cell specific media.</p> <p>VII. Media preparation (any one example)</p> <p>VII. Passaging of cell Lines- adherent and non-adherent</p>	
<b>Unit-4</b>	<b>Animal Biotechnology &amp; Human Therapies</b>	<b>15 H</b>
	<p>I. Transgenic animals and their applications:</p> <p>a. Mice as model system for human diseases and as test case model</p> <p>b. Cows, pigs, sheep, goats as biopharmaceuticals,</p> <p>c. Transgenic insects and birds.</p> <p>II. Recombinant DNA technology to prevent animal diseases.</p> <p>III. Regulation of transgenic animals and patenting genetically engineered animals.</p> <p>IV. Knockout mice (Cre- loxP system)</p> <p>V. Human therapies a. Tissue engineering: Skin, liver, pancreas b. Xenotransplantation</p>	

#### References:

- 1) Martin H. Johnson, Essential Reproduction, Wiley-Blackwell Publication.
- 2) E. L. Marieb, Human Anatomy and Physiology, Pearson Education Low Price Edition
- 3) Taylor, Green and Stout, Biological Science, Cambridge Publication
- 4) E. P. Solomon, L. R. Berg, D. W. Martin, Biology, Thompson Brooks/Cole

<b>Animal Biotechnology</b>	<b>(Internal Assessment Pattern)</b>
	<b>Marks: 40</b>
1 Class Test	15 marks
2 Assignment: (Based on Theory Unit 1,2,3 and 4)	15 marks
3 Class Participation and Overall conduct	10 Marks

<b>Animal Biotechnology</b>	<b>(Theory Paper Pattern)</b>
<b>Duration: 2.5 hrs</b>	<b>Marks: 60</b>
Q.1.A. Answer the following (Any one): Unit 1 A)  OR A)	06 Marks
Q.1. B) Attempt any two of the following: Unit 1 a) b) c)	06 Marks
Q.2.A. Answer the following: (Any one) Unit 2 A)  OR A)	06 Marks
Q.2. B) Attempt any two of the following: Unit 2 a) b)	06 Marks

c)	
Q.3.A. Answer the following: (Any one) Unit 3 A)  OR A)	06 Marks
Q.3. B) Attempt any two of the following: Unit 3 a) b) c)	06 Marks
Q.4.A. Answer the following: (Any one) Unit 4 A)  OR A)	06 Marks
Q.4. B) Attempt any two of the following: Unit 4 a) b) c)	06 Marks
Q.5. Write a note on (All questions are compulsory) a) Unit 1 b) Unit 2 c) Unit 3 d) Unit 4	12 Marks

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**Semester – III**  
**Practicals - Mandatory**  
**Course Code: VGVPSMAPP301**  
**Credits: 2**

**Practical based on Systems' Physiology I, II & Biochemical adaptation, and Instrumentation**

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1. Study of heartbeat in Daphnia, effect of heavy metals / nicotine on heartbeat of Daphnia.
2. Determination of activities of digestive enzymes viz. amylase and trypsin from the given source.
3. Study of effect on activity of salivary/ pancreatic amylase enzyme on various factors: substrate concentration, pH, temperature, activator, inhibitor (enzyme) and determination of Km of a given enzyme.
4. Study of pathological report and interpretation of report with respect to human physiology
  - a. Renal function test
  - b. Liver function test
  - c. CBC ESR
5. Effect of different concentrations of sodium chloride on the diameter of RBCs and determination of concentration isotonic to blood.
6. Determination of urea, uric acid and creatinine in blood – human / goat.
7. Observation of decreasing PO<sub>2</sub> of water on the respiratory rate of a fish.
8. Effect of decreasing PO<sub>2</sub> of water on lactic acid in the fish muscle.
9. Estimation of salt loss and gain in an aquatic animal when transferred to a salt free medium and to natural medium.
10. Effect of temperature on opercula movement of suitable fish.
11. Visit to Pathology Laboratory to study diagnostic instruments.

<b>Practical based on Systems' Physiology I, II &amp; Biochemical adaptation, and Instrumentation (Practical Paper Pattern)</b>	
<b>Duration: 5 hours</b>	<b>Marks: 50</b>
<b>Q 1. Major question</b> Determination of activities of digestive enzymes viz. amylase / trypsin from the given source. <p style="text-align: center;">OR</p> Study of effect on activity of salivary/ pancreatic amylase enzyme on various factors (Any Two): substrate concentration, pH, temperature, activator, inhibitor (enzyme) and determination of Km of a given enzyme. <p style="text-align: center;">OR</p> Estimation of salt loss and gain in an aquatic animal when transferred to a salt free medium and to natural medium <p style="text-align: center;">OR</p> Effect of different concentrations of sodium chloride on the diameter of RBCs and determination of concentration isotonic to blood.	<b>20 Marks</b>
<b>Q 2. Minor question</b> Study of heartbeat in Daphnia, effect of heavy metals and nicotine on heartbeat of Daphnia. <p style="text-align: center;">OR</p> Determination of urea, uric acid and creatinine in blood – human / goat. <p style="text-align: center;">OR</p> Observation of decreasing PO <sub>2</sub> of water on the respiratory rate of a fish. <p style="text-align: center;">OR</p> Effect of decreasing PO <sub>2</sub> of water on lactic acid in the fish muscle.	<b>10 Marks</b>
<b>Q 3 Study of pathological report and interpretation of report with respect to human physiology (Any One)</b> a. Renal function test b. Liver function test c. CBC ESR	<b>05 Marks</b>
<b>Q.4 Viva based on Report on Visit to Pathology Laboratory</b>	<b>05 Marks</b>
<b>Q.4 Viva voce based on theory</b>	<b>05 Marks</b>
<b>Q.5 Journal</b>	<b>05 Marks</b>

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**Semester – III**  
**Practicals - Elective**  
**Course Code: VGVPSELAPP301**  
**Credits: 2**  
**Practical based on Applied Physiology**

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1. Performance of Ouchterlony technique to demonstrate immune-diffusion.
2. Demonstration of single radical immune-diffusion of antibody and antigen.
3. Study of Slide Agglutination Reaction

4. Study of Phagocytosis.
5. Identification of histological slides of lymphoid tissue:
  - a) Spleen
  - b) Thymus
  - c) Lymph node
  - d) Bone marrow
6. Separation of plasma proteins by PAGE electrophoresis.

<b>Practical based on Applied Physiology</b>	<b>(Practical Paper Pattern)</b>
<b>Duration: 5 hours</b>	<b>Marks: 50</b>
<b>Q 1. Major question</b> Performance of Ouchterlony technique to demonstrate immune-diffusion. <p style="text-align: center;">OR</p> Demonstration of single radial immune-diffusion of antibody and antigen.	<b>16 Marks</b>
<b>Q 2. Minor question</b> Study of Slide Agglutination Reaction <p style="text-align: center;">OR</p> Study of Phagocytosis.	<b>08 Marks</b>
<b>Q.3.</b> Identify and describe the histological slides of given lymphoid tissue (Any two)	<b>06 Marks</b>
Q 4 Separation of plasma proteins by SDS-PAGE	<b>10 Marks</b>
Q.5 Viva voce based on theory	<b>05 Marks</b>
Q.6 Journal	<b>05 Marks</b>

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### Semester – III

#### Practicals - **Elective**

**Course Code: VGVPSSELAPP302**

**Credits: 2**

#### **Practical based on Animal Biotechnology**

1. Handling and feeding of the animals.
2. To study Estrous cycle and breeding.
3. Preparation of glass wares for cell culture.
4. Trypsinization & Determination of Viable cell count
5. Preparation of Report to be presented for IAEC approval.
6. Extraction and Estimation of liver glycogen content.
7. Preparation of glycerinated muscle fibre and study of its properties

<b>Practical based on Animal Biotechnology</b>	<b>(Practical Paper Pattern)</b>
<b>Duration: 5 hours</b>	<b>Marks: 50</b>
<b>Q 1. Major question</b> Extraction and Estimation of liver glycogen content.. OR Preparation of glycerinated muscle fibre and study of its properties	<b>15 Marks</b>
<b>Q 2. Minor question</b> Trypsinization & Determination of Viable cell count	<b>15 Marks</b>
Q.3. To identify the stages of Estrous cycle (Any two)	<b>04 Marks</b>
Q 4 To prepare a report to be presented for IAEC proposal	<b>06 Marks</b>
Q.5 Viva voce based on theory	<b>05 Marks</b>
Q.6 Journal	<b>05 Marks</b>

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**Semester – III**  
**RESEARCH PROJECT (RP)**  
**Course Code: VGVPSRPAP301**  
**Credits: 4**

<b>Semester IV: Research project proposal (RP)</b>	<b>(Assessment Pattern)</b>
	<b>Marks: 100</b>
<b>CONTENT</b>	<b>MARKS</b>
Title	02 marks
Introduction	05 marks
Rationale/ Research Perspectives	10 marks
Aims and Objectives	10 marks
Materials and Methods	05 marks
Expected Outcomes/ Results	05 marks
References	03 marks
	40 marks
<b>SUBMISSION OF RESEARCH PROJECT</b>	<b>60 marks</b>

**Semester – IV**  
**Paper I**  
**Course Code: VGVPSMAP401**  
**Credits: 4**  
**SYSTEMS' PHYSIOLOGY III**

<b>Course Objectives</b>
1. To familiarize the learner with various types of locomotory structures in invertebrates.
2. To familiarize the learner to intracellular and extracellular processes involved in movement and locomotion in the vertebrates.
3. To familiarize the learner to structural and functional aspects of neurophysiology.
4. To familiarize the learner to sensory and effector systems in the animal kingdom.

<b>Unit I</b>	<b>Locomotor System</b>	<b>15H</b>
	I. Functions of locomotory organs <ul style="list-style-type: none"> <li>i. Pseudopodia               <ul style="list-style-type: none"> <li>a) Lobopodia</li> <li>b) Reticulopodia</li> <li>c) Filopodia</li> <li>d) Axopodia</li> </ul> </li> <li>ii. Cilia</li> <li>iii. Tentacles</li> <li>iv. Tube feet</li> <li>v. Setae</li> </ul> II. Locomotion in Arthropods <ul style="list-style-type: none"> <li>i. Legs</li> <li>ii. Wings</li> </ul> III. Pyloric rhythm of the crustacean           IV. Comparative physiology of invertebrate muscles <ul style="list-style-type: none"> <li>i. Polyneuronal innervation in arthropod muscle</li> <li>ii. Insect non-oscillatory postural muscle</li> <li>iii. Resonant flight and tymbal muscle in insects</li> <li>iv. Catch muscle and delayed relaxation</li> </ul>	
<b>Unit II</b>	<b>Physiology of Motility</b>	
	I. Biochemistry of contractile proteins           II. Physiology of non-muscular contractile elements: <ul style="list-style-type: none"> <li>a) Axoplasmic movement</li> <li>b) Chromosome involvement</li> </ul> III. Physiology of skeletal muscle fibre: <ul style="list-style-type: none"> <li>a) Actomyosin complex</li> <li>b) Source of energy for muscle contraction</li> <li>c) Sliding filament theory</li> <li>d) Excitation of contraction and mechanism of regulation of contraction by calcium ions</li> <li>e) Mechanism of relaxation</li> </ul>	
<b>Unit III</b>	<b>Neuro Physiology</b>	<b>15 H</b>

	<p>I. Excitable membranes</p> <ul style="list-style-type: none"> <li>i. Membrane potential</li> <li>ii. Ions as current carriers <ul style="list-style-type: none"> <li>a) Protons</li> <li>b) Calcium</li> <li>c) Potassium</li> </ul> </li> <li>iii. Structure of Cation <ul style="list-style-type: none"> <li>a) Permeable channels</li> <li>b) Chloride channels</li> </ul> </li> </ul> <p>II. Primitive nervous system</p> <ul style="list-style-type: none"> <li>i. Nerve nets</li> <li>ii. Central pattern generators in invertebrates</li> <li>iii. Motor control in Arthropods</li> </ul> <p>III. Nervous tissue</p> <ul style="list-style-type: none"> <li>i. Neurons</li> <li>ii. Glial cells</li> </ul> <p>IV. Integrative neurophysiology:</p> <ul style="list-style-type: none"> <li>i. Interneurons</li> <li>ii. Neural circuits</li> </ul> <p>V. Neurotransmitters</p> <ul style="list-style-type: none"> <li>i. Acetylcholine</li> <li>ii. Dopamine</li> <li>iii. Catecholamine</li> <li>iv. GABA</li> <li>v. ATP</li> <li>vi. Adrenaline</li> <li>vii. Noradrenaline</li> <li>viii. FMRF amide family</li> <li>ix. Neuropeptide</li> </ul> <p>VI. Memory and learning</p> <p>VII. Neurophysiological disorders</p> <ul style="list-style-type: none"> <li>i. Alzheimer</li> <li>ii. Parkinson</li> <li>iii. Dementia</li> </ul>	
<b>Unit IV</b>	<b>Sensory and Effector Physiology</b>	<b>15 H</b>
	<p>I. Sensory and effector system in invertebrates</p> <ul style="list-style-type: none"> <li>i. Specificity, membrane bound receptor system, cytosolic receptor system</li> <li>ii. Mechanisms of insect olfactory reception</li> <li>iii. Organs of Equilibrium – statocyst, insect ear</li> <li>iv. Habituation and sensitization in <i>Aplysia</i></li> <li>v. Physiological effectors – Cnidoblast, Chromatophores, Bioluminescent system</li> </ul> <p>II. Sensory and effector system in the vertebrates</p> <ul style="list-style-type: none"> <li>i. Organs of Equilibrium – statocyst, internal ear of vertebrate</li> <li>ii. Sensory modalities of animals: Sensory coding and transduction of sensory stimuli: <ul style="list-style-type: none"> <li>a) Chemoreception (Gustation and olfaction)</li> <li>b) Hygroreception</li> <li>c) Thermoreception</li> <li>d) Mechanoreception</li> <li>e) Echolocation</li> <li>f) Electroreception</li> <li>g) Magnetoreception</li> <li>h) Photoreception</li> </ul> </li> </ul>	



## References:

- 1) Animal Physiology----- Samson & Writy
- 2) Animal Physiology----- Nelson & Nelson
- 3) Animal Physiology----- Medical Physiology-Guiton
- 4) Text book of Animal Physiology ----- Nagbhushenen
- 5) Text book of Animal Physiology ----- Geise
- 6) Text book of Animal Physiology ----- A.K. Berry

<b>Systems' Physiology III</b>	<b>(Internal Assessment Pattern)</b>
	<b>Marks: 40</b>
1 Class Test	15 marks
2 Assignment: (Based on Theory Unit 1,2,3 and 4)	15 marks
3 Class Participation and Overall conduct	10 Marks

<b>Systems' Physiology III</b>	<b>(Theory Paper Pattern)</b>
<b>Duration: 2.5 hrs</b>	<b>Marks: 60</b>
Q.1.A. Answer the following (Any one): Unit 1 A)  OR  A)	06 Marks
Q.1. B) Attempt any two of the following: Unit 1 a) b) c)	06 Marks
Q.2.A. Answer the following: (Any one) Unit 2 A)  OR  A)	06 Marks
Q.2. B) Attempt any two of the following: Unit 2 a) b) c)	06 Marks
Q.3.A. Answer the following: (Any one) Unit 3 A)  OR  A)	06 Marks
Q.3. B) Attempt any two of the following: Unit 3 a) b) c)	06 Marks
Q.4.A. Answer the following: (Any one) Unit 4 A)  OR  A)	06 Marks
Q.4. B) Attempt any two of the following: Unit 4 a) b) c)	06 Marks
Q.5. Write a note on (All questions are compulsory)	12 Marks

a) Unit 1 b) Unit 2 c) Unit 3 d) Unit 4	
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<b>Course Outcome</b>
<b>After the completion of the course, students will able to</b>
<b>CO1</b> understand the functional and operating mechanisms of various locomotory structures and organs in invertebrates.
<b>CO2</b> discern molecular and supra-molecular structures and processes responsible for movement and locomotion in the vertebrates.
<b>CO3</b> comprehend molecular, structural and functional dimensions of neurophysiology in the animal kingdom.
<b>CO4</b> understand the organizational aspects of sensory structures at themolecular, membrane and organ level and their functioning as transducers in reception of sensory stimuli.
<b>CO5</b> understand physiology of effectors.

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**Semester – IV**  
**Paper II**  
**Course Code: VGVPSMAP402**  
**Credits: 4**  
**SYSTEMS' PHYSIOLOGY IV**

<b>Course Objectives</b>
1. To introduce to the learner various Endocrine systems in Invertebrates.
2. To familiarize the learner to vertebrate endocrine cellular structures, organs and glands and types of their secretions.
3. To introduce the learner to temporal aspects of biological systems.
4. To familiarize the learner to various aspects of animal migration.

<b>Unit-1</b>	<b>Endocrine Physiology – I</b>	<b>15 H</b>
	I. Hormonal action in invertebrates i. Feed-back substance (polychaetes) ii. Prothoracicotropic hormone iii. Juvenile hormone iv. Ecdysone v. Trypsin modulating oostatic factor (TMOF) vi. Allomones vii. X and Y Organs viii. Epitracheal glands (Inka cells) ix. Methyl farnesoate (MF) x. Gonadotropic hormone in gastropods and cephalopods xi. 1- Methyl – adenine (meiosis inducing substance) endocrine disruptors xii. Gamete shedding substance (GSS) in Star fish	

	II. Mechanism of hormone action in invertebrates	
<b>Unit-2</b>	<b>Endocrine Physiology II</b>	<b>15 H</b>
	I. Introduction to Endocrine systems (Neurosecretion and classical endocrine glands) – an overview II. Mechanism of Hormone action in the vertebrates III. Chordate endocrine systems <ul style="list-style-type: none"> <li>i. Hypothalamo-hypophyseal axis</li> <li>ii. Pineal gland</li> <li>iii. Thyroid gland</li> <li>iv. Parathyroid gland</li> <li>iv. Ultimobranchial gland</li> <li>v. Corpuscles of stannous</li> <li>vii. Gastroentero-pancreatic cells</li> <li>viii. Maunthner cells</li> <li>ix. Chromaffin tissues</li> <li>x. Steroid hormones</li> </ul> V. Endocrine disorders due to alteration in receptor number and functions	
<b>Unit-3</b>	<b>Biological rhythms</b>	<b>15 H</b>
	I. Temporal organization of the cells II. Circadian Rhythms & Synchronization of circadian rhythms III. Dormancy in fresh water and terrestrial animals <ul style="list-style-type: none"> <li>i. Preparatory phases</li> <li>ii. Induction of dormancy</li> <li>iii. Arousal from dormancy</li> <li>iv. Entrainment and dormancy</li> </ul> IV. Diapause in insects <ul style="list-style-type: none"> <li>i. Induction</li> <li>ii. Factors affecting and termination of diapause,</li> <li>iii. Diapause and endocrine functions</li> </ul> V. Photoperiodism VI. Biological clocks (circadian rhythms, lunar rhythms and circannual rhythms)	
<b>Unit-4</b>	<b>Physiology of Migration</b>	<b>15 H</b>
	I. Physiological stimulus of Migration II. Orientation and Navigation III. Energetic IV. Timing V. Synthesis VI. Migration for food, reproduction, territory VII. Adaptations for Migration VIII. Communication during Migration	

### References:

- 1) Exercise Physiology – Theory and Applications to fitness and performance, Scott K. Powers and Edward T. Howley, 10th edition, McGraw Hill Publication, 2015
- 2) Textbook of Endocrine Physiology----- James E. Griffin and Sergio R. Ojeda, Oxford University
- 3) Handbook of Neuroendocrinology --- Mandal A.(1994). EMKY Publication
- 4) Comparative Endocrinology of the Invertebrates-- Kenneth C. Highnam
- 5) Invertebrate Endocrinology-----Tambhare D.B. (2012), Himalaya Publication
- 6) Invertebrate Endocrinology-----Tombes, Academic Press.

<b>Systems' Physiology IV</b>	<b>(Internal Assessment Pattern)</b>
	<b>Marks: 40</b>
1 Class Test	15 marks
2 Assignment: (Based on Theory Unit 1,2,3 and 4)	15 marks
3 Class Participation and Overall conduct	10 Marks

<b>Systems' Physiology IV</b>	<b>(Theory Paper Pattern)</b>
<b>Duration: 2.5 hrs</b>	<b>Marks: 60</b>
Q.1.A. Answer the following (Any one): Unit 1 A)  OR A)	06 Marks
Q.1. B) Attempt any two of the following: Unit 1 a) b) c)	06 Marks
Q.2.A. Answer the following: (Any one) Unit 2 A)  OR A)	06 Marks
Q.2. B) Attempt any two of the following: Unit 2 a) b) c)	06 Marks
Q.3.A. Answer the following: (Any one) Unit 3 A)  OR A)	06 Marks
Q.3. B) Attempt any two of the following: Unit 3 a) b) c)	06 Marks
Q.4.A. Answer the following: (Any one) Unit 4 A)  OR A)	06 Marks
Q.4. B) Attempt any two of the following: Unit 4 a) b) c)	06 Marks
Q.5. Write a note on (All questions are compulsory) a) Unit 1 b) Unit 2 c) Unit 3 d) Unit 4	12 Marks

<b>Course Outcome</b>
<b>After the completion of the course, students will able to</b>
<b>CO1</b> understand various molecular and structural aspects of invertebrate endocrine systems, the effect of endocrine secretions on various life-processes and development as well as the mechanism of action of hormones in invertebrates.

<b>CO2</b> comprehend various types of endocrine organs, glands, types of their secretions, neurohormones; and effects of these hormones on life processes including reproduction and development.
<b>CO3</b> understand the various types of rhythms encountered in biological systems and their manifestations through various activities.
<b>CO4</b> discern causative, temporal, spatial, energetic and metabolic aspects of animal migration and its adaptive value to the migrating animal species.

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**Semester – IV**  
**Paper III**  
**Course Code: VGVPSMAP403**  
**Credits: 4**  
**RECENT TRENDS IN PHYSIOLOGY**

<b>Course Objectives</b>
1. To introduce the learner to the fundamental concept of drug discovery and designing.
2. To introduce the learner to different steps involved in clinical trials.
3. To introduce the learner to operation and management in clinical trials.
4. To introduce the learner to the fundamentals of stem cell physiology.

<b>Unit-1</b>	<b>Drug Designing &amp; Modelling</b>	<b>15 H</b>
	I. Introduction to Drug Design and Development i. Drug Discovery as a Process ii. Target Identification and Validation iii. Target Validation and Drug Validation Practical II. Drug targets III. Targets: Membrane Proteins, DNA, RNA, Enzymes IV. Lead Identification and Modification: i. Lead Identification and High Throughput Screening ii. Sources of active compounds V. Biologics Computer-Aided Drug Design i. Molecular Modelling ii. Ligand-based Drug Design	
<b>Unit-2</b>	<b>Clinical trials</b>	<b>15 H</b>
	I. Pre-clinical Toxicology: In vivo II. Pre-clinical Toxicology: In vitro III. Clinical Trials: Clinical Trial Design IV. Ethics of Human and Animal Experimentation V. Commercial Considerations in Drug Development VI. Introduction to artificial intelligence and its application i. Clinical trials ii. Toxicology iii. Healthcare	
<b>Unit-3</b>	<b>Clinical Trial Management and Guidelines</b>	<b>15 H</b>

	<p>I. Project Management; protocol in clinical research; quality assurance &amp; clinical data management</p> <p>II. Informed consent; Case report form; investigator's brochure (Ib)</p> <p>III. Introduction to OECD</p> <p>i. Guidelines for the testing of chemicals</p> <p>ii. Description of the method</p> <p>iii. Selection of animal species</p> <p>iv. Housing and feeding conditions, preparation of animals for experiment, preparation of doses</p> <p>v. Administration of doses</p> <p>vi. Limit test and main test</p> <p>vii. Observations:</p> <p>a) Body weight</p> <p>b) Pathology</p> <p>c) Data and Reporting</p> <p>d) Calculation of LD50 for the main test</p> <p>e) Test report</p>	
<b>Unit-4</b>	<b>Stem Cell Physiology</b>	<b>15 H</b>
	<p>I. Introduction to stem cell</p> <p>II. Differentiation, dedifferentiation and redifferentiation</p> <p>III. Wnt Signaling pathway</p> <p>IV. Orchestrating Wnt / B-catenin signaling</p> <p>V. Somatic and cancer stem cells</p> <p>VI. Role of stem cells in physiology, pathophysiology and therapy</p> <p>VII. Future of stem therapy as an alternative to organ transplant</p>	

#### References:

- 1) Kerns, E.H.; Di, L. Drug-Like Properties: Concepts, Structure Design and Methods: from ADME to Toxicity Optimization, Academic Press, Oxford, 2008
- 2) Burger's Medicinal Chemistry and Drug Discovery, 5th Edition, Vol. 1. Principles and Practice, edited by M. E. Wolff, John Wiley & Sons: New York, 1995.
- 3) Principles of Medicinal Chemistry, 4th Edition, edited by W.O. Foye, T.L. Lemke D. A. Williams, Williams and Wilkins: Philadelphia, 1995
- 4) Artificial intelligence – a modern approach, third edition, Stuart J. Russell and Peter Norvig, Pearson India Education services pvt. Ltd. 2015

<b>Recent Trends in Physiology</b>	<b>(Internal Assessment Pattern)</b>
	<b>Marks: 40</b>
1 Class Test	15 marks
2 Assignment: (Based on Theory Unit 1,2,3 and 4)	15 marks
3 Class Participation and Overall conduct	10 Marks

<b>Recent Trends in Physiology</b>	<b>(Theory Paper Pattern)</b>
<b>Duration: 2.5 hrs</b>	<b>Marks: 60</b>
Q.1.A. Answer the following (Any one): Unit 1 A)	06 Marks
OR	
A)	
Q.1. B) Attempt any two of the following: Unit 1	06 Marks

a) b) c)	
Q.2.A. Answer the following: (Any one) Unit 2 A)  OR A)	06 Marks
Q.2. B) Attempt any two of the following: Unit 2 a) b) c)	06 Marks
Q.3.A. Answer the following: (Any one) Unit 3 A)  OR A)	06 Marks
Q.3. B) Attempt any two of the following: Unit 3 a) b) c)	06 Marks
Q.4.A. Answer the following: (Any one) Unit 4 A)  OR A)	06 Marks
Q.4. B) Attempt any two of the following: Unit 4 a) b) c)	06 Marks
Q.5. Write a note on (All questions are compulsory) a) Unit 1 b) Unit 2 c) Unit 3 d) Unit 4	12 Marks

<b>Course Outcome</b>
<b>After the completion of the course, students will able to</b>
<b>CO1</b> comprehend steps involved in discovery and identification of new potential therapeutic molecules using combination of computational and experimental processing drug development.
<b>CO2</b> comprehend types of clinical trials, designing of clinical trials, ethics in clinical trials and its application in health care.
<b>CO3</b> comprehend the monitoring and regulatory affairs with defined guidelines used in clinical trials.
<b>CO4</b> comprehend the physiological aspects of stem cells and their functions in homeostasis of tissues, embryonic and somatic stem cells, cancer stem cells and stem cell therapy.

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**Semester – IV**  
**Paper IV: Electives-1**  
**Course Code: VGVPSSELAP401**  
**Credits: 2**  
**DISSERTATION**

<p>Guidelines to the Dissertation Project:</p> <ol style="list-style-type: none"> <li>1. The Project shall include: <ol style="list-style-type: none"> <li>I. Title of the Project</li> <li>II. Aims, Objectives and Rationale</li> <li>III. Materials and Methods</li> <li>IV. Observation and / Results</li> <li>V. Interpretation of Observation / Results and Discussion</li> <li>VI. Conclusion and / Recommendation</li> <li>VII. Relevance of Work / Justification of Work with Project title</li> <li>VIII. Relevant References</li> </ol> </li> <li>2. The project should be based on topics relevant to animal physiology which may include (but are not limited to) allied areas such as toxicology, pharmaceutical biotechnology, stress physiology, animal cell culture and studies using model animals.</li> <li>3. The project must be type-written using computer and printed for binding.</li> <li>4. No minimum or maximum limit of the number of pages is defined since the volume of the proposal is dependent on the scope of the selected topic.</li> <li>5. Name of the mentor may be reflected on the first page of the project along with the student's names.</li> <li>6. The hard copy of proposal must be retained and submitted along with the dissertation in the examination for the reference of the external examiner/s.</li> <li>7. Student should prepare individual power point presentation (PPT) on the project and must present it in front of examiners at the time of examination.</li> <li>8. The project will be prepared individually by students.</li> </ol>	<b>60 H</b>
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<b>Dissertation Project Proposal</b>	<b>(Internal Assessment Pattern)</b>
<b>Duration:</b>	<b>Marks: 40</b>
<b>CONTENT</b>	<b>MARKS</b>
Title	02 marks
Introduction	05 marks
Rationale/ Research Perspectives	10 marks
Aims and Objectives	10 marks
Materials and Methods	05 marks
Expected Outcomes/ Results	05 marks
References	03 marks

<b>Dissertation</b>	<b>(Theory Pattern)</b>
<b>EVALUATION OF DISSERTATION REPORT</b>	<b>Marks: 60</b>
1. Title of the Project	<b>01 Marks</b>
2. Aim, Objectives and Rationale	<b>04 Marks</b>
3. Material and Methods	<b>05 Marks</b>
4. Observations and Results	<b>10 Marks</b>
5. Interpretation of Observations / Results and Discussion	<b>10 Marks</b>



6. Conclusion and / Recommendation	<b>10 Marks</b>
7. Relevant work / Justification of work with Project title	<b>10 Marks</b>
8. Relevant References	<b>05 Marks</b>
9. Certified Dissertation	<b>05 Marks</b>

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**Semester – IV**  
**Paper IV: Electives-2**  
**Course Code: VGVPSSELAP402**  
**Credits: 2**  
**Reproductive Physiology**

<b>Course Objectives</b>
1. To Explain the various Molecular Events of fertilization, Implantation Process, Pregnancy, Parturition and Lactation
2. To Compare different IVF techniques, gamete collection process and sensitize regarding ethical issues involved in this field
3. To Evaluate the hormonal control of spermatogenesis, sperm maturation and about the potential male contraceptives
4. To elaborate Assisted Reproductive technologies

<b>Unit-1</b>	<b>Male reproductive physiology</b>	<b>15 H</b>
	I. Functional morphology of mammalian testis. II. Brief description of histomorphology and hormonal control of male accessory organs viz., epididymis, vas deferens, seminal vesicles, ventral prostate, bulbourethral gland and preputial gland III. Sperm maturation – morphological and biochemical events, influence of accessory organ secretions; capacitation IV. Biochemistry of semen V. Kinetics of spermatogenesis – wave and cycle, Stem cell renewal VI. Hormonal control of spermatogenesis VII. Ultrastructure of spermatozoa VIII. Abnormalities of sperm IX. Potential Male contraceptives: E.g., Cyproterone acetate, Cotton Seed, papaya seed extract etc	
<b>Unit-2</b>	<b>Female reproductive physiology</b>	<b>15 H</b>
	I. Onset of puberty in human female, factors affecting onset of puberty. II. Role of circadian rhythmicity in reproduction III. Estrous cycle and its hormonal regulation. IV. Menstrual cycle and its hormonal regulation. V. Fertilization – Molecular Events of fertilization VI. Implantation – Process, Types and hormonal control VII. Pregnancy – length of gestation, hormonal Parturition – Process of birth and influence of hormones VIII. Lactation – Hormonal control of mammary gland development and lactogenesis	

	VIII. Female contraceptives: Pills, Spermicides, Copper T, Mechanical barrier (diaphragm)	
<b>Unit-3</b>	<b>Assisted Reproductive Techniques - I</b>	<b>15 H</b>
	I. Maintaining an IVF laboratory i. Setting up an ART laboratory ii. Quality Control II. Gamete Collection & Analysis i. Serum Analysis: - Sperm count, Motility, Morphology and abnormality ii. Physical parameters: - Coagulation/viscosity, Liquification, appearance, odor, volume, pH, presence of other cell debris iii. Semen preparation technique: Swim up, Density gradient.	
<b>Unit-4</b>	<b>Assisted Reproductive Techniques - II</b>	<b>15 H</b>
	I. Intrauterine Insemination (IUI) II. Oocyte Retrieval: - oocyte corona cumulus complex evaluation, Oocyte nuclear maturity evaluation. III. Intracytoplasmic sperm Injection (ICSI) IV. Cryopreservation of ovum and cord blood V. Preimplantation genetic screening- PGS VI. Ethical issues VII. Case Study- Designer baby (Ethical and legal aspects)	

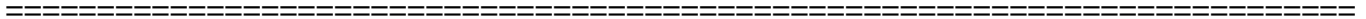
#### References:

- 1) Daniel D Chiras Jones and Bartlett, Human Biology
- 2) E.K.Nobil and J. U. D.Neil, The Physiology of Reproduction Vol I & II, Raven Press, New York.
- 3) David Gardner, Ariel W and et.al, Textbook of Assisted Reproductive Technologies, Third Edition.
- 4) Examination and Processing of human semen, WHO laboratory manual.
- 5) Dr. Kamini A. Rao, Principles and Practice of Assisted Reproductive Technology

<b>Reproductive Physiology</b>	<b>(Internal Assessment Pattern)</b>
	<b>Marks: 40</b>
1 Class Test	15 marks
2 Assignment: (Based on Theory Unit 1,2,3 and 4)	15 marks
3 Class Participation and Overall conduct	10 Marks

<b>Reproductive Physiology</b>	<b>(Theory Paper Pattern)</b>
<b>Duration: 2.5 hrs</b>	<b>Marks: 60</b>
Q.1.A. Answer the following (Any one): Unit 1 A)  OR A)	06 Marks
Q.1. B) Attempt any two of the following: Unit 1 a) b) c)	06 Marks
Q.2.A. Answer the following: (Any one) Unit 2 A)  OR A)	06 Marks

Q.2. B) Attempt any two of the following: Unit 2 a) b) c)	06 Marks
Q.3.A. Answer the following: (Any one) Unit 3 A)  OR  A)	06 Marks
Q.3. B) Attempt any two of the following: Unit 3 a) b) c)	06 Marks
Q.4.A. Answer the following: (Any one) Unit 4 A)  OR  A)	06 Marks
Q.4. B) Attempt any two of the following: Unit 4 a) b) c)	06 Marks
Q.5. Write a note on (All questions are compulsory) a) Unit 1 b) Unit 2 c) Unit 3 d) Unit 4	12 Marks



**Semester – IV**  
**Practicals - Elective**  
**Course Code: VGVPSSELAPP401**  
**Credits: 2**  
**Practical based on Dissertation**

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- The practical of Dissertation comprises the Research Project for which students will have to take up a particular topic based on which they will be doing research applying the ethics of research, methods and methodology, etc.
- They are expected to abide rules of Scientific Research and if possible, derive at a conclusion for the same. This will help the learners to build a strong foundation for pursuing research.
- Learners will acquaint about preparation of lay out, structure and language of typical reports, illustrations and tables.
- Learners will gain the knowledge about how to write bibliography, referencing and footnotes in reports and thesis or in research articles. Further, learners will be oriented to presentation of data through effective communication with the help of advanced visual technology.
- In addition to that they will be aware about the application of results, environmental impacts, conservation of biodiversity, ethical issues and ethical committees.
- The practical should be organized in such a manner that learners can be trained to manage large data sets generated via multiple observations, arrange them in a proper format and present them in relevant graphs/charts by adopting a hands-on in silico approach.

<b>Presentation of Dissertation</b>	<b>Practical Paper Pattern</b>
<b>Duration: 5 hrs</b>	<b>Marks: 50</b>
1. Content of Presentation	<b>10 Marks</b>
2. Quality of Presentation	<b>10 Marks</b>
3. Presentation Skill	<b>10 Marks</b>
4. Quality of Work	<b>10 Marks</b>
5. Viva based on Proposal / Question Answer Session	<b>10 Marks</b>

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**Semester – IV**  
**Practicals - Elective**  
**Course Code: VGVPSSELAPP402**  
**Credits: 2**  
**Practical based Reproductive Physiology**

The practical based on reproductive physiology comprises of internship/observership at IVF laboratory. Internship Program meant for students who wish to understand basic day today operations of IVF Clinic. This is an observership program wherein participants shadow a senior Embryologist during their day's work. In this programme the students should learn and get hands-on-experience in

- Basic of Semen Analysis
- Basics of Semen Preparation Techniques.
- Orientation of IVF Lab disposables and Media
- Basics of IVF Cycle.
- Basics of Plating and Media Equilibration
- Observe entire IVF Cycle, from Ovum Pick Up to Embryo Transfer
- Observe vitrification and warming of oocytes and embryos

<b>Presentation of Internship/Observership Report</b>	
<b>Practical Paper Pattern</b>	
<b>Duration: 5 hrs</b>	<b>Marks: 50</b>
1. Content of Presentation	<b>10 Marks</b>
2. Quality of Presentation	<b>10 Marks</b>
3. Presentation Skill	<b>10 Marks</b>
4. Quality of Work	<b>10 Marks</b>
5. Viva based on Proposal / Question Answer Session	<b>10 Marks</b>

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## **Semester – IV**

### **RESEARCH PROJECT (RP)**

**Course Code: VGVPSRPAP401**

**Credits: 6**

- The Semester 4 Research Project (RP) comprises of the Research work, which can include Internship and Training work as a part of Research project, for which students will have to select a research problem and apply the ethics of research, methodology and its implications.
- The Research Project Report has to be submitted with Results of the study and Conclusion.
- Learners will also acquire the knowledge of a Research design according to the topic.
- Learners will be able to focus on the insights of data documentation, instrumentation and scientific writing
- The learners will be trained in research orientation with awareness pertaining to socio-economic and environmental problems with a multi-disciplinary approach.

### **EVALUATION OF RESEARCH PROJECT (RP)**

1. Title of the Project
2. Purpose of the Research Work/ Rationale
3. Materials and Methods
4. Observations and / Results
5. Interpretation of Observations / Results and Discussion
6. Conclusion and / Recommendation
7. Relevant work / Justification of work with Project title & Research Design
8. Relevant References
9. Certified Research Project Report

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