



University of Kerala

Discipline	<b>Zoology</b>				
Course Code	<b>UK5DSCZOO302</b>				
Course Title	<b>Animal Physiology</b>				
Type of Course	<b>DSC</b>				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class 12				
Course Summary	This course provides a comprehensive exploration of animal physiology, focusing on how interconnected organ systems maintain internal stability ( <i>homeostasis</i> ) in response to environmental challenges. Students will analyse the biophysical principles governing internal gas transport, circulation, nutrient absorption, and waste excretion across diverse animal groups. Furthermore, the curriculum emphasises the cellular and molecular networks of the nervous, sensory, and endocrine systems, demonstrating how multi-system feedback loops dynamically coordinate animal movement, behaviour, and reproduction.				

### Detailed Syllabus

Name of the Course: **Animal Physiology**

Theory: Credit - 3 (Total 45 hours)

Module	Unit	Contents	45 Hrs
I		<b>Internal Transport</b> <i>Respiratory System 1.1, 1.2, Blood Vascular System 1.3, 1.4</i>	<b>8</b>
	1.1	<b>Gas Exchange in Animals &amp; Physical Principles</b> Fick's Law of Diffusion and its application to respiratory surfaces Gas exchange in aquatic vs terrestrial environments. Respiratory Structures in animals: Tracheal systems (insects), gills (fish), and lungs (vertebrates) (Brief account only). Counter current exchange mechanisms in gills and lungs; unidirectional vs bidirectional (tidal) ventilation (Brief account only).	2
	1.2	<b>Respiratory Pigments &amp; Delivery of gases</b> Brief mention of respiratory pigments in animals. Structure and function of respiratory pigment-Haemoglobin. The Oxygen-Haemoglobin Dissociation Curve: Cooperativity and oxygen affinity. Factors shifting the curve: The Bohr Effect, pH/CO <sub>2</sub> , temperature, and organic phosphates.	2

		Carbon dioxide transport in blood: Carbamino compounds, dissolved CO <sub>2</sub> , and the bicarbonate pathway (the chloride shift).	
	1.3	<b>The Vertebrate Heart &amp; Cardiac Cycle</b> Brief account of evolutionary transition of the vertebrate heart: Two-chambered (fish), three-chambered (amphibians/reptiles), and four-chambered (birds/mammals). Myogenic properties of the mammalian heart: Mention cardiac conduction system (SA node, AV node, Purkinje fibres); the cardiac cycle: systole, diastole	2
	1.4	<b>Methods of Prevention of Blood Loss: Haemostasis</b> Vascular Spasm (Vasoconstriction) Primary Haemostasis (Platelet Plug Formation) Secondary Haemostasis (Blood Coagulation, Coagulation pathways) Clot Retraction and Fibrinolysis (Healing and Removal)	2
II	<b>Integrating Systems</b> <i>Nervous System 2.1, 2.2, 2.3, Sensory Systems 2.4, 2.5, 2.6, Endocrine System 2.7, 2.8</i>		<b>12</b>
	2.1	<b>Nerve Impulse generation and Synaptic Transmission</b> Generation and propagation of action potential . Electrical and chemical synapses. Neurotransmitters and their receptors (ionotropic and metabotropic).	2
	2.2	<b>Nervous System Organisation</b> Brief account of the functional divisions of the vertebrate nervous system- Central Nervous System (CNS) and Peripheral Nervous System (PNS). Non neuronal cells of Nervous systems The Autonomic Nervous System (ANS): Sympathetic and parasympathetic antagonism.	1
	2.3	<b>Central Integration and Reflexes</b> (brief mention) Reflex arcs as the simplest integrative circuits (e.g., stretch reflex). Central pattern generators (CPGs) in rhythmic behaviours (locomotion, breathing).	1
	2.4	<b>Principles of Sensory Reception</b> Classification of sensory receptors (mechanoreceptors, chemoreceptors, photoreceptors, thermoreceptors, nociceptors).	1
	2.5	<b>Somatosensory and Mechanical Senses</b> Mechanoreception and proprioception : Brief account with examples.	1
	2.6	<b>Visual and Chemical Senses</b> Photoreception and chemoreception (olfaction & gustation): Brief account with examples across species.	2
	2.7	<b>Major Endocrine Axes and Homeostasis</b> The Hypothalamic-Pituitary Axis: The "master switchboard" connecting the brain to the endocrine system. Brief account of thyroid, parathyroid, pancreas and adrenal gland secretions. Feedback loops: Negative feedback (e.g., thyroid hormone regulation, cortisol) and positive feedback (e.g., oxytocin in parturition).	3
	2.8	<b>Neuroendocrine Integration</b> Neurohormones and their functions (Brief account only)	1

III	<b>Muscle system and Reproduction</b> <i>Muscle System 3.1, 3.2, 3.3, 3.4, 3.5 Reproductive System 3.6</i>		<b>10</b>
	3.1	<b>Muscle Diversity</b> Types of muscles: Skeletal (striated, voluntary), Cardiac (striated, involuntary, intercalated discs), and Smooth (unstriated, involuntary).	1
	3.2	<b>Ultrastructure of the Skeletal Muscle Fiber</b> Sarcomere: Z-discs, A-band, I-band, H-zone; molecular architecture of actin, myosin, tropomyosin, and the troponin complex.	1
	3.3	<b>Molecular Mechanism of Muscle Contraction</b> Sliding Filament Mechanism and the Cross-Bridge Cycle (ATP binding, hydrolysis, power stroke, ADP release, and detachment). Neuromuscular Junction. Propagation of action potential down Transverse tubules (T-tubules). Calcium release from the Sarcoplasmic Reticulum (SR) via DHPR and RyR receptor channels.	3
	3.4	<b>Physiological Types of Muscle Contraction</b> Isometric contraction (tension develops without a change in muscle length). Isotonic contraction (muscle length changes under constant tension: Concentric vs. Eccentric).	1
	3.5	<b>Muscle Mechanics and Energetics</b> Mechanical properties: Muscle twitch, wave summation, and incomplete/complete tetanus. Metabolic pathways powering contraction: Phosphagens (creatine phosphate), anaerobic glycolysis, and oxidative phosphorylation (brief account only)	1
	3.6	<b>Reproductive Strategies and Cycles</b> Evolutionary strategies: External vs. internal fertilization; oviparity, ovoviviparity, and viviparity. Mammalian reproductive cycles: Hormonal regulation of the Ovarian cycle (follicular, ovulation, luteal phases) and Uterine/Menstrual cycle. Contrast: Menstrual vs. Estrous cycles.	3
IV	<b>Energy Balance, Digestion, and Excretion</b> <i>Digestive System 4.1, 4.2, Excretory System 4.3, 4.4</i>		<b>8</b>
	4.1	<b>Nutritional Strategies and Digestive Diversity</b> Nutritional categories (herbivores, carnivores, omnivores and Detritivores/Saprophages and feeding mechanisms (Suspension/Filter Feeding, Substrate/Deposit Feeding, Fluid Feeding, Bulk Feeding) across animal phyla. (Brief account only) Symbiotic digestion: Ruminant vs hindgut fermentation strategies for handling structural carbohydrates (cellulose).	1
	4.2	<b>Chemical Digestion and Epithelial Absorption</b> Enzymatic breakdown of macromolecules: Carbohydrates (amylases, brush-border enzymes), proteins (peptidases, zymogen activation cascades), and lipids (emulsification by bile salts, lipolysis by lipases). Mention active transport, facilitated diffusion, and solvent drag mechanisms.	2
	4.3	<b>Nitrogenous Waste and Osmoregulatory Strategies</b>	1

		Excretory trade-offs: Ammonotelic (aquatic), ureotelic (mammals/amphibians), and uricotelic (birds/reptiles/insects) strategies relative to water availability and energetic costs. Osmoconformers vs. osmoregulators; challenges in freshwater vs. marine environments. (Brief account only)	
	4.4	<b>Kidneys and Nephrons</b> The mammalian kidney: Gross anatomy and cortical vs juxtamedullary nephrons (brief mention). Glomerular Ultrafiltration: Forces driving filtration (hydrostatic vs. colloid osmotic pressures) and the glomerular filtration barrier. Proximal Convolted Tubule (PCT): Bulk reabsorption of water, ions, and organic nutrients via secondary active transport. Loop of Henle: The Countercurrent Multiplier System - renal osmotic gradient formation- and Counter current exchanger system. Distal Convolted Tubule (DCT) & Collecting Duct: Fine-tuning of water and electrolyte balance.	4
V	<b>Homeostatic Regulation and Feedback Control</b>		7
	5.1	<b>Regulation of Internal Transport Systems</b> Circulatory designs: Open vs closed circulatory systems (haemolymph vs blood; hemocoel vs capillaries). Neuroendocrine control of cardiovascular system Chemical and neural regulation of ventilation Cardiovascular and respiratory responses to hypoxia and exercise	2
	5.2	<b>Regulation of Energy Balance, Digestion, and Excretion</b> Enteric nervous system and gastrointestinal hormones The Arcuate Nucleus of the Hypothalamus: Integration centre for feeding behaviour. Satiety vs. Hunger Signalling: Short-term signals (Ghrelin vs PYY/CCK) and long-term adiposity signals (Leptin and Insulin). Endocrine regulation of blood glucose: The antagonistic feedback loops of Insulin (beta cells) and Glucagon (alpha cells). Neuroendocrine Control of Fluid, Electrolyte, and Acid-Base Balance Endocrine regulation of excretion.	3
	5.3	<b>Regulation of Movement</b> Mechanism of smooth muscle activation via the Calcium-Calmodulin-MLCK pathway (lacking troponin).	1
	5.4	<b>Regulation of Reproduction</b> The Hypothalamic-Pituitary-Gonadal (HPG) Axis: GnRH control of Gonadotropins (FSH and LH) secretion. The GnRH Pulse Generator: The hypothalamic clock driving cyclical vs. continuous reproductive profiles; kisspeptin neural pathways regulating seasonal breeding rhythms in response to environmental cues (photoperiod, temperature)-Brief account only.	1

## PRACTICUM

Credit - 1 (Total 30 hours)

Name of the Course: Animal Physiology

(Any 8 practical including any two major and any four minor from the prescribed list must be completed and recorded during the course. Preferences may be given to cover as many systems as possible)

Sl. No.	Topics
<b>Part I: Haematology &amp; Internal Transport (Module I)</b>	
1	<b>Preparation and Staining of Human Blood Smear (Major)</b> Preparation of a thin blood film, air-drying, Leishman's or Wright's staining, and microscopic differential identification of leukocytes (Neutrophils, Lymphocytes, Monocytes, Eosinophils, and Basophils) based on nuclear morphology and cytoplasmic granules.
2	<b>Determination of Solution Tonicity Using Human RBC (Major)</b> Exposing red blood cells to varying concentrations of saline solution (hypotonic, isotonic, hypertonic) to observe hemolysis, crenation, or structural stability under a microscope, demonstrating membrane transport and osmotic behavior.
3	<b>Estimation of Haemoglobin Using Sahli's Haemoglobinometer (Major)</b> Quantitative estimation of hemoglobin concentration in blood by converting it to acid hematin using 0.1N HCl and diluting it until it matches the standard reference visual block.
4	<b>Enumeration of Human Red Blood Cells and White Blood Cells Using a Haemocytometer-Demonstration (Major)</b> Demonstration of serial blood dilution using specific thoma pipettes and counting mature erythrocyte and leukocyte densities within the grid quadrants of a Neubauer counting chamber.
5	<b>Preparation of Haemin Crystals (Minor)</b> Microscopic crystal test (Nippe's or Teichmann's method) where blood is heated gently with glacial acetic acid and a chloride salt to form characteristic brown rhombic crystals of hemin, confirming the presence of hemoglobin.
6	<b>Determination of Clotting Time Using a Capillary Tube (Minor)</b> Non-invasive monitoring of intrinsic coagulation pathways by drawing blood into a non-heparinized capillary tube and breaking it at 30-second intervals until a distinct fibrin thread spans the gap.
<b>Part II: Cardiovascular &amp; Respiratory Mechanics (Modules I, IV &amp; V)</b>	
7	<b>Recording and Measurement of Human Blood Pressure and Pulse Rate Under Varying Physiological States (Minor)</b> Tracking baseline systemic arterial pressure and pulse mechanics using a manual/electronic sphygmomanometer, followed by comparative re-testing after posturing shifts or brief physical exertion to observe short-term baroreflex or sympathetic adjustments.
8	<b>Measurement of Oxygen Saturation (SPO<sub>2</sub>) and Blood Pulse Profiles (Minor)</b> Using a digital pulse oximeter to non-invasively record the percentage of oxygenated haemoglobin molecules (SPO <sub>2</sub> ) and monitor immediate adaptations in arterial perfusion.
9	<b>Counting and Recording of Human Heartbeat (Minor)</b>

	Measuring cardiac frequency over time through radial/carotid palpation or direct auscultation of S <sub>1</sub> /S <sub>2</sub> valvular heart sounds using a stethoscope.
10	<b>Measurement of the Rate of Respiration in Human Beings Using a Volumetric Spirometer -Demonstration (Minor)</b> Utilizing a basic spirometer or volumetric respirometer system to evaluate respiratory frequency and air exchange volumes at rest.
11	<b>Demonstration of Insect Respiration Using a Respirometer (Minor)</b> Quantifying oxygen gas consumption rates in ectothermic model organisms (e.g., cockroach) via closed-chamber respirometry containing a carbon dioxide absorbing matrix (KOH).
12	<b>Microscopic Inspection of Comparative Respiratory Structures (Major)</b> Microscopic analysis and diagrammatic rendering of: <ul style="list-style-type: none"> <li>• Insect Tracheae (Whole Mount): Observing chitinous spirals (taenidia) ensuring structural patency.</li> <li>• Fish Gills: Visualizing primary and secondary gill lamellae structured to support high-efficiency counter-current exchange.</li> </ul>
<b>Part III: Neuro-Sensory &amp; Reproductive Integration (Modules II, III &amp; V)</b>	
13	<b>Determination of Receptive Fields and Thresholds (Minor)</b> Using a calliper to map tactical resolution limits on the fingertips, palm, forearm, and back, demonstrating mechanoreceptor density variations and receptive field sizes.
15	<b>Observation of the Patellar Reflex (Stretch Reflex) and Latency Shifts (Minor)</b> Striking the patellar ligament with a neurological reflex hammer to observe the involuntary monosynaptic extension circuit, followed by tracking reinforcement changes during cortical distraction (Jendrassik maneuver).
16	<b>Demonstration of Pregnancy Test Kit (Minor)</b> Utilizing an immunochromatographic lateral-flow cassette to demonstrate rapid colorimetric detection of Human Chorionic Gonadotropin (HCG) in urine matrix configurations, explaining early embryonic/placental signaling.

## REFERENCES

### I. Core Textbooks (Prescribed Reading)

1. **Hill, R. W., Wyse, G. A., & Anderson, M.** (2022). *Animal Physiology* (5th ed.). Oxford University Press.  
*(The gold standard for undergraduate animal physiology; exceptional for comparative respiration, circulation, and MaxEnt/ecological modeling context).*
2. **Moyes, C. D., & Schulte, P. M.** (2016). *Principles of Animal Physiology* (3rd ed.). Pearson.  
*(Highly recommended for cell-signaling pathways, molecular mechanisms of muscle contraction, and evolutionary physiological adaptations).*
3. **Randall, D., Burggren, W., & French, K.** (2002). *Eckert Animal Physiology: Mechanisms and Adaptations* (5th ed.). W. H. Freeman.  
*(A classic comparative physiology textbook with rigorous breakdowns of biophysical transport laws and neurobiology).*
4. **Sherwood, L., Klandorf, H., and Yancey, P. H.** (2013). *Animal Physiology: From Genes to Organisms* (2nd ed.). Cengage Learning.  
*(Excellent for homeostatic regulation, feedback loops, and an accessible approach to organ-system integration).*

## II. Medical & Mammalian Physiology References (Deeper Study)

1. **Boron, W. F., & Boulpaep, E. L.** (2016). *Medical Physiology* (3rd ed.). Elsevier. *(An advanced reference book providing unmatched quantitative descriptions of Wiggers diagrams, fluid hemodynamics, and renal tubule transepithelial transport).*
2. **Hall, J. E., & Hall, M. E.** (2020). *Guyton and Hall Textbook of Medical Physiology* (14th ed.). Elsevier. *(Crucial reference for clear, mechanical explanations of the cardiac cycle, nervous reflexes, and the endocrinology of reproduction and lactation).*
3. **Silverthorn, D. U.** (2018). *Human Physiology: An Integrated Approach* (8th ed.). Pearson. *(Highly praised for its student-friendly conceptual mapping of complex multi-system feedback loops, such as the baroreceptor reflex and the RAAS axis).*

## III. Specialized & Comparative References

1. **Barrett, K. E., Barman, S. M., Brooks, H. L., & Yuan, J. X. J.** (2022). *Ganong's Review of Medical Physiology* (26th ed.). McGraw Hill. *(Perfect for high-yield summaries of neuroendocrine axes, synaptic summation, and acute stress responses).*
2. **Johnson, M. H.** (2018). *Essential Reproduction* (8th ed.). Wiley-Blackwell. *(An excellent, targeted resource for detailing the hypothalamic-pituitary-gonadal clock and the hormonal surges of mammalian estrous and menstrual cycles).*
3. **Withers, P. C.** (1992). *Comparative Animal Physiology*. Saunders College Publishing. *(Though older, it remains the definitive mathematical and physics-based reference for allometric metabolic scaling, Fick's law equations, and complex osmoregulatory strategies across diverse phyla).*

### Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Explain the physical principles of gas exchange, compare respiratory and circulatory adaptations in different animal groups, and analyse the physiological and regulatory mechanisms involved in transport of respiratory gases, cardiac function, and haemostasis.	R,U,Ap,An,E, C	PSO-1, PSO-3
CO-2	Illustrate the mechanisms of nerve impulse transmission, sensory reception, and hormonal regulation, and evaluate the integrated role of the nervous, sensory, and endocrine systems in maintaining physiological homeostasis and coordinating body responses.	R,U,Ap,An,E, C	PSO-1, PSO-4
CO-3	Analyse the ultrastructure, excitation-contraction coupling, and mechanical properties of different muscle types, and explain the neuroendocrine feedback networks regulating animal reproductive cycles, gestation, and lactation.	R,U,Ap,An,E, C	PSO-1, PSO-4

CO-4	Differentiate the nutritional strategies and digestive adaptations across animal groups, and analyse the physiological mechanisms of nutrient absorption, nitrogenous waste excretion, and osmoregulation involved in maintaining internal homeostasis.	R,U,Ap,An,E, C	PSO-1, PSO-3, PSO-4
CO-5	Apply the principles of homeostasis to analyse the neuroendocrine and feedback mechanisms regulating circulation, respiration, energy balance, fluid and electrolyte balance, movement, and reproductive rhythms in animals.	R,U,Ap,An,E, C	PSO-1, PSO-3, PSO-4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

**Name of the Course: Animal Physiology**  
**Credits: 3:0:1 (Lecture: Tutorial: Practical)**

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Explain the physical principles of gas exchange, compare respiratory and circulatory adaptations in different animal groups, and analyse the physiological and regulatory mechanisms involved in transport of respiratory gases, cardiac function, and haemostasis.	PO1, 3, 5, 6, 7/ PSO 1, 3	R,U,Ap, An,E,C	F, C, P	L	P
CO-2	Illustrate the mechanisms of nerve impulse transmission, sensory reception, and hormonal regulation, and evaluate the integrated role of the nervous, sensory, and endocrine systems in maintaining physiological homeostasis and coordinating body responses.	PO1, 3, 5, 6, 7/ PSO-1, 4	R,U,Ap, An,E,C	F, C,P	L	P
CO-3	Analyse the ultrastructure, excitation-contraction coupling, and mechanical properties of different muscle types, and explain the neuroendocrine feedback	PO1, 3, 5, 6, 7/ PSO-1, 4	R,U,Ap, An,E,C	F, C,P	L	P

	networks regulating animal reproductive cycles, gestation, and lactation.					
CO-4	Differentiate the nutritional strategies and digestive adaptations across animal groups, and analyse the physiological mechanisms of nutrient absorption, nitrogenous waste excretion, and osmoregulation involved in maintaining internal homeostasis.	PO1, 3, 5, 6, 7/PSO-1, 3, 4	R,U,Ap,An,E,C	F, C	L	P
CO-5	Apply the principles of homeostasis to analyse the neuroendocrine and feedback mechanisms regulating circulation, respiration, energy balance, fluid and electrolyte balance, movement, and reproductive rhythms in animals.	PO 5, 6, 8/PSO-1, 3, 4	R,U,Ap,An,E,C	F, C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

#### Mapping of COs with PSOs and POs:

	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6	PS O7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	-	1	-	2	-	-	-	1	-	2	-	1	1	1	-
CO 2	-	1	-	2	-	-	-	1	-	2	-	1	1	1	-
CO 3	-	1	-	2	-	-	-	1	-	2	-	1	1	1	-
CO 4	-	1	-	2	-	-	-	1	-	2	-	1	1	1	-
CO 5	-	1	-	-	1	2	-	-	-	-	-	1	2	-	1

#### Correlation Levels:

Level	Correlation
-	Nil
1	Slightly/Low
2	Moderate/Medium
3	Substantial/High

#### Assessment Rubrics:

##### Assignments

1. The impact of gut bacteria on digestion, immunity, and overall health.
2. The Glycemic Index and blood sugar control.
3. The role of artificial intelligence in cardiovascular diagnosis.
4. Mechanisms behind muscle memory and its application to rehabilitation and fitness.
5. The physiology of sleep.

6. Pain management

**Continuous Comprehensive Assessment**

1. Assignments
2. Seminar
3. Submission of report
4. Submission of a field report
5. Test
6. Quiz/Debate

**End Semester Evaluation**

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions
5. Practical Examination

**Mapping of COs to Assessment Rubrics:**

	<b>Internal Exam</b>	<b>Assignment</b>	<b>Project Evaluation</b>	<b>End Semester Examinations</b>
CO 1	✓	-	-	✓
CO 2	✓	-	-	✓
CO 3	✓	✓	-	✓
CO 4	✓	✓	-	✓
CO 5	✓	-	✓	✓